

FILE

FINAL REPORT

MERCURY CONTROL TECHNOLOGY ASSESSMENT STUDY

Veterans Administration Medical Center Dental Services Clinic  
Salt Lake City, Utah

Mercury Control Technology In-depth Survey Report  
for the site visit of  
January 11-12, 1982

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## FOREWORD

A Control Technology Assessment Team (CTA) consisting of members of Dynamac Corporation met with representatives of the Veterans Administration Medical Center Dental Services Clinic of Salt Lake City, Utah on January 11 and 12, 1982, to conduct an in-depth survey on the techniques to control worker exposure to mercury. Participants in the survey were:

### Dynamac Corporation

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### V.A. Dental Clinic

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The in-depth CTA survey was completed in two days. The study included personal and area air sampling and detailed inspections of mercury controls.

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## INTRODUCTION

### CONTRACT BACKGROUND

The Mercury Control Technology Assessment Study has been initiated to assess the current technology used to protect the worker from exposure to mercury. The specific objective is to identify and evaluate the exemplary methods employed by industries to control worker exposure to elemental mercury and mercury compounds. A result of the study will be the publishing of a comprehensive document describing the most effective means of controlling emissions and exposures. This report will be available to companies which handle mercury in order to transfer technology within the major mercury using industries. The study will also identify directions where additional research is necessary.

### JUSTIFICATION FOR MERCURY CTA SURVEY

The Veterans Administration Medical Center Dental Services Clinic (V.A. Dental Clinic) was selected for an in-depth Mercury CTA study because of its use of pre-enclosed dental capsules and its mercury handling procedures.

## CLINIC DESCRIPTION

The Veterans Administration Medical Center Dental Services Clinic of Salt Lake City is located in Building 1 of the Medical Center. The clinic has been in operation since 1950. There are currently 9 chairs at the facility. Each chair is located in a separate operatory bay. There is also an office area and a dental lab in the clinic (Figure 1).

There are 17 employees in the clinic who may be exposed to mercury. This includes 5 full time dentists, 1 part-time dentist, 2 dental residents, 5 dental assistants, 1 dental hygienist, 2 lab technicians, and one clerk.

