

COVER STORY

Purchasing, installing and operating dental amalgam separators

Practical issues

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Placement and removal of dental amalgam restorations generate amalgam waste particles that can be suctioned into the dental unit vacuum line and discharged into the public sewer system. Chairside traps and vacuum pump filters generally remove 40 to 80 percent of the

amalgam particles from the wastewater stream¹⁻³; however, some amalgam waste particles still enter the sewer system.

In some areas of the United States, wastewater treatment plants are facing increasing pressure from environmental regulators to decrease the concentration of mercury in effluent from their plants or the concentration of mercury in sludge. Consequently, treatment plants are looking to identifiable sources of mercury or mercury-containing waste (such as dental amalgam) to control the amount of mercury discharged into the public waste stream from those sources (in this case, the dental office).

Amalgam separators are devices designed to remove amalgam waste particles in dental office discharge.

Although there is no national regulation requiring the installation of amalgam separators in U.S. dental offices, regional and local requirements exist in some areas. For example, dental offices in Seattle/King County, Wash., are required to either show that the office can limit the total mercury concentration in discharged wastewater to 0.2 parts per million or install an amalgam separator selected from among those recommended by the King County Department of Natural Resources and Parks Industrial Waste Program.⁴ Dental

Before purchasing or installing an amalgam separator, dentists should consider factors specific to the available models, including size and maintenance requirements.

Background. Growing environmental concern over the accumulation of mercury in some fish has led some state and local environmental agencies to pursue stricter regulation of mercury in wastewater.

Dental offices are an identifiable source of mercury in the form of dental amalgam.

Although mercury in dental amalgam is not immediately bioavailable (that is, it has not been shown to contribute significantly to the problem of mercury in fish tissue), environmental agencies in some locales are asking dental offices to install amalgam separators in an effort to reduce amalgam discharges beyond those already achieved through chairside traps and vacuum filters. Field experience indicates that the configuration and operation of the dental office infrastructure can significantly affect the choice of separator, as well as the operation and maintenance of the installed equipment.

Overview. The authors review factors related to office infrastructure and operation that dentists should consider when investing in an amalgam separator. They also provide a cost-analysis worksheet and checklist that may be useful to dentists who are considering purchasing a separator.

Conclusions and Clinical Implications. Before purchasing or installing an amalgam separator, dentists should consider factors specific to the available models, including size and maintenance requirements. In addition, office-specific actors should be considered (such as the plumbing configuration, available space for installation and subsequent access to that space for equipment replacement and maintenance). Dentists also should research whether any local or state regulations exist that might influence product selection or installation. Dentists should consider the effect an amalgam separator could have on existing suction equipment. Finally, dentists will want to consider the short- and long-term costs (including maintenance and parts replacement) of the available options.



offices in Wichita, Kan., also must be equipped with devices to reduce the amount of amalgam being discharged into the public waste stream.⁵ In Minnesota and Washington state, the dental associations have encouraged offices to voluntarily install amalgam separators.^{6,7}

A variety of amalgam separators are available (Table 1). In some areas that require installation of amalgam separators, dentists must choose a separator from a list of models; in other localities with such regulations, dentists can select any model provided that it meets certain performance criteria—such as those established by the International Organization for Standardization, or ISO.⁸ If a practitioner decides to install a separator, he or she may wish to consult with the local wastewater treatment facility before purchasing one to determine whether there are any limitations regarding the model being considered.

Amalgam is a solid intermetallic compound, quite different from elemental, cationic and organic mercury. Amalgam separators typically are not equipped to handle elemental or non-amalgam forms of mercury. Amalgam particles in dental office wastewater can range in size from colloidal particles (smaller than 0.45 micrometers) to those larger than 3 millimeters.^{1,9} To remove these various-sized particles from waste discharge, amalgam separator units can use several separation techniques, alone or in combination: sedimentation, filtration, centrifugation or ion exchange.

