VERMONT DENTAL AMALGAM SEPARATOR PILOT PROJECT

Field Testing Observations of Six Models and Practical Considerations in Choosing an Amalgam Separator

VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
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Bio-Sym Medical (Merc II)
Pure Water Development (ECO II)
Rebec (Catch 1000)
SolmeteX (Hg5)

EXECUTIVE SUMMARY

The Vermont Department of Environmental Conservation (DEC) field-tested six commercially available dental amalgam separators over a six to eight month period in 2003 – 2004 in Vermont dental practices. The DEC contacted several vendors and manufacturers of amalgam separators who provided one to six units each and covered the cost of installation at volunteer dental clinics. The objective of the study was to gather first-hand information and experience with the installation and operational issues regarding amalgam separators over the course of the pilot. This information would then be shared with the Vermont dental community to familiarize them with the technologies to remove amalgam and its associated mercury and other heavy metals from the wastewater discharges. Field observations are reported for each of the amalgam separators including ease of installation, space and utility requirements, maintenance requirements, effects on suction systems, and performance issues.

The pilot demonstrated that there are several commercially available amalgam separators that can reliably perform with minimal maintenance. In general, these separators did not interfere with vacuum or suction when properly installed, maintained, and operated. The report includes a list of considerations and recommendations on choosing an amalgam separator, product specifications, descriptions of the amalgam separators in the pilot, and unit cost information.

BACKGROUND

Dental offices have been identified as a source of mercury to municipal wastewater treatment plants and septic systems through placement and removal of dental amalgam. Dental amalgam is formed when mercury reacts with an alloy of silver, tin, and copper. Mercury makes up about 45-50 percent of dental amalgam. Municipal wastewater sludge containing mercury are sometimes incinerated, releasing elemental mercury to the air, and eventually settling on land and water. Municipal sludge can also be applied directly to agricultural lands, or disposed of in solid waste landfills, where the potential exists for release of mercury to air, water and soil. Some of this “environmental” mercury accumulates in the aquatic food chain, along with other sources of mercury, such as mercury released from the burning of fossil fuels, like coal. Vermont and most other states have issued fish consumption advisories, alerting the public to limit their consumption of certain fish due to high mercury levels.

Mercury-containing amalgam particles are suctioned through dental vacuum lines where the larger particles are removed to some extent by chairside traps and vacuum filters. These devices can remove anywhere from 40 to 80% of the amalgam particles by weight. Amalgam separator units, a newer technology that has recently entered the marketplace, can remove 95-99% or more of the amalgam from dental wastewater. Some states and municipalities around the country have mandatory requirements for installation of amalgam separators. Maine, New Hampshire, Connecticut, and Massachusetts have recently enacted regulatory requirements for amalgam separators. Although there is currently no requirement for the installation of amalgam separators in Vermont, some dentists are beginning to install them.

Vermont’s Advisory Committee on Mercury Pollution (ACMP) was established by the Vermont Legislature in 1998 to seek methods to reduce mercury releases and risks to Vermonters and annually reports its findings and recommendations to the Legislature. In December 2002, a subcommittee of the ACMP was formed to evaluate the feasibility of dental amalgam separators as a technology to reduce mercury releases by dental clinics in Vermont. The subcommittee members consisted of the Vermont Department of Environmental Conservation (DEC), Vermont State Dental Society(VSDS), Mercury Policy Project of Montpelier, Vermont, and the National Wildlife Federation office in Montpelier. The ACMP directed the amalgam separator subcommittee to develop a pilot project to field test amalgam separators in dental clinics to gain first hand knowledge of installation and operational issues that could be shared with the dental community. No evaluation or testing of amalgam removal efficiency of the separators was considered in this study due to the cost and measurement challenges. This study gathered first hand information on installation and operational issues of six commercially available separators over a period of six to eight months. We believe that the results of this study answer the questions posed by the Advisory Committee and can serve as a useful guide to dental offices in choosing an amalgam separator.

AMALGAM SEPARATOR TECHNOLOGY OVERVIEW

Evacuation systems in existing dental practices typically contain either one or two components that are capable of removing solids such as amalgam particles from wastewater - chairside traps and vacuum pump filters. Chairside traps are commonly used in both wet and dry vacuum systems. They remove particles down to approximately 0.7 mm. In addition to chairside traps, systems with a wet vacuum pump typically have a filter located just upstream of the pump that is designed to protect the pump from large solids. Vacuum pump filters have pore sizes of either 0.84 mm (20 mesh screen) or 0.42 mm (40 mesh screen). Chairside traps and vacuum pump filters successfully remove anywhere from 40 – 80% of the total mass of amalgam particles from dental office wastewater, leaving 20 – 60% to be discharged to sewers and septic systems.

Amalgam separators are designed to remove amalgam particles that are too small to be captured by chairside traps and vacuum filters. In 1999, the International Organization for Standardization (ISO) developed a standard for dental amalgam separators (ISO 11143) that included a laboratory test method for determining the amalgam removal efficiency of amalgam separators. The standard also established a minimum amalgam removal efficiency of 95%. Manufacturers who want their amalgam separators ISO certified must have their equipment tested using the ISO 11143 testing method and meet all of the requirements of ISO 11143, including an amalgam removal efficiency of at least 95%. Certification is a step beyond simply performing the ISO 11143 removal efficiency test procedure. For an amalgam separator to be ISO 11143 "certified", a certification body must issue a certificate to the manufacturer confirming that the separator passed all of the requirements of ISO 11143. The certificate and the associated procedures serve as certification, which puts into place an ongoing quality control system between the certification body and the separator manufacturer. Most regulatory bodies requiring the use of amalgam separators require that they be ISO 11143 certified.

Most amalgam separators are compatible with both wet and dry vacuum systems and are installed in the vacuum system between the operatories and the vacuum system discharge to the sewer. The location of the amalgam separator in the vacuum system depends primarily upon two things: 1) on whether the system has a wet or a dry vacuum pump, and 2) on the brand or type of amalgam separator being installed (see Figure 1). In offices with dry vacuum systems, the amalgam separator is installed either in the suction line just upstream of the air/water separator or in the air/water separator discharge line to the sewer. Amalgam separators installed in clinics with wet vacuum pumps are installed either at the inlet to the vacuum pump just upstream of the vacuum filter or at the vacuum pump discharge line to the sewer. In some cases, the existing equipment will not only dictate the installation location of the separator, but may also determine how the separator itself is configured. For example, two of the separators in the pilot can be purchased with or without an air/water separator depending on whether or not there is an existing one that can be utilized. All of these variables emphasize the need to consult with vendors and suppliers of both dental vacuum systems and amalgam separators prior to making a purchase.

