

ORIGINAL COPY

2

AFOEHL REPORT 89-053EQ00076GIB



AD-A212 955

Mercury and Silver in Clinic Wastewater Goodfellow AFB TX

ROBERT D. BINOVI, Lt Col, USAF, BSC

DTIC
S **ELECTE** **D**
OCT 0 2 1989
& D

JULY 1989

Final Report

Distribution is unlimited; approved for public release

**AF Occupational and Environmental Health Laboratory (AFSC)
Human Systems Division
Brooks Air Force Base, Texas 78235-5501**

89 10 2 005

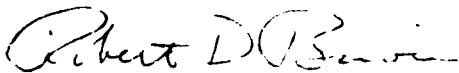
NOTICES

When Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated, or in any way supplied the drawing, specifications, or other data, is not to be regarded by implication, or otherwise, as in any manner licensing the holder or any other person or corporation; or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The mention of trade names or commercial products in this publication is for illustration purposes and does not constitute endorsement or recommendation for use by the United States Air Force.

The Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nations.

This report has been reviewed and is approved for publication.



ROBERT D. BINOVI, Lt Col, USAF, BSC
Chief, Environmental Quality Branch



DENNIS R. SKALKA, Lt Col, USAF, BSC
Chief, Consultant Services Division

Air Force installations may direct requests for copies of this report to:
USAF Occupational and Environmental Health Laboratory (USAFOEHL) Library,
Brooks AFB TX 78235-5501.

Other Government agencies and their contractors registered with the DTIC should direct requests for copies of this report to: Defense Technical Information Center (DTIC), Cameron Station, Alexandria VA 22304-6145.

Non-Government agencies may purchase copies of this report from: National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield VA 22161



JAMES C. ROCK, Colonel, USAF, BSC
Commander

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE				Form Approved OMB No 0704-0188	
1a REPORT SECURITY CLASSIFICATION Unclassified			1b RESTRICTIVE MARKINGS N/A		
2a SECURITY CLASSIFICATION AUTHORITY N/A			3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release. Distribution is unlimited.		
2b DECLASSIFICATION/DOWNGRADING SCHEDULE N/A					
4 PERFORMING ORGANIZATION REPORT NUMBER(S) AFOEHL Report 89-053E00076GIB			5 MONITORING ORGANIZATION REPORT NUMBER(S)		
6a NAME OF PERFORMING ORGANIZATION USAF Occupational and Environmental Health Laboratory (AFSC)		6b OFFICE SYMBOL (If applicable) ECO	7a NAME OF MONITORING ORGANIZATION		
6c ADDRESS (City, State, and ZIP Code) Brooks AFB TX 78235-5501			7b ADDRESS (City, State, and ZIP Code)		
8a NAME OF FUNDING SPONSORING ORGANIZATION Same as 6a		8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c ADDRESS (City, State, and ZIP Code) Same as 6c			10 SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO	PROJECT NO	TASK NO
11. TITLE (Include Security Classification) Mercury and Silver in Clinic Wastewater, Goodfellow AFB TX					
12. PERSONAL AUTHOR(S) Lt Col Robert D. Binovi					
13a. TYPE OF REPORT Final		13b TIME COVERED FROM 8901090 890117		14 DATE OF REPORT (Year, Month, Day) Jul 89	
15 PAGE COUNT 19					
16 SUPPLEMENTARY NOTATION					
17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Wastewater Hazardous Waste Management Priority Pollutants		
FIELD	GROUP	SUB-GROUP			
19 ABSTRACT (Continue on reverse if necessary and identify by block number) The AFOEHL conducted a wastewater survey to identify the high concentrations of mercury in the wastewater from the USAF Clinic, Goodfellow AFB TX. The sources of mercury were identified. The high volume oral evacuation system (HVE), was found to be the major contributor to mercury levels in the sewer. Material suctioned from teeth restoration are collected in a central separator/collection tank. The tank is automatically cleaned by rinsing it with water once a day. The rinsate is flushed to the sewer system. Silver from a silver recovery unit processing waste photographic fixer was also found in high levels in samples. Discarded amalgam capsules were found not to be a RCRA waste.					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS			21 ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a NAME OF RESPONSIBLE INDIVIDUAL Robert D. Binovi, Lt Col, USAF, BSC			22b TELEPHONE (Include Area Code) (512) 536-3305 AV 240		22c OFFICE SYMBOL USAF/OEHL/ECO