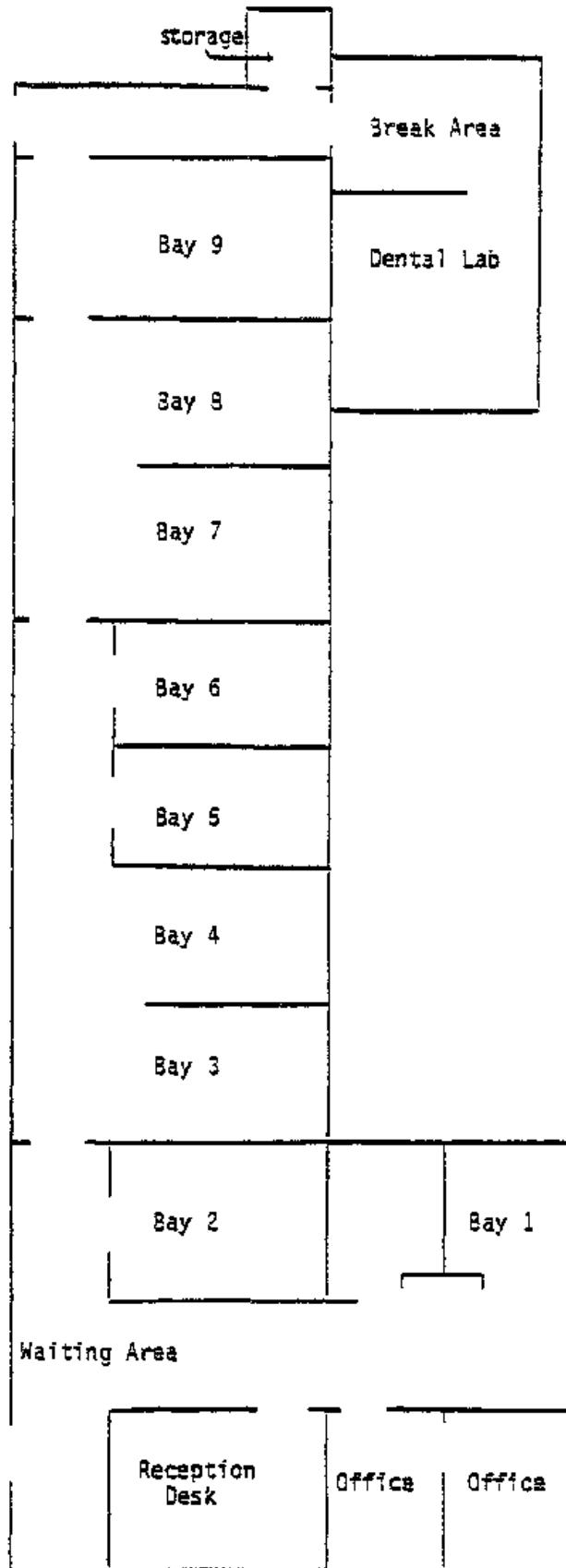


Figure 1. V.A. Dental Clinic Layout

## PROCESS DESCRIPTION

Mercury is used at the V.A. Dental Clinic in the preparation of dental amalgam for use in operatory dentistry. Mercury amalgam is formed by mixing elemental mercury with an alloy powder. The mercury and alloy powder are contained in a plastic capsule in an amount large enough for completing an average tooth filling. Capsules arrive at the clinic in boxes of 100 and are kept in a store room. Each bay (compartment containing dental chair and equipment) has a store of capsules in a dental supply cabinet.

When a tooth filling is to be made, the dental assistant removes a capsule from the cabinet, activates the capsule so that the mercury contacts the alloy, and triturates (agitates) the capsule using a whirly-gig (shaking device) to mix the amalgam. After trituration, the capsule is opened and amalgam is poured into a stainless steel vessel called an amalgam well. The dental assistant uses a tool called an amalgam carrier to collect the amalgam from the well in preparation for insertion into the drilled tooth. The dentist takes the amalgam carrier from the assistant and uses it to apply the amalgam to the tooth. The amalgam is condensed (compacted), burnished (smoothed), and carved to fit the form of the tooth. Periodically, an amalgam squeeze cloth is used instead of the amalgam well. The dental assistant mulls the amalgam by hand using this cloth. The mulling absorbs excess mercury from the amalgam, an operation which is not normally necessary when using pre-enclosed capsules. Amalgam is collected from the cloth using the amalgam carrier. Excess amalgam not used for the filling is disposed of in a covered plastic bottle containing an inch of water. The empty capsules are discarded in waste baskets.

Most tooth fillings performed at the clinic involve the use of a "rubber dam" which is a thin rubber sheet that covers the mouth and collects residual amalgam. This residual amalgam is removed from the dam using an aspirator connected to a suction system. Each chair has a trap for amalgam and other solids drawn through the aspirator. The suction line from each chair connects through a central system to a liquid-air separator and a vacuum pump which are located in a utility room on the floor below.

## MERCURY CONTROL TECHNIQUES

### PROCESS SUBSTITUTION (Pre-enclosed Amalgam Capsules)

Traditional formation of amalgams for use in dental applications involved the open-air mixing of mercury and alloy powder. The mixed amalgam was often mullied by hand in order to obtain the proper consistency by removing excess mercury. Handling amalgam in this manner increased the potential for exposure of dentists and dental assistants to mercury vapor in the ambient air of the dental office. It also increased the potential for dermal contact with mercury and subsequent injection of mercury. Many dentists still practice this type of amalgam formulation.

Instead of mixing a spill (drop) of mercury with the alloy powder inside a capsule, a pre-measured spill of mercury is enclosed in a sealed capsule along with the proper amount of alloy powder. The process of filling the capsule with mercury is therefore eliminated by substituting the pre-enclosed capsules. The use of pre-enclosed dental capsules for amalgam formulation minimizes the exposure of elemental mercury to the ambient air.

Dermal contact with the amalgam is also minimized because the proportions of mercury and alloy powder are pre-measured at amounts which will form the optimal amalgam. This usually eliminates the need for the worker to mull the amalgam before application.