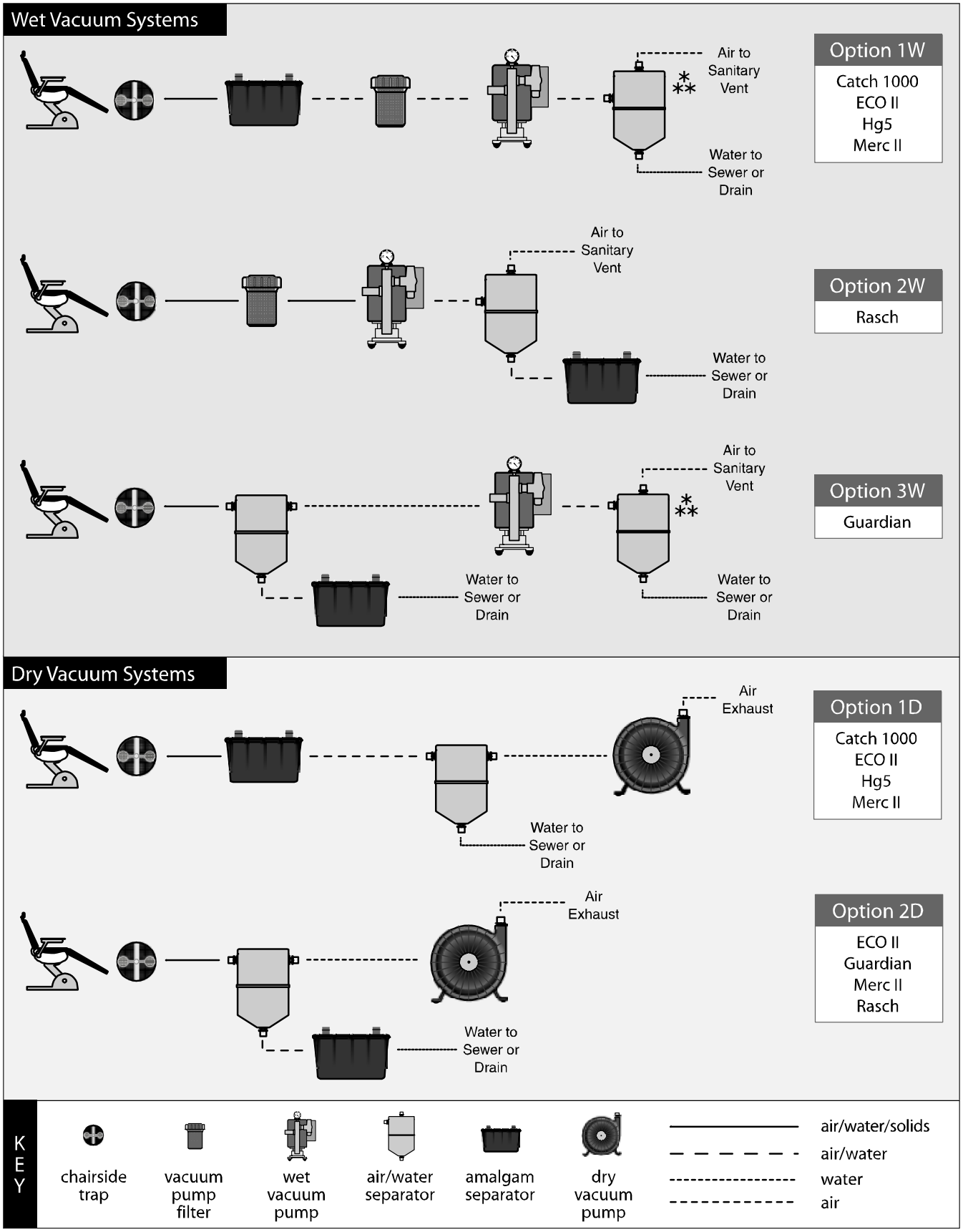
Amalgam separators remove amalgam by employing one or more of three technologies: sedimentation, filtration, and/or ion exchange. All of the amalgam separators in the Vermont pilot used sedimentation either alone or in conjunction with filtration and/or ion exchange. In separators incorporating sedimentation technology, the wastewater is directed through a collector box or cartridge that typically includes a series of chambers, baffles or other means to slow the flow through the box, allowing the relatively dense amalgam particles to settle. Mechanical filtration is added in some units to help remove additional smaller particles that may have made their way past the sedimentation stage. Mechanical filtration consists of some type of fine screen or porous material that blocks the passage of very small particles. Some units include a third stage, ion exchange, that is capable of removing dissolved mercury from the wastewater. In the ion exchange process, dissolved mercury is adsorbed onto the surface of a resin or other material. Ion exchange is the only one of the three technologies capable of removing the dissolved fraction of mercury from dental wastewater. However, the ISO 11143 test procedure does not evaluate a separator's removal of dissolved mercury, only amalgam solids.

Many of the amalgam separators in the pilot incorporate some type of bypass to allow continued operation of the vacuum system in the event there is a problem with the collector box or cartridge. However, while the unit is bypassing there may be little or no treatment of the wastewater occurring. In some amalgam separators, bypass is more difficult to detect than others and can go unnoticed for extended periods of time.

PILOT PROJECT DESCRIPTION

DEC staff contacted several vendors and distributors of amalgam separators who provided 1-5 units each and paid for installation costs at 18 Vermont dental clinics. The Vermont State Dental Society contacted members and identified participants. DEC arranged with one plumbing firm to do most of the installations. Three of the installations were performed by the manufacturer's own technician (Air Techniques Guardian Amalgam Collector). In two instances, local plumbers were used for the installations. Table 1 lists the amalgam separators in the pilot along with a description of the unit features and characteristics. The amalgam removal efficiencies reported in Table 1 were provided by the amalgam separator manufacturers and were determined through laboratory testing under controlled conditions. The actual removal efficiencies of amalgam separators installed in dental clinics may differ.

DEC staff worked with the plumber to match the amalgam separator equipment being provided by the manufacturers with existing conditions at the participating dental clinics and DEC was present for most of the installations. Factors that were considered in matching the separators with dental offices included: space considerations, elevation of building sewer connection relative to vacuum pump, access to building sanitary system vent, and vacuum system type and configuration. Each amalgam separator was observed over a period of six months or more. Several visits were made to each site and observations were made on the following criteria: ease of installation, space and utility requirements, integrity of unit construction, sludge accumulation and frequency of cartridge/canister replacement, ease of cartridge/canister replacement, effect of the unit on the suction in the clinic, and problems with the separator clogging. The line cleaning practices and type of line cleaners used were noted. The number of operatories and hygiene chairs was noted and the use of special techniques such as air abrasion.



** Optional air/water separator installation location.

Figure 1. Optional Amalgam Separator Installation Locations for Separators in the Pilot