Block 19 Cont'd

The recommendations were (1) A finer mesh screen should be used in the strainer attached to the dental aspirator kit. (2) A gravity separation or filtration unit should be installed to remove the mercury from the HVE system. (3) A study of the economics of the silver recovery process should be conducted. (4) If silver recovery continues, a metallic replacement unit should be fitted after the electrolytic unit. (5) Samples for metals should be obtained carefully.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the exceptional work that MSgt Benjamin Hernandez, AFOEHL/ECQ performed in coordinating, sampling, analyzing, and generally preparing this report. Many thanks to the base personnel, TSgt Williams and SSgt Cox who also greatly helped in the accomplishment of this survey.



Accession For	
NTIS CRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

CONTENTS

	Page
DD Form 1473	i
Acknowledgements	iii
Illustrations	v
I. INTRODUCTION	1
II. DISCUSSION	1
III. CONCLUSIONS	5
IV. RECOMMENDATIONS	6
References	8
Appendix Dental Aspiration Kit	9
Distribution List	19

Illustrations

Table	Title	Page
1	Silver and Mercury Results	7
2	EP Toxicity Testing on Amalgum Capsules	8
Figure		
1	Typical Duplex Vacuum Equipment Installation	2
2	Easy Access to the Sewer Connections	4
3	Goodfellow AFB Basement Sampling Locations	5
4	Manhole on Perimeter Road	6
5	Electrolytic Silver Recovery Unit	6

I. INTRODUCTION

At the request of the Training Center Vice Commander, personnel of the Air Force Occupational and Environmental Health Laboratory (AFOEHL) performed a survey at Goodfellow AFB from 9-12 January 89. The purpose of the survey was to identify the source of high concentrations of mercury in the sewer from the clinic. The survey was performed by Lt Col Robert D. Binovi and MSgt Benjamin Hernandez.

The clinic bioenvironmental engineering section performs quarterly sampling of the sewage leaving the base at three locations. One location is a sewer manhole at the base perimeter behind the clinic. The clinic is the only facility serviced by this sewer. The discharge limits are set down in a municipal ordinance by the city of San Angelo. A limit on mercury of 0.005 mg/L has been established. Results of samples for mercury have fluctuated in a range of from one to two times over the limit, but reached 0.145 mg/L in October 1988. A limit of 0.10 mg/L has been placed on silver.

II. DISCUSSION

Mercury and its compounds generally are insoluble or sparingly soluble in water. In neutral or alkaline solutions, mercury is oxidized directly to the mercuric state with the formation of relatively soluble mercuric oxide whose solubility rises rapidly below pH 3 as the metal dissolves to the mercurous state.

There are only a few uses for mercury and mercuric compounds at the clinic. Dentists use amalgam from capsules containing more than 200 milligrams of mercury for tooth restoration. Excess amalgam is collected and stored in waste photographic fixer solution. Empty capsules are thrown in the trash. Amalgam drilled and suctioned or rinsed from the mouth enters the central dental evacuation system. A high-volume oral evacuation (HVE) type system has been in use at the Goodfellow clinic since 1986.

The HVE system consists of two vacuum turbines (turboexhausters), a central separator/collector tank equipped with overflow protectors, flow and drain controls, self-cleaning capability, and a sewer connection. The system is designed for scavenging, collecting and disposing of liquids, solids, and aerosols from the patients mouth produced by the high speed hand piece (see Figure 1).