TYPES OF AMALGAM SEPARATORS

Sedimentation-based separator units have baffles or tanks that reduce the speed of the wastewater flow, allowing amalgam particles to settle out of the waste. Filtration units also can remove amalgam particles, in addition to colloidal particles and dissolved mercury, depending on the types of filters used. Centrifuge-based separator units spin wastewater, relying on centrifugal force to draw the amalgam particles to the sides of the unit. Ion-exchange systems take advantage of the tendencies of certain chemicals to bind with dissolved mercury in the dental water stream, causing the minute amalgam particles to separate from the solution and rest at the bottom of the separator. Amalgam separators that use ion exchange are well-suited for use in municipalities that have specific concentration limits on mercury-containing discharge into the waste stream, because they can remove very small amalgam and cationic mercury particles more readily than can

sedimentation models. Separators that use ion exchange also do not rely totally on physical settling of particles, which is better for an in-line system handling peak flows.

Many models use sedimentation, which collects amalgam particles that settle out from the wastewater. Because of the high specific gravity of amalgam, sedimentation removes a considerable amount of amalgam in wastewater. Simple sedimentation can remove about 90 percent of amalgam particles from a water sample in a matter of several hours.¹⁰ Some amalgam separators use sedimentation followed by filtration and ion exchange, with the aim of removing smaller amalgam particles not removed by sedimentation as well as dissolved mercury particles (for example, cationic mercury).

Designs are incorporated into some amalgam separators that allow for longer sedimentation time. Draining of the wastewater collected in the amalgam separator can be achieved by suction, electrical pumps or gravity drainage. A laboratory evaluation¹¹ of 12 commercially available amalgam separators that used various separation techniques documented more than 95 percent efficiency for amalgam removal, a performance level that exceeds the ISO's requirement for this equipment.⁸

When selecting the correct separator for their offices, dentists should consider the following:

- space and utility requirements;
- dental office/building constraints;
- regulatory considerations;
- ease of maintenance and replacement;
- effect on other equipment;
- cost.

We discuss these issues in relation to the purchase, installation and operation of dental amalgam separators. To help summarize and simplify this process, we have provided a checklist (Box 1, "Amalgam Separator Buyer's Checklist," page 1059) that dentists can use as they review systems. We recommend that this checklist be completed, and the key specifications be reviewed for different units being considered during the purchase process.

SPACE AND UTILITY REQUIREMENTS

The size of an amalgam separator is a major consideration when deciding which unit to purchase or lease. The models on the market range in size from approximately 3 inches in diameter (occupying a 9-square-inch area) to 48 × 24 inches

TABLE 1

AMALGAM SEPARATOR MODELS BY TECHNOLOGY.							
BRAND NAME AND MANUFACTURER	COST			SIZE IN INCHES (DEPTH × WIDTH × HEIGHT)	INSTALLATION SITE	EFFICIENCY† (CERTIFICATION‡)	MAINTENANCE
	Purchase or Lease Price*	Replacement Parts	Recycling Included				
Sedimentation							
Guardian Amalgam Collector models Air Techniques 1-800-AIRTECH www.airtechniques.com	Dry vacuum A1100 (with non-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): \$3,255	Replacement kit: \$750	Yes	6.25 × 10.5 × 7.5	In-line at outlet of air/water separator (requires air/water separator); drains by gravity	> 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.theamalgam collector.com	CH9 or CH12: \$495; CE15 or CE18: \$695; CE24: \$1,250	Not applicable (canister replacement optional)	No	CH9: 6 × 6 × 9 CH12: 6 × 6 × 12 CE15: 6 × 6 × 15 CE18: 6 × 6 × 18 CE24: 8 × 8 × 24	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	8.5 × 8.5 × 20.5	In-line; AC power supply needed to pump settled effluent	98.3%–99.6% (ISO 11143–certified)	Replace separator annually

* Manufacturer’s suggested retail price as of 2003.
 † According to manufacturer.
 ‡ International Organization for Standardization Specification 11143 requires 95 percent removal.⁸

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TABLE 1

AMALGAM SEPARATOR MODELS BY TECHNOLOGY (CONTINUED).							
BRAND NAME AND MANUFACTURER	COST			SIZE IN INCHES (DEPTH × WIDTH × HEIGHT)	INSTALLATION SITE	EFFICIENCY† (CERTIFICATION‡)	MAINTENANCE
	Purchase or Lease Price*	Replacement Parts	Recycling Included				
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	8.7 × 8.7 × 13.8	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.com	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: 8 × 22 × 23.5 REB 5000: 6 × 9.5 × 6.5 REB 7000: 6 × 20 × 6.5 REB 9000: 10 × 26 × 24	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	5.5 × 5.5 × 16	In-line	95% - 99% (ISO 11143–certified)	Replace filter every three to eight months depending on workload
MSS models Maximum Separation Systems 1-800-799-7147 www.amalgamseparators.com	MSS Model 1000 (≤ 11 chairs): \$968; MSS Model 2000 (12-22 chairs) includes two settling tanks: \$1,395	Settling tank: \$165; tank recycling fee: \$185	No	1000: 15 × 18.5 × 24 2000: 15 × 18 × 28	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)
§ Canadian program.							