Table 1 – Amalgam Separators Evaluated in the Vermont Pilot Project

Amalgam Separator Name/Model # Manufacturer/Distributor	Removal Technology	Physical Dimensions	Installation Location	Maximum Capacity	Removal Efficiency[1]	Tested Flow Rate[1]	Suggested Collector/ Cartridge Replacement	Recycling/Disposal Program	Cost	Unit Availability
Economy System Type 2/(ECO II) Manufacturer: Metasys Medizintechnik Innsbruck, Austria www.metasys.com Distributor: Pure Water Development, LLC. Miami, FL (877) 638-2797 or (305) 663-2989 www.ecotwo.com pwdmetasys@aol.com 	Sedimentation	Diameter: 8.7" Height: 13.8"	Chairside or single central location upstream of the vacuum pump.	6 - 8 chairs	96.7%	2 liters/min	Manufacturer suggests annual replacement.	Yes. Supplier is contacted at year-end for the replacement unit and the recycling kit, which includes shipping of the filled unit to Pure Water Development. Pure Water ships the separators to Dental Eco Service in Innsbruck, Austria for recycling. The dentist will receive a recycling certificate from Pure Water Development.	ECO II Amalgam Separator Intro Kit (which includes recycling of the initial unit when full): $650 Replacement unit: $160 Annual recycling renewal: $128 Line Cleaning Kit (Green & Clean M2): $102 (optional)	Available directly from Pure Water Development or through authorized dealers including: Tri-State Dental Supplies Island Dental Supplies Net32.com
Guardian Amalgam Collector/A1000 Manufacturer/Distributor: Air Techniques, Inc. Hicksville, NY (800) AIR-TECH or (516) 433-7676 www.airtechniques.com 	Sedimentation	Collector box and an 8 gallon separator tank (for wet systems without air/water separators) Height: 48" Width: 14" Depth: 14"	Single central location between dental suction system separator/collection tank and building sewer drain. The amalgam collection container and separation tank must be located so that the system will drain by gravity.	7 chairs	99.3%	2.5 liters/min	Manufacturer provides the following replacement guidelines: ▪ 1-3 dentists, 9-12 months ▪ 4-7 dentists, 6-8 months ▪ 7 or more dentists, 6 months or less	Yes. Every amalgam collector package includes all materials (including packing material and a prepaid FedEx shipping label) to send the full collector to Bethlehem Apparatus for recycling. The dentist will receive a recycling certificate from Bethlehem Apparatus.	The Guardian comes in three different configurations: A1400 [PILOT UNIT] for use with any dual pump wet vacuum system (includes required 8 gallon air/water separation/ collection tank): $3,255 (includes two collector boxes) A1100 for use with any existing dry vacuum systems: $1,500 (includes two collector boxes) A1300 for use with any single pump wet vacuum system (includes required 4 gallon air/water separation/ collection tank): $3,100 (includes two collector boxes) After initial purchase, collector replacement kit: $750 (includes shipping and recycling of collector being replaced)	Available through Air Techniques authorized dealers including: Barton Cyker Benco Dental Patterson Dental Sullivan-Schein
Hg5 Manufacturer/Distributor: SolmeteX Northborough, MA (800) 216-5505 or (508) 393-5115 www.solmetex.com 	Sedimentation Filtration Ion Exchange	Height: 29" Width: 14" Depth: 8"	Single central location just upstream of the vacuum pump.	10 chairs	99.8% 97.4%	0.050 liters/min 0.750 liters/min	Manufacturer suggests one to six months, depending on the number of dentists and the type of practice.	Yes. Replacement cartridges come in a reusable box with all materials necessary for return shipment of full cartridge to Mercury Waste Solutions (recycling company). The dentist will receive a recycling certificate from Mercury Waste Solutions.	Hg 5 [PILOT UNIT] initial purchase cost: $695 Replacement cartridge: $250 (includes shipping and recycling of cartridge being replaced) Hg5 HV for larger practices (includes two cartridges) initial purchase cost: $2,500 Hg10/Hg 20 for very large systems such as institutional/ governmental practices initial purchase cost: $7,450	Available directly from SolmeteX or through authorized dealers including: Patterson Dental Sullivan-Schein

Amalgam Separator Name/Model # Manufacturer/Distributor	Removal Technology	Physical Dimensions	Installation Location	Maximum Capacity	Removal Efficiency[1]	Tested Flow Rate[1]	Suggested Collector/ Cartridge Replacement	Disposal/Recycling Program	Cost	Unit Availability
Merc II Manufacturer/Distributor: Bio-Sym Medical (800) 947-7550 	Sedimentation Filtration Ion Exchange	Length: 13" Width: 7" Height: 8"	Single central location just upstream of the vacuum pump.	8 chairs	95.2%	2 liters/min	Annual replacement.	Yes. Bio-Sym or an authorized dealer contacts the clinic prior to the annual changeout to arrange for replacement. The filled collector is shipped to GFM Precious Metals in Edmonton, Alberta for recycling. The dentist will receive a recycling certificate from GFM Precious Metals.	The initial purchase cost: $895 Replacement collector cost: $595 (includes shipping and recycling of the collector being replaced)	The Merc II is currently available directly through Bio-Sym Medical. Dealers handling the Merc II in Vermont will be announced in the future.
Rasch 890 Manufacturer/Distributor: AB Dental Trends, Inc. Lyden, WA (800) 817-6704 www.amalgamseparation.com roger@amalgamseparation.com 	Sedimentation Filtration Ion Exchange	Width: 10.25" Depth: 12.75" Height: 28.5"	Single central location between dental suction system discharge and the building sewer drain. The amalgam collection container and separation tank must be located so that the system will drain by gravity.	12 chairs	99.3% 96.7%	2 liters/min 4 liters/min	Collection canister requires replacement after 18 doctor-months.	Yes. The installation date is marked on the collector box when installed. The dental office must monitor the amount of time the collector is in operation and contact AB Dental or one of their distributors for a replacement according to the recommended changeout schedule. The filled collector box is returned to AB Dental for recycling by Precious Waste Recovery Ltd. of London, England. A certificate of disposal will be issued to the clinic for their records.	The Rasch 890 can be purchased in a number of configurations depending on the existing vacuum system in place: Rasch 890-1000 [PILOT UNIT] for use with existing wet vacuum systems without air/water separators: $1,190 (includes wall/floor mount rack, air/water separator, and one collection canister) Rasch 890-6000 for use with dry vacuum systems: $666 (includes one collection canister and connection kit) Rasch 890-2000 replacement canister kit: $596 (includes shipping and recycling of canister being replaced)	AB Dental Trends has made their systems available through local dental dealers including: Benco Dental Patterson Dental Sullivan Schein
RME2000 Series Catch 1000 Manufacturer/Distributor: Rebec, LLC. Lynnwood, WA (800) 569-1088 www.rebecsolutions.com contact@rebecsolutions.com 	Sedimentation Filtration	Width: 20" Depth: 7.5" Height: 23.5"	Single central location just upstream of the vacuum pump.	8 - 10 chairs	96.9%	1 liter/min	Annual replacement.	Yes. Rebec tracks the installation date of each collector and contacts the local dental dealer about 1 month before change out is required to arrange for the shipment of the new collector. Once the changeout is made, the used collector is prepared for shipment and Rebec is called to have it picked up. Once received, Rebec issues a certificate of disposal to the clinic for their records. The clinic can choose to have the mercury recycled by Mercury Waste Solutions or disposed by Chemical Waste Management at a licensed hazardous waste disposal facility.	Rebec has a number of units in various sizes: Catch 1000 [PILOT UNIT] initial purchase cost: $1,895 Catch 400 initial purchase cost: $985 (this is a smaller unit than the Catch 1000 installed in the pilot, capacity 1-4 chairs) Catch 9000 initial purchase cost: $3295 (capacity up to 30 chairs) Replacement collector cost: $395 (includes shipping and recycling of collector being replaced)	Rebec has made their systems available through local dental dealers including: Patterson Dental Sullivan Schein

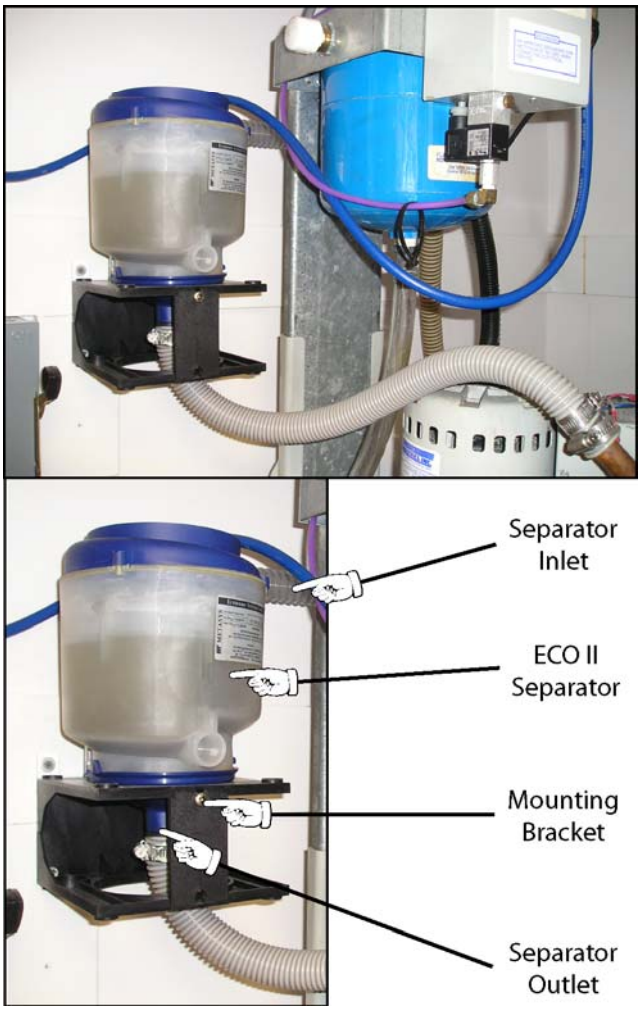
[1] The information provided for tested flow rates and removal efficiencies were provided by the amalgam separator manufacturers.