Dispersalloy<sup>®</sup> Dispos-a-cap capsules manufactured by Johnson and Johnson Dental Products Company are used at this facility. Each capsule is approximately 1-1/4 inch long and 5/8 inch diameter. There are two chambers in each capsule (Figure 2). The upper chamber (a two piece plastic assembly) contains a pre-determined amount of mercury, usually one but possibly two or three spills. The bottom chamber contains a steel pestle and the amount of alloy powder required to amalgamate with the mercury. By pulling out the top portion of the top chamber assembly, mercury is allowed to flow through a hole into the bottom chamber to contact the alloy powder. The amalgam is now triturated by agitating the capsule in a whirly-gig. The pestle ensures proper mixing



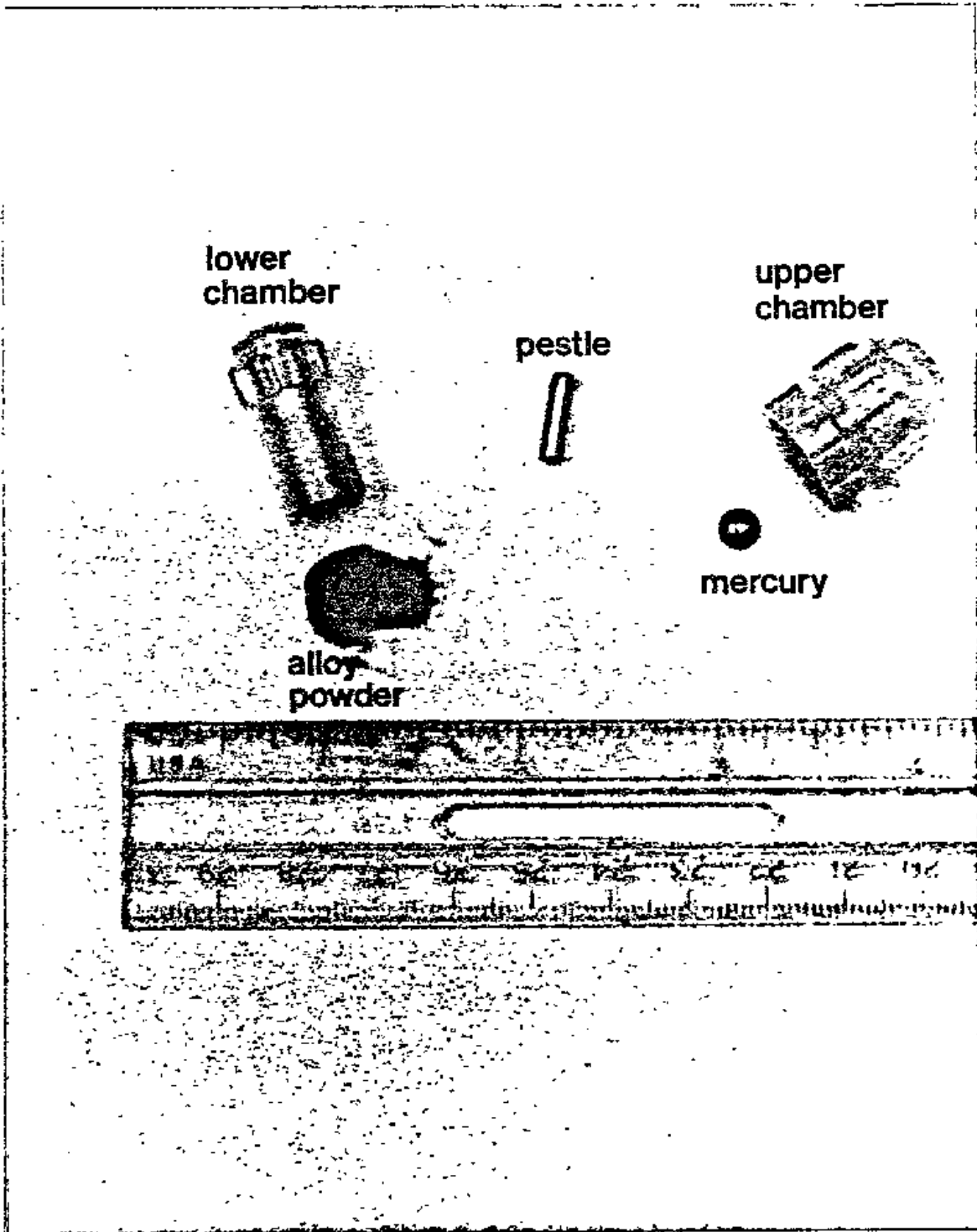


Figure 2. Dispersalloy<sup>®</sup> Dispos-a-cap Components

inside the capsule. After trituration, the capsule is opened by separating the top chamber from the bottom chamber. The bottom chamber is emptied into the amalgam well, and the amalgam is ready for application.