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(1,152 square inches). Heights of units vary from 9 to 36 inches.

Installation locations. The performance of amalgam separators relies, in part, on correct installation within the dental office’s existing wastewater and vacuum system. There are gener-

ally three distinct installation locations for units: directly within the vacuum system piping (or “in-line”) at or near individual operatory chairs; in-line at a central location upstream of the vacuum pump; or at the outlet side of the air/water separator.

TABLE 1

AMALGAM SEPARATOR MODELS BY TECHNOLOGY (CONTINUED).							
BRAND NAME AND MANUFACTURER	COST			SIZE IN INCHES (DEPTH × WIDTH × HEIGHT)	INSTALLATION SITE	EFFICIENCY† (CERTIFICATION‡)	MAINTENANCE
	Purchase or Lease Price*	Replacement Parts	Recycling Included				
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	12 × 12 × 21	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
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: 10 × 13 × 29 Hg10: 48 × 24 × 48	Hg5: in-line; Hg10: after vacuum and sewer drain AC power supply needed	Hg5: > 98% (King County [Washington] Industrial Waste Program–approved); Hg10: < 0.2 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 1-800-947-7550	\$1,295	Replacement unit installation and disposal: \$495	Yes	13 × 7 × 8	Chairside or in-line	> 95% (ISO 11143–certified; King County [Washington] Industrial Waste Program–approved)	Replace unit annually
MRU models Dental Recycling North America 1-800-360-1001 www.drna.com	MRU 10c; MRU 100v	Costs included in lease fee	No	10c: 12 × 16 × 24 100v: 12 × 16 × 24	In-line In-line	> 95% (ISO 11143–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.amalgamseparation.com	890-1000: \$1,190; 890-6000: \$666	Canister: \$596	No	890-1000: 12.75 × 10.25 × 28.5 890-6000: 12.25 × 9.0 × 5.12	In-line	> 95% (ISO 11143–certified; King County [Washington] Industrial Waste Program–approved)	Replace canister every 18 months depending on workload

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

BOX 1

AMALGAM SEPARATOR BUYER'S CHECKLIST.	
FACTOR	COMMENTS
Office Considerations	
Operatories (number of chairs)	Offices with four or more chairs should consider central, not chair-side, units
Number of amalgam restorations placed or removed per day Office operations (number of days per week)	Offices that perform more than 40 amalgam-related activities per week* may need a unit with a large storage capacity
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 [‡]	Evaluate 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
<p>* Source: Kidd K, Cameron M, Peters J. Recommendations for controlling mercury and dental wastes. Tufts University Graduate Program Capstone Study conducted for Massachusetts Water Resources Authority, 1998.</p> <p>† See figure, page 1060, for typical installation locations.</p> <p>‡ See Table 2, page 1064.</p>	