Information provided on dimensions, capacity, flow rate, removal efficiency, and collector/cartridge replacement applies to the models installed in the pilot. Where multiple models are listed in the cost column of the table, the model installed in the pilot is identified with [PILOT UNIT]. The information was provided by the amalgam separator manufacturers.

Information accurate as of 8/2004.

PILOT INSTALLATIONS/OBSERVATIONS

Amalgam Separator: ECO II
Manufacturer: Metasys Medizintechnik
Pilot Installations: 3
Removal Technology: Sedimentation



Operational Description: The ECO II is an amalgam separator and a collection tank in a single unit. The air/water/solids mixture enters the unit through the inlet in the lid at the top. The amalgam particles are separated from the wastewater by sedimentation. Very fine particles are separated out in a second sedimentation step and the air/water leaves the unit through an opening at the bottom. The housing of the ECO II is constructed of a transparent plastic, allowing the solids accumulation level to be monitored. The housing is marked with lines indicating the 95% and 100% full levels. The ECO II is ISO 11143 certified and has a removal efficiency of 96.7% at a tested flow rate of 2 L/min.

Maintenance: The ECO II does not require any routine maintenance. However, the manufacturer recommends daily suction line cleaning using their line cleaner/disinfectant, Green & Clean™ or other enzymatic, non-foaming, pH neutral cleaner. Daily line cleaning will ensure the unit remains transparent to allow monitoring of the solids accumulation level. The manufacturer requires that the ECO II be replaced at least annually. The actual fill time will vary depending on the activity level in the dental practice. In the event the unit becomes overfilled, vacuum to the operatories may not be affected but the wastewater containing amalgam particles will pass through the unit untreated and be discharged to the sewer. Because the unit is both the separator and collection tank, the entire unit is removed and replaced when full. Removal is simple: disconnect the upper hose and pour the provided disinfectant into the inlet. Seal the inlet with the provided plug. Disconnect the lower hose and seal with the provided plug. Remove the entire unit from its mounting bracket and ship to the mercury recycler using the shipping materials provided in the recycling kit.

Pilot Installations: Three ECO II amalgam separators were installed and observed in the pilot.

Pilot Installation Sites	Wet/Dry Vacuum	Operatory/Hygiene Chairs	Notes
Location 1	Wet	6/3	Air abrasion performed
Location 2	Wet	2/0	Endodontist
Location 3	Wet	3/1	

Pilot Observations:

- No loss of suction observed.
- The small size of the unit allows for installation where space is limited.
- Monitoring of the level of accumulated solids was easily accomplished through the unit's transparent housing.
- The ECO II unit installed in Location 1 filled in less than six months (vendor claims annual changeout). Suspect frequent use of air abrasion to be the cause of the premature filling.
- The unit that filled during the pilot was replaced. Changeout was simple and performed in less than ten minutes.

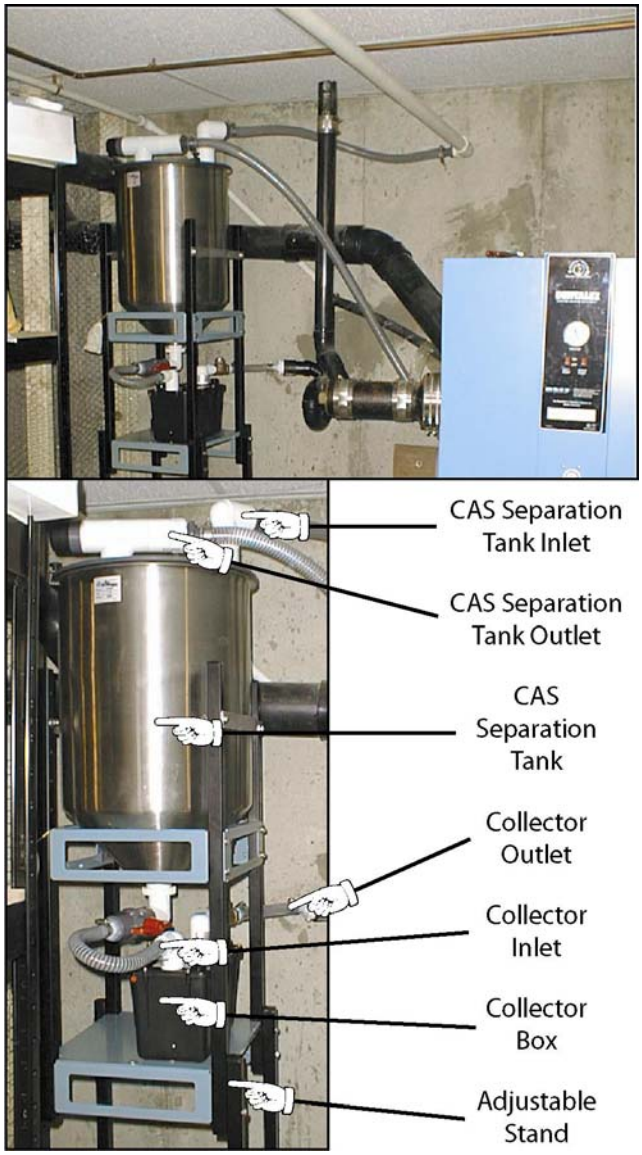
Possible Areas for Improvement:

Inlet and outlet fittings are not standard plumbing fittings which may complicate installation. It would be helpful if the separator included a couple of short lengths of flexible hose that were sized to fit not only the fittings which connect to the inlet and outlet ports of the separator but also to standard plumbing fittings (i.e. ¾" or 1" barbed fittings). *Note: Subsequent to the installation of the ECO II units installed in the pilot, the manufacturer changed the fittings on the unit to better fit standard 1 inch hose.*

Although none of the installed units leaked during the course of the pilot, the manner in which the hoses are connected to the unit is not very secure. Each of the two fittings has an o-ring on it to seal the connection and the fitting is simply pushed into the housing with the o-ring essentially holding it in place. Other units that rely on similar means of connection include set screws on the fittings to prevent accidental disconnection. DEC would recommend adding set screws to the fittings or, as has been suggested by St. Paul Minnesota's Metropolitan Council Environmental Services, that unions be used to connect the unit to the plumbing. This would provide a more secure connection and would also allow the separator to be connected using standard plumbing fittings.

