GUIDANCE ON REDUCING MERCURY RELEASES FROM DENTAL FACILITIES

INTRODUCTION

One goal of the UNDP GEF project is to protect public health and the global environment from the impacts of mercury releases. In response to requests from project countries, this document provides a brief general guidance on best management practices and technologies to reduce mercury releases from dental departments in hospitals, private dental clinics, dental schools, dental laboratories, and other dental facilities.

This guidance focuses only on mercury. It does *not* cover other environmental best management practices for dental facilities, such as those relating to infectious waste, chemical disinfectants, cleaning solutions, x-ray waste (e.g., spent fixer solutions), pharmaceutical waste, lead shields, and recyclable general office waste.

MERCURY RELEASES FROM DENTAL FACILITIES

Mercury is about 50% of dental amalgam by weight. In many dental facilities, a powder mix of metals (generally silver, tin, copper, and zinc) are weighed and mixed with mercury to form the amalgam. Other facilities use small capsules with the right proportions of the metal powders and mercury. These are mixed just prior to filling a cavity. Depending on the size of the amalgam, the amount of mercury could range from 327 to 982 milligrams per amalgam.

Dental facilities are a significant source of mercury in the wastewater. Studies in the United States, for example, estimate that 31.9 tonnes of mercury in the form of amalgam are used annually and 26.9 tonnes are released into the internal wastewater systems of dental facilities every year. With the use of chair-side traps and vacuum filters, some of the mercury is removed but an estimated 5.9 tonnes are still discharged into public wastewater treatment plants.[1]

Estimates of the contribution of mercury from dental facilities to the public wastewater treatment plants in the U.S. range from 11% to 80% of the total mercury load depending on the location.[2] The amount of mercury discharged by a single dental facility depends, among others, on

[1] J.A. Vandeven and S.L. McGinnis, "An Assessment of Mercury in the Form of Amalgam in Dental Wastewater in the United States," Water, Air, and Soil Pollution, 164: 349-366 (2005).
[2] A. Dubé, "Mercury: From the Dentist's Chair to Public Treatment Works," Water & Wastes Digest, Volume 47, Number 9, September 2007.

whether or not mercury retention devices are used. When no filters are used, one study estimated an average of 2 grams of mercury per dentist per day may be discharged into the wastewater.[3]

GENERAL RECOMMENDATIONS

At the top of the waste management hierarchy is pollution prevention. In accordance with that principle, **the first recommendation is to use amalgam substitutes in cases where they are appropriate and feasible** as determined by the dental practice in order to avoid mercury and silver releases from dental facilities. Alternatives to mercury are commercially available, including cold silver, gallium, ceramic, porcelain, polymers, composites, and glass ionomers.[4] However, these alternatives are not yet widely known nor accepted in many countries.

In cases where mercury is used, the following general recommendations are made:

- Always wear personal protection equipment when working with mercury. These include rubber or nitrile gloves, protective eyewear, and a respirator or mask[5] specifically designed to protect from mercury vapors.
- Have mercury spill kits available and make sure that all personnel are trained in proper spill clean-up procedures[6].
- Ensure good ventilation in the work area to prevent build up of mercury vapors.
- Use pre-dosed precapsulated amalgam alloy instead of bulk elemental mercury to minimize occupational risks.
- Use amalgamators with enclosed mixing areas to contain any mercury leaks during trituration.
- Store different sizes of capsules and use only the correct amount to minimize amalgam waste.
- Collect and recycle disposable empty capsules after confirming that they do not contain any visible amalgam.
- Do not use bleach or chlorine-based cleaners to clean out pipes and drain lines since these cleaners help dissolve amalgam in