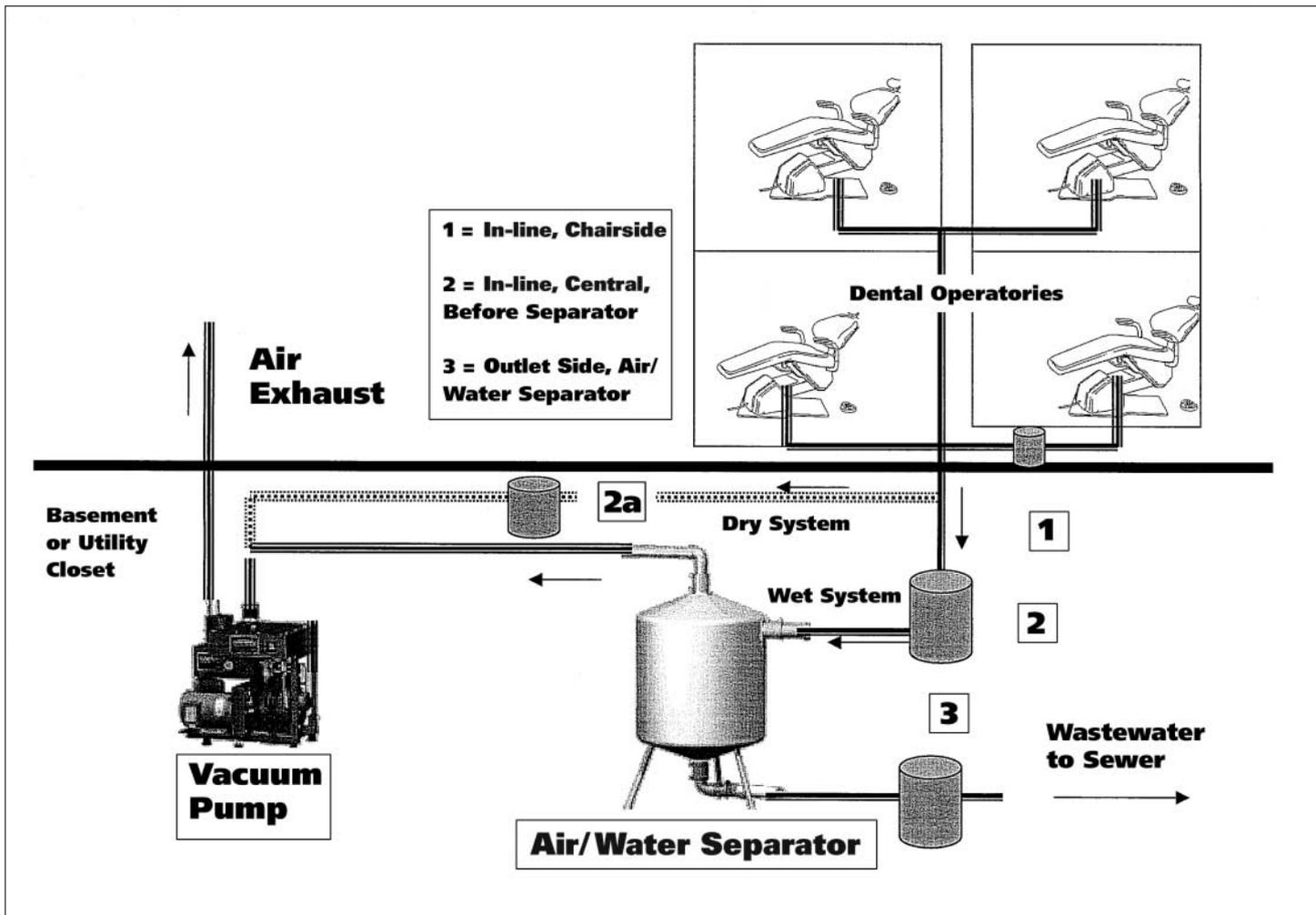


Figure. Amalgam separator installation locations.

Most systems are designed to be installed in-line between the dental operatories and the vacuum pump. An evaluation of amalgam separators installed in dental offices showed that amalgam waste particles were collected adequately in amalgam separators located in the system after the chairside trap or vacuum-pump filter traps.¹² The figure illustrates the typical recommended locations for installation of the various systems listed in Table 1.

Many separators rely on gravity or the vacuum system to operate and, therefore, do not require an electrical power source. However, some units do require electrical power connections for the control panel or to operate pumps that remove the settled effluent from the separator unit and discharge it into the sewer. Typically, these pumps are designed to operate at the end of the day or overnight, when the vacuum system is turned off.

DENTAL OFFICE/BUILDING CONSTRAINTS

In addition to the size of the unit, a number of factors can affect placement and installation of amalgam separators, including the following:

- building configuration;
- available installation space;
- access to centralized plumbing lines;
- office space leasing agreements.

Building configuration. Building configuration primarily refers to the existing plumbing setup in the dental office. For example, if the office is centrally plumbed, with all of the plumbing systems draining into one pipe, the dentist may need to modify the plumbing so that only drainage from amalgam-generating sources runs through the separator. Additional water flows (for example, from cuspidors, sinks and operatories used exclusively for hygiene appointments) can adversely affect performance of sepa-

rators. All sources that generate amalgam wastes should be identified and, when feasible, plumbed separately to the separator.