It might be helpful to include a small funnel to facilitate pouring the disinfectant into the filled collector. One of the other units in the pilot that requires the addition of a disinfectant to the collector prior to packaging for shipment includes a funnel with the replacement collector. *Note: The manufacturer stated that they are currently looking into changing the design of the disinfectant pouch to facilitate pouring the disinfectant into the unit.*

Amalgam Separator: Guardian Amalgam Collector/A1400
Manufacturer: Air Techniques
Pilot Installations: 3
Removal Technology: Sedimentation



Operational Description: The Guardian Amalgam Collector A1400 is designed for installation in wet vacuum systems and consists of a solids collector box (the initial purchase cost also includes a second, spare collector box) and an eight gallon air/water separation tank (CAS Separation Tank). The Guardian is also available in a configuration for dry vacuum systems. The A1400 is installed just upstream of the vacuum pump. The air/water/solids from the operatories enters the CAS Separation Tank where the air is separated from the water/solids. The air passes through the separation tank and continues to the vacuum pump, while the water and solids accumulate in the separation tank. At the end of each day (or when the vacuum system is shut down) a check valve opens allowing the water/solids in the separation tank to flow into the Guardian Amalgam Collector. The solids are separated from the water by sedimentation and remain in the collector box and the water flows to drain by gravity. The units installed in the pilot included an adjustable stand so that the collector box could be set at the proper height to allow for gravity drain to the sewer connection. The Guardian is ISO 11143 certified and has a removal efficiency of 99.3% at a tested flow rate of 2.5 L/min.

Maintenance: The Guardian Amalgam Collector does not require any daily maintenance, however, daily line cleaning is recommended using a non-foaming line cleaner such as their CleanStream™ product. If the system includes the CAS Separation Tank, annual maintenance of the tank is required. This involves hosing out the inside of the tank to remove any biological growth that may have accumulated inside the tank. The manufacturer requires that the collector box be replaced at least annually. The actual fill time will vary depending on the activity level in the dental practice. The A1400 is designed to prevent the discharge of amalgam to the sewer and does not include an automatic bypass of the collector box. If the collector were to fill or clog, liquid would accumulate in the CAS Separation Tank until it reached a point where a float inside the tank would cause vacuum to the operatories to be interrupted. This would alert dental office staff to check the system. Initially, this may only require that the collector box be rocked from end to end to settle the solids enough to allow the tank to drain and then the vacuum system can resume operation. However, this is an indication that the collector box is nearly full and will need to be replaced shortly thereafter. The manufacturer suggests the following guidelines for changeout of the collector box:

1-3 dentists	9-12 months
4-7 dentists	6-8 months
7 or more dentists	6 months or less

Replacement of the collector box is simple and can be performed without interrupting vacuum to the operatories. Close the valve on the CAS Separation Tank, then pull the inlet and outlet fittings off the collector box. Pour some disinfectant into the collector box, seal the inlet and outlet with the plugs provided in the collector replacement kit. The replacement kit also includes all the materials necessary to package and ship the collector box to the mercury recycler, Bethlehem Apparatus, who will in turn send the dentist a recycling certificate.

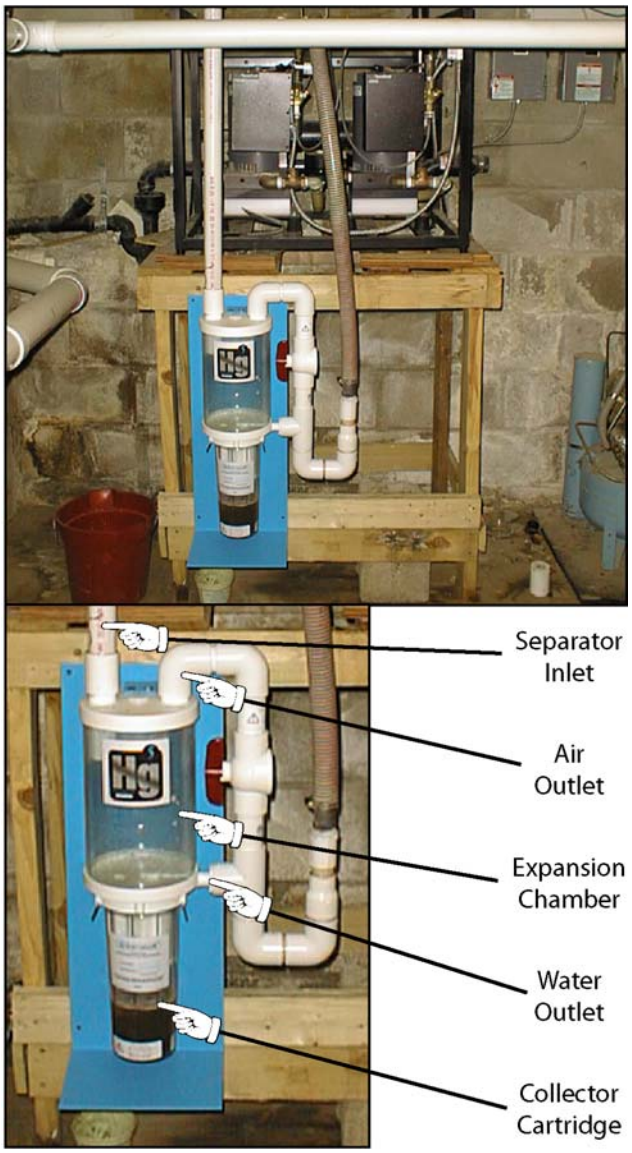
Pilot Installations: Three Guardian Amalgam Collector A1400 amalgam separators were installed and observed in the pilot.

Pilot Installation Sites	Wet/Dry Vacuum	Operatory/Hygiene Chairs
Location 1	Wet	3/1
Location 2	Wet	4/2
Location 3	Wet	8/4

Pilot Observations:

- No loss of suction observed.
- Product installation, replacement and recycling instructions are very thorough.
- Eliminates the need for a vacuum pump filter in wet vacuum systems because only air from the operatories passes through the vacuum pump, resulting in cost saving associated with the purchase and disposal of vacuum filters.
- Collector box changeout is simple and can be performed without interrupting vacuum to the operatories.
- None of the collector boxes filled during the course of the pilot.

Amalgam Separator: Hg5
Manufacturer: SolmeteX
Pilot Installations: 6
Removal Technology: Sedimentation/Filtration/Ion Exchange



Operational Description: The Hg5 consists of an air/water expansion chamber and a replaceable solids collection cartridge. Air, water and solids enter an air/water expansion chamber where their velocity is reduced allowing the water and solids to fall to the lower part of the chamber. The air exits the top of the chamber and is returned to its initial velocity. The water and solids drop into the collection cartridge where the larger particles settle. As the water level rises in the collection cartridge, it flows through a mechanical filter pack which provides additional filtration of the wastewater. The water that passes through the filter then passes through a proprietary resin for chemical filtration of dissolved mercury. The water is then recombined with the air stream and proceeds to either the vacuum pump (wet system) or to the air/water separation tank (dry system). The Hg5 is ISO 11143 certified and has a removal efficiency of 99.28% at a tested flow rate of 0.050 L/min and 97.4% at a tested flow rate of 0.750 L/min.