#### ISOLATION

Waste amalgam from the patient's mouth and from the amalgam well or squeeze cloth is disposed of in a way which minimizes the exposure of the amalgam to the ambient air of the clinic. This is achieved through special procedures for removal, enclosure, and submersion in water. These procedures are particularly important when the amalgam is still moist, as the mercury has a higher propensity to vaporize under this condition.

Amalgam is removed from the patient's mouth by an aspirator system. Each chair in the clinic has a suction hose with a special fitting used for drawing the amalgam from the patient's mouth. An enclosed in-line trap for each suction hose is located in a console on the floor under each chair. The trap collects the waste amalgam and other solids from the suction stream. Traps are emptied on a weekly basis. The suction hoses from each chair connect to a central vacuum pump and a liquid/air separator located in a utility room on the floor below the clinic. The vacuum pump is exhausted inside the utility room.

Excess amalgam from the amalgam wells and squeeze cloths are emptied into small plastic containers which have water in them to suppress mercury vapor emission. The containers are kept closed and are periodically emptied into a large glass jar which serves as a central waste amalgam storage container.

#### PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment intended for use in controlling worker exposure to mercury is not in use at this facility. Latex surgeon's gloves are worn by some of the staff during operatory activities. Gloves are worn primarily for protection against biological agents, however, they also reduce dermal contact with amalgam.

## WORK PRACTICES

Practices which reduce exposure to liquid mercury and mercury vapor are in effect at this clinic. They have been implemented primarily for good dental practice rather than for the control of worker exposure to mercury. These practices include the following:

- Workers (dentists and assistants) wash their hands before and after patient contact, and before and after breaks and lunch.
- Workers do not eat food in clinic areas.
- Dental instruments which are used to handle mercury are cleaned on a regular basis.
- Waste amalgam is placed in a container having approximately one inch of water to suppress the emission of mercury vapors.
- Operatory floors are dry-swept daily. There are no carpets in operatory areas.
- Operatory floors are wet mopped three times per week using soap and water or water only.
- Carpeted areas (offices, corridors and reception areas) are vacuumed daily.

## MONITORING PROGRAMS

Biological monitoring to determine the level of mercury in biological samples is not conducted. Air monitoring to determine the concentration of mercury vapor in operatory areas is not performed.

## OTHER PROGRAMS - Education

The Chief of Dental Service and the staff of the V.A. Dental Clinic are aware of the potential hazards associated with the use and handling of liquid mercury and amalgam. New staff members are made aware of the potential hazards of working with mercury.

## SURVEY DATA

Monitoring of workplace air for mercury vapor was conducted using a mercury vapor detector (Jerome Model 401) to take grab samples, and sampling pumps connected to Hopcalite solid sorbent tubes to determine time-weighted-average concentrations.

A summary of grab sampling is presented in Table 1. The highest concentration recorded in the operatory area ( $0.010 \text{ mg/M}^3$ ) was in the breathing zone of a dentist during tooth filling and condensation. Area samples in operatory bays, where routine operatory activities are conducted, ranged from none detected to  $0.004 \text{ mg/M}^3$ . A spot check of the carpet indicated that widespread contamination of mercury was not occurring.

TABLE 1  
Results of Grab Samples Taken with Mercury Vapor Detector  
1/11/81 - 1/12/82

Location	Concentration Range ( $\text{mg/M}^3$ )	Average	Comments
Bay 9	<0.001(2)**	<0.001	Routine operatory activity - no amalgam prep.
Bay 8	<0.001-0.002(2)	0.001	Routine operatory activity - no amalgam prep.
Bay 3	0.005-0.006(2)	0.005	Recently completed filling
Near Bay 4	0.006 (4)	0.006	In corridor ~2' from carpet (various locations)
Bay 9	0.005-0.010(5)	0.006	Dentist during filling and condensation (BZ*)
Bay 9	0.006-0.007(2)	0.006	3 ft. from dentist during filling and condensation
Bay 9	0.004(2)	0.004	Routine operatory activity - no amalgam
Bay 8	0.002(2)	0.002	Routine operatory activity - no amalgam
Bay 3	0.002(3)	0.002	Routine operatory activity - no amalgam
Outside Facility	0.002(2)	0.002	Background outdoor air sample
Utility Room	0.200-0.350(3)	0.280	Utility Room at Vacuum pump discharge
Utility Room	0.020-0.012(2)	0.016	Utility Room ~10' from discharge
Utility Room	0.005-0.008(2)	0.006	Utility Room ~15' from discharge

\*BZ = Breathing Zone

\*\*number in parentheses indicates number of samples taken at the specified location.