[3] J. Drummond, M. Caila., et. al., "Dental Waste Water: Quantification of Constituent Fractions," Academy of Dental Materials, Abstract P-22 (1995); cited in "Specific Source Descriptions," New Jersey Mercury Task Force, Volume III, Chapter 3, New Jersey Department of Environmental Protection, December 2001.
[4] "Guide for Reducing Major Uses and Releases of Mercury," UNEP-Chemicals, United Nations Environment Programme, June 2006.
[5] To reduce the inhalation hazard posed by mercury vapors, the following respirators or masks should be used in the order of decreasing effectiveness: fit-tested full- or half-face air-purifying respirators with mercury vapor cartridges, face masks with sulfur or iodide impregnated activated carbon, or face masks made of sandwiched activated charcoal-impregnated cloth (face masks that do not seal tightly around the face could allow contaminated air to enter through the edges). If no specialty masks are available, a face mask with a 0.3 micron HEPA filter could capture amalgam particles and mercury-laden dust but regular masks will *not* protect against mercury vapor.
[6] See, for example, "Guidance on the Cleanup, Temporary or Intermediate Storage, and Transport of Mercury Waste From Healthcare Facilities," UNDP GEF Global Healthcare Waste Project, July 21, 2010.

the pipes. Instead, use non-chlorine, environmentally friendly cleaners.

The following are general recommendations pertaining to mercury and amalgam waste:

- Store or send all elemental mercury and amalgam waste to an approved mercury disposal facility, recycler, or amalgam reclamation company.
- Store elemental mercury safely. Proper storage includes: an unbreakable primary container such as a plastic jar that is re-sealable, leak-proof and air-tight; a vapor suppression agent or water in the primary container to minimize volatilization (note that some mercury recycling companies may prefer dry storage); a label on the container; and a secondary container such as a re-sealable plastic bag as a redundant safety measure.
- Store capsules, non-contact amalgam, contact amalgam, contents of traps, and used filters in appropriate, wide-mouthed, air-tight, properly labeled, unbreakable containers. Water or photographic fixative solution could be added to reduce volatilization (some amalgam reclamation companies may require dry storage). A secondary container such as a re-sealable plastic bag should be used for amalgam waste, used traps, and filters as an extra safety measure. Bleach could be added to contact amalgam waste for disinfection.
- Never dispose of mercury-contaminated wastes into containers that will be incinerated
- Depending on the recycler or amalgam reclamation company, it may be necessary to separate non-contact scrap amalgam (I.e., excess left over from the mixing and preparation of the amalgam alloy) from contact amalgam (i.e., amalgam that has been in contact with the patient such as extracted teeth with amalgam restoration or carving scrap).

The following are general recommendations regarding mercury retention devices for dental facilities:

- Have multiple levels of amalgam retention devices installed as much as possible, since chair-side traps and vacuum pump filters only remove between 40 to 80% of amalgam from the wastewater. Multiple levels refer to the installation of dental amalgam separators and vacuum filters along with chair-side traps.
- Amalgam separators should be correctly installed according to the manufacturers' specifications. Figure 1 gives examples of different configurations of multiple amalgam retention devices depending on whether a dry or wet vacuum system is used.
- After installing amalgam retention devices, replace old plumbing sink traps and other low points in the plumbing where amalgam may have settled. Collect, store, and label the amalgam waste.