Maintenance: The Hg5 does not require any daily maintenance. Periodic flushing of the air/water expansion chamber may be required to remove any accumulated sludge. The manufacturer recommends daily line cleaning using a non-foaming, de-odorizing, sanitizing line cleaner with a pH between 4 and 10. The use of line cleaners outside this pH range may cause clogging of the cartridge's filter. (Note: Most sewer use ordinances in Vermont prohibit the discharge of solutions with a pH lower than 5.0 or greater than 9.5.) If the cartridge were to overfill or clog, the design of the Hg5 would allow the vacuum system to continue operating but wastewater would be bypassing the amalgam collector cartridge. Maintenance primarily involves monitoring the solids accumulation level and changing the collector cartridge. The manufacturer requires that the Hg5's collector cartridge be replaced every six months or when the accumulated solids reach the fill line, whichever occurs first. The manufacturer sends reminder cards every six months to ensure each dental clinic is reminded to inspect their system. Replacement of the cartridge is relatively simple: begin by sanitizing the vacuum system. With the vacuum system still running, place the zip lock bag (included with the replacement cartridge) over the cartridge to catch any liquid that may drip from the air/water expansion chamber. Support the cartridge with one hand and remove the retaining pins. Pull the cartridge down to remove it from the expansion chamber. Remove the plastic caps from the replacement cartridge, place them on the inlet and outlet fittings of the used cartridge, and close the zip lock bag. Place the used cartridge in the shipping box for shipment to the mercury recycler.

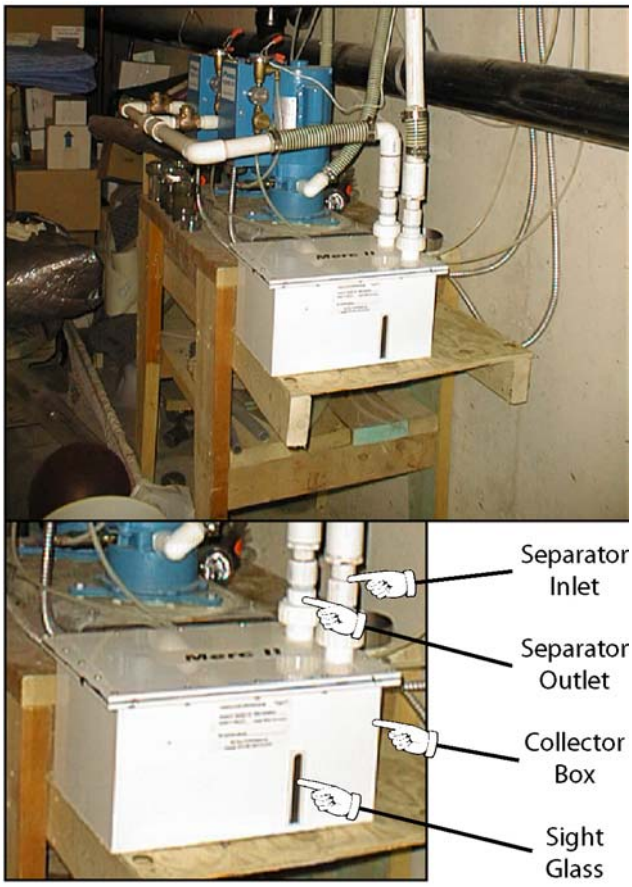
Pilot Installations: Six Solmetex Hg5 amalgam separators were installed and observed in the pilot.

Pilot Installation Sites	Wet/Dry Vacuum	Operatory/Hygiene Chairs	Notes
Location 1	Wet	5/2	
Location 2	Dry	3/1	
Location 3	Wet	3/2	
Location 4	Wet	6/2	
Location 5	Wet	5/2	Air abrasion used
Location 6	Dry	4/2	

Pilot Observations:

- No loss of suction observed.
- Installation is simple and fast.
- Product installation, replacement and recycling instructions are very thorough.
- Monitoring of the level of accumulated solids was easily accomplished through the collector cartridge's transparent housing.
- Collector cartridge changeout is simple.
- None of the collector cartridges filled during the course of the pilot. As expected, the collector cartridge at Location 5 filled most rapidly due to the practice's use of air abrasion.
- There was some liquid and solids build up in the air/water expansion chamber in some units during the pilot. Information on the manufacturer's website indicates this might be related to plugging of the filter in the cartridge due to the use of line cleaners with a pH outside the separator manufacturer's recommended range.
- The unit installed at Location 2 developed a crack at the collector cartridge outlet resulting in small amount of leakage. The manufacturer supplied a replacement unit; no cause for the breakage was determined. *Note: The manufacturer has stated that some materials used in the construction of the pilot units have since been changed to address this issue.*

Amalgam Separator: Merc II
Manufacturer: Bio-Sym Medical
Pilot Installations: 1
Removal Technology: Sedimentation/Filtration/Ion Exchange



Operational Description: The Merc II amalgam separator consists of a solids collector box that contains mechanical filtration and an ion exchange resin. The separator can be installed just upstream of the vacuum pump (wet system) just upstream of the air/water separation tank (dry system) or between the air/water separation tank discharge and the sewer drain (dry system). The Merc II amalgam separator is a three-stage system that uses sedimentation, filtration and ion exchange. Wastewater enters the collector box through the inlet port and passes through a series of chambers where the solids are settled. The wastewater then passes through a filter that removes smaller particles. Before exiting through the outlet port, the wastewater passes through an ion exchange resin that, according to the manufacturer, is capable of removing dissolved mercury. The Merc II is ISO 11143 certified and has a removal efficiency of 95.2% at a tested flow rate of 2 L/min.

Maintenance: The Merc II does not require any daily maintenance, however, the manufacturer recommends daily suction line cleaning. Maintenance primarily involves changing the collector box when full. The manufacturer suggests annual replacement of the collector box. The actual fill time will vary depending on the level of activity in the dental practice. Although the Merc II installed for the pilot did not include a built-in bypass, the separator inlet and outlet fittings have since been changed to allow them to be removed from the collector box and connected together to allow for a bypass should the collector become plugged. Replacement of the collector box is simple: with the vacuum system turned off, disconnect the unions on the inlet and outlet ports of the collector box. Replace the halves of the unions which remain connected to the vacuum system plumbing with those provided with the replacement collector box. Screw the threaded plugs, also provided with the replacement box, into the open ends of the inlet and outlet port unions of the full collector box. The collector box is then shipped to a recycler.

Pilot Installations: One Merc II amalgam separator was installed and observed in the pilot.

Pilot Installation Sites	Wet/Dry Vacuum	Operatory/Hygiene Chairs
Location 1	Wet	4/2

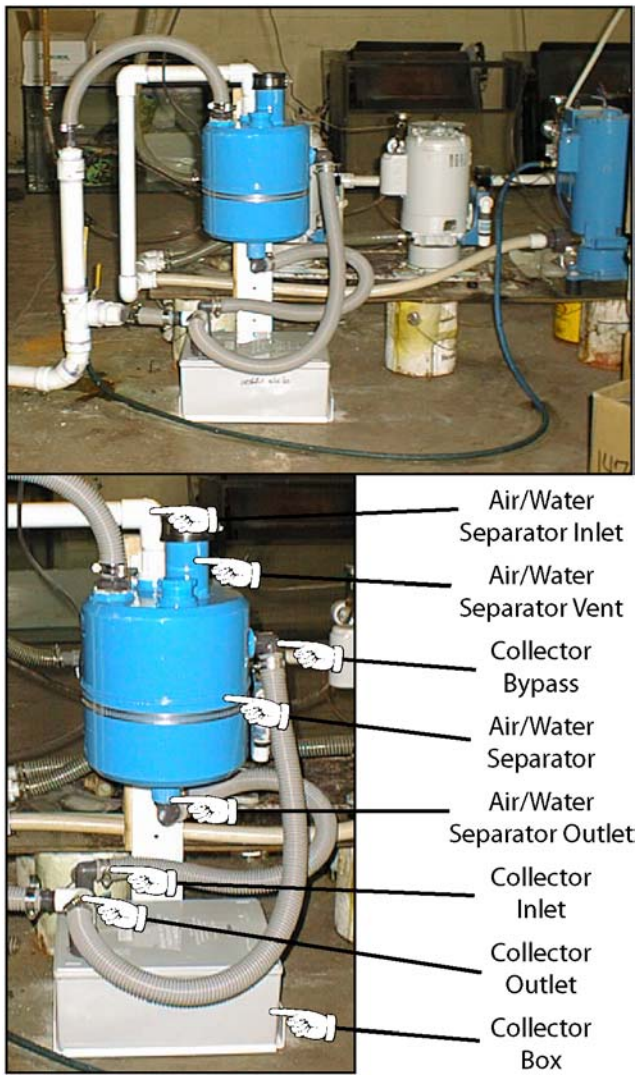
Pilot Observations:

- Loss of suction occurred after approximately six months of use. All that was required to restore suction was to shake the collector box to level the solids accumulating in the first chamber of the box.
- Although the collector box contains a clear sight glass, a film developed on the glass that made monitoring the level of accumulated solids impossible. This may have been caused by inadequate line cleaning practices at this location.
- Collector box changeout is simple.