Installation space. Many dental offices face space limitations, particularly those that do not have access to a basement. Before investing in a separator, dentists should determine whether they will be installing the separator in the basement or inside the office. Many dental offices install vacuum systems and air/water separators at the basement level to conserve office space. In these cases, installation of a separator usually is easier, because there is sufficient space upstream of the vacuum system to collect flow. Systems that are gravity fed require sufficient collection space for the daily flow to be properly discharged into the drain without backing up.

Installation can be more complicated in offices without basements. Often, these offices install vacuum systems in utility closets or cabinets, which limits the available space upstream for the amalgam separator. In some cases, space limitations may require the use of chairside amalgam separators in individual operatories.

Access to plumbing lines. It is important to ensure that the dental office staff has suitable access to the separator to inspect and maintain it. Dental practices that share plumbing or vacuum systems—as is often the case in multiunit office buildings—will need to coordinate maintenance activities so that they do not interfere with work schedules. Such coordination is particularly important if vacuum systems must be turned off for maintenance activities, or if basement or closet access must be provided.

Offices in large, multistory buildings also will likely face plumbing access issues because flows typically will be connected with larger building risers that may or may not be easily accessed. Practices in such buildings may need to consider chairside systems or systems that install upstream of the vacuum pump, depending on space availability.

Office-space leasing agreements. Lease restrictions also can affect decisions regarding amalgam separator installation. Dentists who lease office space should review the terms of their lease to determine whether they can make any electrical or plumbing connections under the existing agreement. Many commercial lease agreements contain language that restricts the tenant's ability to modify the building infrastructure.

In addition, dentists who lease their offices, as well as those who have space in a multiunit building, may wish to consult with their lawyer to minimize liability should a pipe break or waste release occur at or near a separator that they have installed.

REGULATORY ISSUES

Regulatory requirements associated with amalgam separators can vary widely depending on office location. While environmental or public health/safety permits typically are not required for installation of amalgam separators, dentists should be aware of the potential for other regulatory issues.

Waste disposal. Mercury and silver that might be present in amalgam wastes can be recovered through a distillation process and reused in new products. The ADA strongly recommends recycling as a best management practice for dental offices.¹³

Many amalgam separator manufacturers offer recycling programs as part of their service, which allows spent or full cartridges/separators to be shipped to recycling facilities for a service fee or as part of a lease. Offices should check with vendors to find out whether this service is available in their states and whether there are any storage requirements.

Dental offices should be aware that as the waste generator, they are responsible for ensuring proper disposal of amalgam waste—whether they have contracted with a vendor-sponsored program or have arranged for a recycler independently. Offices should ask for, and separator vendors or recyclers should be willing to provide, appropriate documentation to demonstrate that they are working with reputable waste handlers (Box 2, “Questions to Ask Your Amalgam Recycler”).

Plumbing code requirements. Dentists should investigate state and municipal plumbing code requirements before selecting and installing a separator system. In Massachusetts, for example, systems installed upstream of the vacuum system are classified as part of the dental facility equipment and are exempt from facility plumbing code requirements. However, systems that are installed downstream of the vacuum system and discharge directly into the sewer system are subject to plumbing board requirements, and require a permit and installation by a licensed plumber. Most states and cities have dif-

BOX 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, or EPA, 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?

* Source: American Dental Association.¹³

† Since the generator of the waste is responsible for proper disposal, dentists should obtain replies to these questions in writing from their recyclers.

‡ Amalgam waste can be classified as “contact” and “noncontact” or “scrap.” As suggested, contact refers to amalgam that has been in contact with the patient (removed restorations, carving scraps). Noncontact (or scrap) amalgam is excess mix left over at the end of a dental procedure.

ferent requirements, and offices should check with vendors and their local plumbing inspector to ensure that they meet local ordinance requirements.

Local wastewater treatment plant approved equipment lists. As noted above, some wastewater treatment facilities maintain lists of “approved” amalgam separators and vendors. These lists may be issued as a regulatory requirement (for example, as an amendment to local sewer ordinances) or as guidance included in “best management practices” programs. Dental offices should check with local officials to determine whether any specific requirements exist in their area. Dental offices also should ask how often they need to renew approval or certification for installed units.

Separators that incorporate advanced treatment of amalgam-containing waste (for example, chemical binding/ion exchange) may be necessary if the local utility or regulatory body has adopted stringent mercury-reduction requirements.