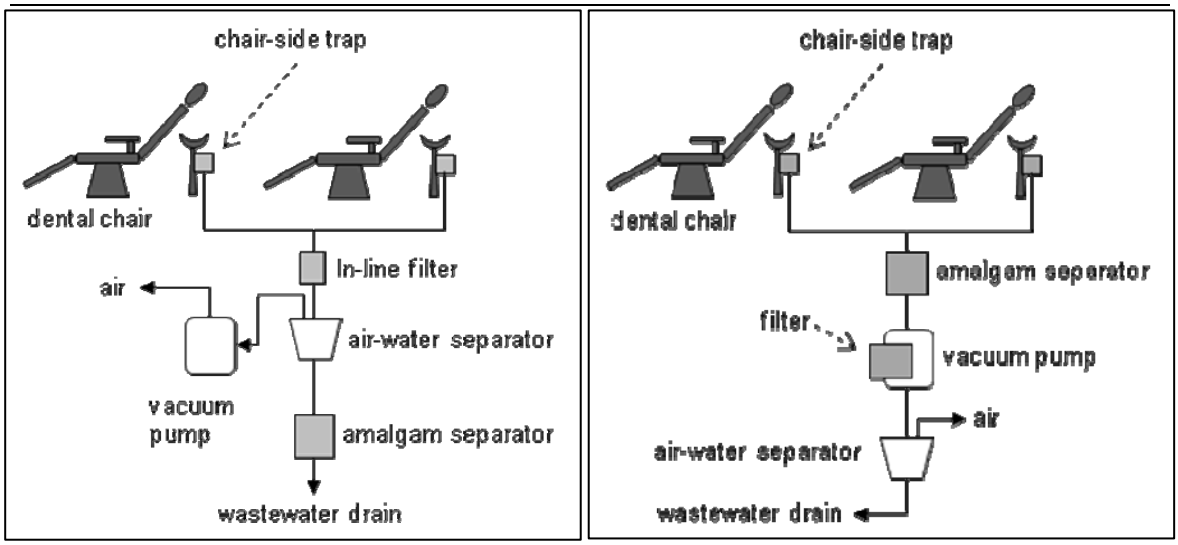

Figure 1. Examples of Multiple Levels of Amalgam Retention Devices[7]

RECOMMENDATIONS REGARDING CHAIR-SIDE TRAPS

In a typical dental facility, wastewater from each chair or operatory is collected and brought to a central discharge location. At the chair, there may be a "spit bowl" or cuspitor. Water drains from the cuspitor by gravity or by being suctioned by a vacuum system. Traditional chair-side traps capture large amalgam particles in the wastewater from the cuspitor and suction tubes. An example is shown in Figure 2.

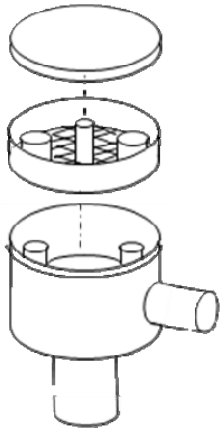

Figure 2. Example of a Chair-Side Trap

[7] Adapted from: K.R. McManus and P.L. Fan, "Purchasing, installing and operating dental amalgam separators: Practical Issues," J Am Dent Assoc, Vol 134, No 8, 1054-1065 (2003); "Manage Dental Amalgam Wastes," Department of Ecology, State of Washington (accessed 21 February 2011); "Protocol for the Verification of Mercury Amalgam Removal Technologies," report prepared by NSF International (Ann Arbor, MI) for the Environmental Technology Verification Source Water Protection Pilot Program, 2001.

The chair-side traps vary in size but are usually about 5 cm in diameter and 2 cm deep. Traditional traps have a 40-mesh screen with 0.7 millimeter pores to catch the largest amalgam particles, although screens with smaller pores (higher mesh numbers up to 100 mesh) are now available. A good chair-side trap is reported to remove between 60% to 70% of mercury[8].

RECOMMENDATIONS FOR CHAIR-SIDE TRAPS:

- Use a disposable or reusable chair-side trap to capture the amalgam. Many users prefer disposable amalgam traps because of the difficulty in removing amalgam particles from a reusable trap without spilling them into the drain or waste container.
- There are no international standards for chair-side traps but it is generally recommended to use smaller mesh sizes to trap amalgam particles more efficiently as long as the drain or suction system can function properly with the finer mesh size. For example, use size 100 mesh traps instead of size 40 mesh traps whenever possible.
- Clean reusable chair-side traps daily or in accordance with manufacturers' specifications. Change disposable chair-side traps as often as necessary in accordance with manufacturers' specifications.
- For reusable traps, flush the vacuum system with an environmentally friendly non-chlorine disinfectant and allow the trap contents to dry before opening the trap. Remove non-amalgam particles using forceps and empty the amalgam into a wide-mouthed, air-tight, properly labeled, unbreakable container. Be careful not to spill any amalgam. Do not wash the trap under running water since this will release amalgam particles into the drain. Check that the reusable trap remains in good condition before putting it back in place.
- For disposable traps, remove the trap and place it directly into a large, wide-mouthed, air-tight, properly labeled, unbreakable container and send it to a reclamation company.
- Use personal protection equipment when removing or cleaning traps.