Samples taken at the vacuum pump discharge for the aspirator system ranged from 0.200 to 0.350 mg/M<sup>3</sup>. Concentrations ranged from 0.0020 to 0.012 mg/M<sup>3</sup> approximately 10 feet from the discharge. Maintenance workers usually spend less than 1 hour per day in the utility room, consequently, exposure to mercury vapor in excess of the OSHA standard of 0.1 mg/M<sup>3</sup> (as a time-weighted-average) is not likely to occur in the utility room.

Time-weighted-average concentrations of mercury vapor are presented in Table 2. Personal sampling results ranged from none detected to 0.008 mg/M<sup>3</sup>; area sampling results ranged from none detected to 0.002 mg/M<sup>3</sup>. All sample results were well below the OSHA standard of 0.1 mg/M<sup>3</sup> (as an 8-hour time-weighted-average). The employee with the highest reported concentration of mercury vapor (sample #5) did not use pre-enclosed amalgam capsules or any other mercury or mercury amalgam product on the day of sampling.

TABLE 2  
Results of Personal and Area Monitoring for Mercury Vapor

Number	Date	Employee/Title	Location	Daily TWA Concentrations (mg/M <sup>3</sup> )
1	1/11/82	D.F. Dental Asst.	Bay 3	0.002
2	1/11/82	S.C. Dental Asst.	Bay 8	<0.002
3	1/11/82	B.P. Dentist	Bay 8	<0.002
4	1/11/82	R.P. Dentist	Bay 3	0.003
5	1/11/82	R.W. Dentist	Bay 9	0.008
6	1/11/82	R.G. Dental Asst.	Bay 9	0.004
7	1/11/82	Area Sample	Bay 8	<0.002
8	1/12/82	D.R. Dental Asst.	Bay 3	<0.002
9	1/12/82	R.P. Dentist	Bay 3	0.002
10	1/12/82	Area Sample	Bay 3	<0.002
11	1/12/82	B.P. Dentist	Bay 8	0.002
12	1/12/82	S.C. Dental Asst.	Bay 8	<0.002
13	1/12/82	Area Sample	Bay 8	<0.002

Use of pre-enclosed capsules and amalgam preparation during the survey was considered to be slightly less than normal. The following table shows the capsule usage and number of tooth fillings in the sampled areas.

TABLE 3

Amalgam Capsule Usage and  
Number of Fillings (Tooth Surfaces)

Date	Location	Number of Capsules used	Number of Tooth Surfaces filled
1/11/82	Bay 8	2	4
1/11/82	Bay 3	5	7
1/11/82	Bay 9	None	None
1/12/82	Bay 8	4	13
1/12/82	Bay 3	1	2

## CONCLUSIONS

The control techniques employed at this dental clinic reflect the basic principles required for control of worker exposure to mercury. Handling of mercury is minimized, product mix involving mercury is enclosed, mercury containing wastes are contained and submerged in water, dermal contact is minimized, and good housekeeping is practiced. Each of these techniques can be applied to other mercury industries.

The use of pre-enclosed dental amalgam capsules is an approach to mercury control which is specific to the dental industry because of the very small quantities of amalgam used in operatory work as compared to other amalgam using industries. According to readings taken during the survey, the capsules succeed in maintaining low mercury vapor concentrations in the clinic. The capsules eliminate mercury handling operations such as liquid mercury storage and transfer and trituration, thus reducing the potential for mercury vapor generation. Since measurements of vapor concentrations were not made prior to the use of the capsules, it can not be determined if the capsules have resulted in significantly lower concentrations than traditional amalgam handling methods.

The fact remains that the use of the capsules and the standard mercury handling techniques described in the body of the report have resulted in mercury vapor concentrations significantly lower than the OSHA standard of  $0.1 \text{ mg/M}^3$ . This shows that worker exposure to mercury in dental operations may be easily controlled through the use of sound work practices and standard dental equipment, such as capsules and aspirators.