EASE OF MAINTENANCE AND REPLACEMENT

The maintenance requirements and schedules for amalgam separators vary widely and should be considered before buying. Smaller practices, with fewer support staff members, may choose to pur-

chase a system that provides longer maintenance intervals and fewer inspection requirements.

Operations and maintenance manuals. Before purchasing a separator, dentists should ask vendors about maintenance requirements and request copies of system manuals to compare features and manufacturers’ recommendations. Sales brochures may not provide sufficient details about maintenance requirements; as a result, the operations and maintenance manuals are an important resource for accurately determining maintenance needs. Vendors also should be willing to provide a reference list with contact information for similar dental offices that have installed their separator; direct experience in operating a system is valuable information

for the prospective buyer.

Recommended treatment schedule. In particular, offices may want to ask vendors about the recommended treatment schedule and procedure to limit biological growth within the system, which can impair equipment performance. Some vendors recommend the use of a sterilant solution once per week (added chairside) to control such growth. Others recommend a daily treatment with nonfoaming cleaning solutions. The amount of cleaner used and frequency of use generally will be determined by the length of the vacuum system lines and the amount of biological materials introduced into the system. In any circumstance, dentists should not use bleach or other corrosive solutions to clean out lines, because they may remobilize bound mercury within the lines, which would be released into the waste stream and thereby reduce the effectiveness of separator units.

Table 1 (page 1056) provides a summary of the recommended maintenance and inspection intervals for various units. In general, the in-line systems require more frequent inspection and maintenance to prevent blockages. For example, some models require a series of initial inspections to calibrate the system to the amount of wastewater and associated solids (such as amalgam, tissue, cement debris, pastes) flowing through the sepa-

rator. In addition, some units may require a daily check of the system thereafter to determine when the fluid in the unit needs to be decanted and the outlet tube height adjusted for proper operation. Other systems, however, require only annual maintenance.

In addition to clarifying the maintenance schedule, dentists should talk to the vendor about the potential effect on the practice should the separator break down. Dentists should ask questions that will help them determine what type of postinstallation servicing the vendor will offer. Dentists also might ask about the typical response time for removing or replacing a system in the event of clogging or failure. In addition, they may ask whether canister or tank replacement needs to be performed by a vendor technician.

As part of their efforts to obtain maintenance information, dentists should determine whether there are any special material handling instructions from the vendor or state or local amalgam waste handling regulations. In addition, dentists should request that the vendor supply a list of recommended cleaners for use with their specific amalgam separator.

EFFECT ON SUCTION EQUIPMENT

Dental offices need to understand how specific separator units may affect their existing vacuum systems.

Existing vacuum systems. Units installed upstream of vacuum systems must be carefully installed to prevent loss of suction. The most common reasons for reduced vacuum suction include improper fittings, excessive hose bends or angles, or long hose runs (4 to 6 feet, depending on the model) added to existing vacuum pump piping. Vacuum systems are designed to provide a preset level of suction (expressed in inches of mercury), and a typical unit is installed at a vacuum level of 7 to 10 inches of mercury.

After installing the separator, the installer should test the vacuum system performance under typical conditions (for example, multiple operatories and their associated evacuators in use), as well as under closed conditions (that is, when no evacuators are in use within the operatories) to ensure that suction has not been compromised. In general, a noticeable loss in vacuum power indicates a potential installation problem.

Clogs in the line also can degrade vacuum performance. Systems that are designed to be

installed directly in the vacuum line potentially are prone to clogging because of nonamalgam materials being carried in-line to the vacuum system filters. Offices that are centrally plumbed have systems that are more prone to clogs owing to the flow of amalgam and nonamalgam wastes (such as prophy pastes, tooth or gum tissue, or cements), than are offices in which the plumbing has numerous bends in the piping.

As noted above, these offices may need to replumb as part of the installation process. If plumbing reconfiguration is not an option, these practices could conduct more frequent inspection and maintenance of separator equipment to maintain sufficient vacuum pressures (and should be sure to factor this increased labor into costs). Dentists in centrally plumbed offices also could look more closely at systems that are installed at the discharge side of air/water separators. These systems are designed to be drained and settled when the vacuum system is turned off.