RECOMMENDATIONS REGARDING VACUUM FILTERS

Vacuum filters can capture particles as small as 0.4 mm. The filter unit is usually composed of a canister, screw-on lid, gasket, and filter with a diameter of about 15 cm. Some canisters are made of transparent plastic, as shown in Figure 3, to allow the user to see if the filter needs changing. In many filter systems, all the parts are reused except for the

[8] "Specific Source Descriptions," New Jersey Mercury Task Force, Volume III, Chapter 3, New Jersey Department of Environmental Protection, December 2001.

filter which is removed and replaced. In others, all the filter parts are intended to be replaced as one unit. Filters are manufactured to fit specific vacuum systems. The filters are often sold as cartridges with different pore sizes.

When chair-side traps and filter traps are used together, a combined removal rate of 40% to 80% of amalgam particles are achieved.

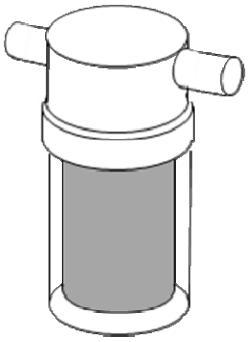

Figure 2. Example of a Vacuum Filter

RECOMMENDATIONS FOR VACUUM FILTERS:

- Use filters with the smallest pore sizes as long as the vacuum system can function properly with them.
- Replace vacuum filters every quarter or according to manufacturers' specifications.
- When removing the filter, hold it under a tray to catch spills; amalgam-free liquid can be released to the drain. Amalgam-containing liquid and the filter should be stored and labeled as "contact-amalgam waste" and sent to a reclamation company.

RECOMMENDATIONS REGARDING AMALGAM SEPARATORS

A dental amalgam separator is installed centrally so that the whole wastewater stream from the dental facility passes through it before being discharged into the sewer system. As shown in Figure 1 above, the amalgam separator can be placed before the vacuum pump or after the air-water separator depending on the system design and the manufacturer's specifications.

There are five types of dental separators: (a) sedimentation systems that decrease the velocity of the wastewater to allow amalgam particles to settle out, (b) centrifugal systems that use centrifugal force to separate amalgam particles from the wastewater, (c) filter systems that can remove amalgam of fine and colloidal sizes, (d) chemical systems that use a chelating agent or an ion exchange resin, and (e) a combination of

two or more of the above systems. The U.S. EPA found that sedimentation, either alone or in conjunction with filtration and ion exchange, can achieve removal efficiencies of about 99%.[9]

RECOMMENDED SPECIFICATIONS FOR DENTAL SEPARATORS:

- The dental separator should meet or exceed the 95% minimum removal efficiency required under the international standard International Organization for Standardization (ISO) 11143 "Dental Equipment-Amalgam Separators."
- The dental separator should be tested under the ISO 11143 protocol and certified by an independent and accredited third party as meeting the ISO 11143 requirements.
- The dental separator should be compatible with any existing wet ring or dry vacuum pump system in the facility.
- The size of the dental separator must fit within the space limitations of the dental facility.
- The flow capacity of the dental separator must be able to meet the needs of the number of dental chairs in the facility.

ADDITIONAL OPTIONAL FEATURES OF AMALGAM SEPARATORS:

In addition to the international standard and specifications, below are some ideal features of a dental separator:

- The separator should not adversely affect suction power.
- The separator should require minimal or no manual operation.
- The separator should have a simple design with a fail-safe mechanism that protects the user from spills or back-ups in the event of a blockage.
- The separator should operate quietly.
- The separator should be easy to install and maintain.
- The separator should be affordable with low operating and maintenance costs.
- The separator company ideally also provides a recycling or amalgam reclamation service.

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December 2012

[9] "Health Services Industry Detailed Study: Dental Amalgam," EPA-821-R-08-014, U.S. Environmental Protection Agency, Washington, DC, August 2008.