Possible Areas for Improvement:

Merc II documentation should be more detailed. Although the pilot installation was very simple, it would be helpful if the installation/operation manual included installation instructions containing diagrams or photographs showing how the unit should be installed in various wet and dry vacuum systems. Also, since the unit has been redesigned to allow for bypass in the event of a problem with the collector, the installation/operation manual should also include instructions showing how to reconfigure the connections to the collector to allow for bypass. This should include diagrams or photographs for clarity. Replacement collectors should include specific instructions for the changeout, packaging and shipping of full collectors. Again, diagrams or photographs should be used in collector changeout and packaging instructions where appropriate for clarity.

Amalgam Separator: Rasch 890
Manufacturer: AB Dental Trends
Pilot Installations: 3
Removal Technology: Sedimentation/Filtration/Ion Exchange



Operational Description: The Rasch 890 amalgam separator can be purchased in a number of configurations tailored to the vacuum system in which it is to be installed. The Rasch 890-1000 is used in wet vacuum systems and consists of a solids collector box and an air/water separator. The Rasch 890-1000 is unique among the amalgam separators included in the pilot in that it is installed on the discharge side of the wet vacuum pump rather than on the suction side. The Rasch 890-6000 is used in dry vacuum systems and consists of a solids collector box and a by-pass loop. The unit is installed between the existing air/water separation tank and the sewer drain. Both of the Rasch units can be purchased with an optional bypass alarm to notify staff when wastewater is bypassing treatment. The Rasch amalgam separator is a three-stage system that combines sedimentation, filtration and ion exchange in a single collector box. Wastewater enters the collector box through the inlet port and passes through a series of chambers where the solids are settled. The wastewater then passes through a filter that removes smaller particles. Before exiting through the outlet port, the wastewater passes through an ion exchange matrix that, according to the manufacturer, is capable of removing dissolved mercury. The Rasch 890 is ISO 11143 certified and has a removal efficiency of 99.3% at 2 L/min tested flow rate and 96.7% at a tested flow rate of 4 L/min.

Maintenance: The Rasch 890 does not require any daily maintenance, however, the manufacturer recommends that suction lines be cleaned daily according to the pump manufacturer's requirements. The manufacturer recommends replacement of the collector box approximately every 18 doctor-months. The actual fill time will vary depending on the level of activity in the dental practice. In the event the collector box fills or clogs, the unit incorporates an automatic bypass. Vacuum to the operatories will not be interrupted but wastewater would be bypassing the amalgam collector box. Replacement of the collector box is simple: with the vacuum system turned off, tilt the box in the direction of the outlet port to drain off any remaining water. Loosen the inlet and outlet retaining screws and pull the fittings from the box. Pour the disinfectant (provided with the replacement box) into the inlet and outlet ports and seal the openings with the caps provided. Package and ship the collector box to the mercury recycler using the shipping materials provided. The dentist will receive a recycling certificate from the mercury recycler.

Pilot Installations: Three Rasch 890 amalgam separators were installed and observed in the pilot.

Pilot Installation Sites	Wet/Dry Vacuum	Operatory/Hygiene Chairs	Notes
Location 1	Wet	5/2	
Location 2	Wet	3	Installed 2 collector boxes in parallel due to flow rate
Location 3	Dry	16	Installed 2 collector boxes in parallel due to flow rate

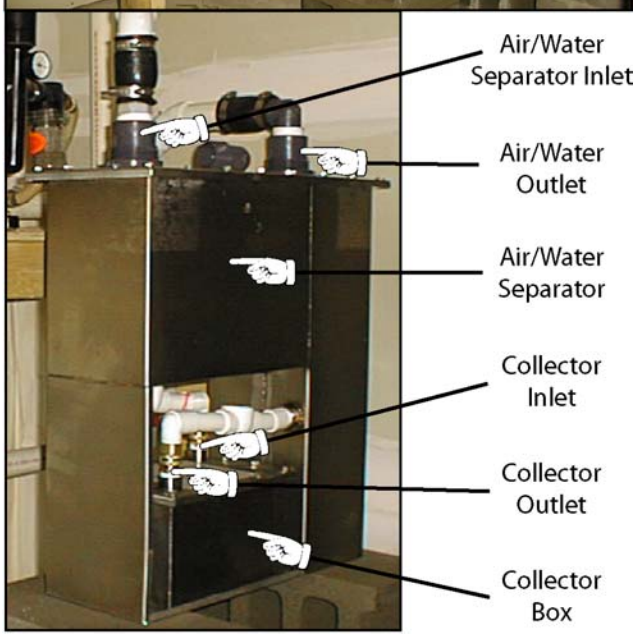
Pilot Observations:

- No loss of suction observed.
- Product installation, replacement and recycling instructions are very thorough.
- No collector boxes filled during the course of the pilot.
- Opacity of collector box doesn't allow monitoring of solids accumulation level.
- Collector box changeout is simple.
- In wet vacuum systems, the Rasch 890-1000 is installed on discharge side of a wet vacuum pump. All of the other amalgam separators in the pilot are installed on the suction side of a wet vacuum pump. Installation on the discharge side requires that the collector box be located so that it can drain by gravity into the building's sewer connection.
- The installation at Location 2 required the addition of a second collector box installed in parallel with the first box to split the flow. The practice at this location has a two-pump wet system without water recirculation and both pumps are always operating. The combined flow from these two pumps exceeded the maximum flow rate of the single collector box. Due to the size of the practice at Location 3, the initial installation included two collector boxes to ensure that there was sufficient capacity to handle flow from the air/water separation tank when the system was shut down.
- An optional audible bypass alarm is available for both Rasch units to alert staff when wastewater is bypassing treatment.

Possible Areas for Improvement:

The changeout of the collector box requires that the two set screws be backed out. An allen wrench should be included with the unit or, preferably, the set screws should be changed to a knurled thumb screw type that can be removed by hand.

Amalgam Separator: RME2000 Series/Catch 1000
Manufacturer: Rebec
Pilot Installations: 2
Removal Technology: Sedimentation/Filtration



Operational Description: The Catch 1000 amalgam separator consists of an air/water separation chamber and a solids collector box. Air and water from the operatories enter the upper chamber. The water/solids fall to the bottom and flow through the collector box where the solids are removed by sedimentation and mechanical filtration. The treated water then rejoins the airflow from the operatories and proceeds to the vacuum pump. The Catch 1000 is ISO 11143 certified and has a removal efficiency of 96.9% at a tested flow rate of 1 L/min.