Finally, dental offices should review the warranty information for their vacuum systems, and contact their vendors to determine whether installation of a separator within the vacuum system could void the equipment warranty. Some manufacturers may not honor warranties on their equipment if parts of the system are modified by third parties. For dentists' own protection, they should obtain all warranty-related information in writing.

COST

As with the purchase of any equipment, cost clearly is a key issue when choosing an amalgam separator. True side-by-side comparisons of system costs are difficult because numerous pricing and leasing programs exist. For example, some vendors offer purchase plans for just the system, while others provide lease-based systems that include replacement of filter cartridges or ion-exchange cartridges and recycling of amalgam waste. We have developed a system that dentists can use to estimate the life-cycle cost of purchasing or leasing and maintaining an amalgam separator (Table 2). Essentially, any approach used to compare the cost of separators should analyze upfront and ongoing expenses, including the following:

- purchase price;
- installation fees;
- cost of replacement parts and accessories;
- cost of replacement tanks or cartridges;

TABLE 2

CALCULATING LIFE-CYCLE COST OF AMALGAM SEPARATORS.*						
EQUIPMENT VARIABLE	COST (\$)					
	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Purchased Equipment						
Purchase price	1,000	—†	—	—	—	1,000
Installation‡	150	—	—	—	—	150
Tank, cartridge replacement§	—	50	50	50	50	200
Inspection¶	23	24	24	24	24	119
Maintenance#	3	6	6	6	6	27
Recycling preparation**	3	3	3	3	3	15
Recycler fees††	50	50	50	50	50	250
TOTAL	1,229	133	133	133	133	1,761
Leased Equipment						
Annual lease fee	500	500	500	500	500	2,500
Installation‡	150	—†	—	—	—	150
Tank, cartridge replacement§	—	—	—	—	—	—
Inspection¶	23	24	24	24	24	119
Maintenance#	3	6	6	6	6	27
Recycling preparation**	3	3	3	3	3	15
Recycler fees††	—	—	—	—	—	—
TOTAL	679	533	533	533	533	2,811
<p>* Life-cycle costing, as the name suggests, estimates how much a piece of equipment will cost from the time it is purchased until it is replaced. The authors based the sample calculations on a life expectancy of five years. This calculation considers initial purchasing price, cost of replacement parts, labor cost associated with maintenance and inspection, and so forth. The sample worksheet illustrates both separator purchase and leasing scenarios in present-day U.S. dollar values.</p> <p>† Dash indicates “not applicable.”</p> <p>‡ Requiring plumber/electrician services for three hours at \$50/hour.</p> <p>§ Annual cartridge replacement (in the case of leases, included in lease price).</p> <p>¶ Five-minute inspections twice a month by dental assistant at a salary of \$12/hour.</p> <p># Two 15-minute maintenance sessions a year by dental assistant at a salary of \$12/hour.</p> <p>** Preparing recycling once a year (about 15 minutes by dental assistant at a salary of \$12/hour).</p> <p>†† Some manufacturers bundle recycling costs into purchase price.</p>						

— office maintenance costs (labor).

When evaluating costs, buyers often overlook the cost of replacement parts. Dentists should be sure to ask about these, as well as request an estimated replacement schedule. For many systems, replacement cartridges can be up to 20 to 25 percent of the initial unit price. In addition, one should recognize that the frequency of replacement and, therefore, the cost of parts and maintenance will depend, in part, on each practice’s patient load and the number of amalgam

restorations that are placed or removed. Although the manufacturer can estimate these figures, dentists need to consider factors specific to their own practices to more accurately predict the cost of a system.

Practitioners should assign a cost to the hours that will be required to monitor and maintain the separator. For example, determine which staff member will be responsible for cleaning the trap and performing any maintenance of the unit, estimate the number of hours per week or month he

or she will invest in maintenance and recycling activities, and multiply this number by the staff member's hourly wage.

In addition, dentists need to keep in mind that some of the current maintenance costs (including labor) could change as a result of installing a separator. For example, if a separator is installed within the piping system ahead of the existing vacuum pump filters in the dental office's system, practitioners may be able to slightly reduce the estimated maintenance cost of pump filter changes, because fewer may be needed with this setup.

CONCLUSION

This article has highlighted the questions that a dental office should review before contacting amalgam separator vendors, and that will guide discussions with them. The bottom line is that one size does not fit all, and office configurations and operations can significantly affect the selection and installation of an amalgam separator. ■

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