Maintenance: The Catch 1000 does not require any daily maintenance, however, the manufacturer recommends the use of an enzymatic line cleaner and that suction lines be cleaned according to the vacuum pump manufacturer's requirements. The manufacturer recommends annual replacement of the collector box. The actual fill time will vary depending on the level of activity in the dental practice. In the event the collector box fills or clogs, the unit incorporates an automatic bypass so that vacuum to the operatories will not be interrupted. Replacement of the collector box is simple and can be performed without interrupting vacuum to the operatories. Close the two valves between the air/water separation chamber and the collector box. Loosen and remove the outlet fitting then open the inlet valve slightly for a moment to remove some of the liquid that might otherwise spill. Disconnect the inlet fitting and remove the full collector box. Seal the full collector box using the brass caps that come with the replacement box. Package the collector box for shipment to the mercury recycler and contact Rebec to arrange for pickup.

Pilot Installations: Two RME2000 amalgam separators were installed and observed in the pilot.

Pilot Installation Sites	Wet/Dry Vacuum	Operatory/Hygiene Chairs	Notes
Location 1	Wet	4/2	
Location 2	Dry	10/4	Separator serving 2 offices

Pilot Observations:

- Fast, simple installation.
- No loss of suction observed.
- Product installation, replacement and recycling instructions are very thorough.
- Durable stainless steel construction.
- No collector boxes filled during the course of the pilot.
- Stainless steel collector box does not allow monitoring of solids accumulation level.
- Collector box changeout is simple and can be performed without interrupting vacuum to the operatories.
- Includes shut off valves on inlet and outlet of collector box to prevent leakage during changeout.

CHOOSING AN AMALGAM SEPARATOR – CONSIDERATIONS AND RECOMMENDATIONS

The pilot project demonstrated that there are several types or brands of amalgam separators that can reliably perform with minimal maintenance. In general, these separators did not interfere with vacuum or suction when properly operated and maintained. The following considerations should help you in deciding which separator or separators are right for your office.

- **ISO Compliance** Choose an amalgam separator that is ISO 11143 certified. Separators that are ISO certified must pass all ISO 11143 requirements including removal of at least 95% of amalgam particles from the discharge.

- **Wet and Dry Vacuum Systems** All amalgam separators tested were compatible with wet and dry vacuum systems. In some situations, amalgam separators can be purchased without an air/water separator if you have a dry vacuum system with an existing air/water separator. This can reduce the purchase cost of the separator. When comparing costs between brands, be sure you are comparing the costs for each unit based on your vacuum system type and existing components.

- **Maintenance Cost Considerations** Aside from purchase and installation costs, the main cost of an amalgam separator will be the replacement and recycling of amalgam collector boxes or cartridges. In general, these will need to be replaced once or twice per year. Some vendors may require regular changeout of cartridges or collector boxes, even when they are not full. Check on this with the vendor or your dealer. We suggest that when comparing costs, consider the total cost for purchase and operating over a three-year period. This will give you a more accurate picture of long-term costs. You can ask the vendor or dealer to help you with this calculation. See Table 2 for estimated 3-year system costs for amalgam separators in the pilot.

- **Servicing the Separator** We recommend that you purchase a separator that has a convenient replacement/recycling program for the cartridges/collector boxes. Some separators reported on in this project are not serviced or carried by dental suppliers in Vermont at this time. You need to know what maintenance and/or servicing you or your dental supplier will be responsible for.

- **Space Considerations** If you have a small amount of space available near your vacuum system and discharge lines, then you should choose one of the smaller separators.

- **Need for Access to Electrical Power** None of the separators in this pilot required electrical hookup. However, there are some separators that have pumps that require an electrical source. This can add to installation cost and maintenance.

- **Number of Chairs in Office** Table 1 shows the capacity (in number of chairs and flow rate) for the separators in the pilot. Make sure you choose a separator that can handle your current and future capacity. Separators installed either on the discharge line of an air/water separation tank in a dry vacuum system or on the discharge side of a wet vacuum system require units with higher flow rates.

- **Understand Collector Replacement Schedule** All vendors/manufacturers of separators may require replacement at a specified interval – whether or not the collection canister is full. You should understand the replacement schedule that will apply to you. Dental clinics using air abrasion will accumulate solids at a much faster rate and may require replacement sooner.

- **Cleaning of Suction Lines** Regular line cleaning with proper line cleaning solutions is extremely important to the proper functioning of all separators. The use of enzymatic and neutral pH line cleaners is recommended; line cleaners with a pH greater than 9.5 or lower than 5.0 should be avoided. Check with the separator vendor or your dealer for recommendations.

- **Warranty of Vacuum System** Check the terms of the vacuum system warranty to insure that installation or operation of the separator does not void warranty provisions.

- **Installation Considerations** If you purchase a separator from a dental supply company, they may install the unit. Otherwise you may need to contact a local plumber. Installation takes generally ½ hour to 2 hours.

- **Large Systems** Large centralized systems serving multiple offices will often require custom designed separators. In these cases, it is recommended that the dental office work closely with a dental supplier and/or a vendor and carefully evaluate the options that are available for larger clinics.

- **Amalgam Recycling/Disposal Documentation** Confirm that you will receive documentation through the amalgam separator vendor/manufacturer that your amalgam waste has been recycled or disposed of at a facility licensed to handle mercury-containing wastes. You should keep these records on file.

- **Treatment Bypass** Many amalgam separators incorporate some type of bypass to allow continued operation of the vacuum system in the event there is a problem with the collector box or cartridge. During bypass, wastewater may be discharged with little or no treatment. In some units bypass is harder to detect than others and may go unnoticed for extended periods of time. When purchasing a separator be sure to understand how bypass occurs in that particular unit, how a bypass is detected and how to return the unit to normal operation as quickly as possible.

- **Other Good Review Articles** For further reading on amalgam separators, we recommend the following articles that can be obtained on-line: *Purchasing, Installing and Operating Dental Amalgam Separators*, JADA, August 2003 and *Re:Amalgam Recovery* available from the Minnesota Dental Association at www.mndental.org, click on *"dental professionals"*. In the future, the ADA will be conducting further review of amalgam separators as technologies change and evolve.

- **See an Installed Amalgam Separator** In choosing a separator, consider contacting or visiting one or more dental clinics with installed separators. Contact the DEC Environmental Assistance Office (EAO) at (800) 974-9559 or your dental supplier for available installation sites.

- **Assistance Available** Staff of the Vermont Department of Environmental Conservation, Environmental Assistance Office are available to provide assistance to dental offices in evaluating amalgam separator options. For more information, contact the Environmental Assistance Office at (800) 974-9559.

Table 2 - Cost Comparison of Amalgam Separators in a Small Practice (4 Operatories, 2 Hygiene Chairs and 1 Dentist) Over a Three-Year Period[1].

Amalgam Separator	Vacuum System Type	Initial Capital Cost	Collector/Cartridge Replacement and Recycling Costs 3-Years[2]	Total Cost for 3-Years	Annualized Cost
ECO II	wet/dry	$650	$864	$1,514	$505
Guardian	wet	$3,255	$1,500	$4,755	$1,585
	dry	$1,500	$1,500	$3,000	$1,000
Hg5	wet/dry	$695	$1,500	$2,195	$732
Merc II	wet/dry	$895	$1,785	$2,680	$893
Rasch	wet	$1,190	$1,192	$2,382	$794
	dry	$666	$1,192	$1,858	$619
Rebec[3]	wet/dry	$895	$1,185	$2,080	$693

[1] Cost information shown does not include labor associated with installation or maintenance of the amalgam separators.
[2] The costs shown include replacement and recycling of collector/cartridge at the end of third year.
[3] The costs shown in the table are for the Rebec Catch 400 amalgam separator.

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