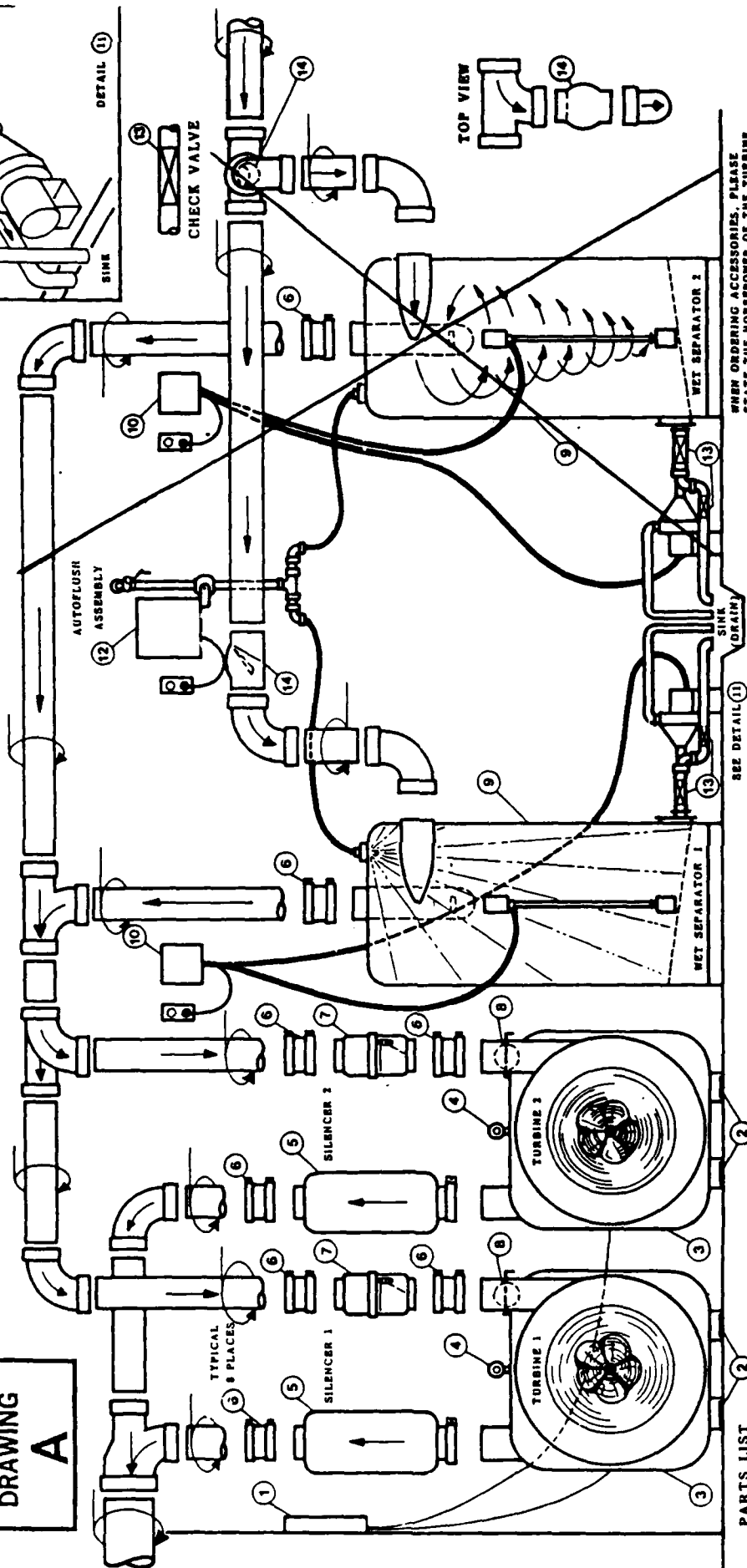
Both the dental and medical laboratories can discharge mercury to the sewer if thermometers or other instruments containing mercury are accidentally broken and the mercury enters the sink or floor drain, or if mercuric compounds are used in analysis.

A walk-through survey of the clinic was conducted. The clinic basement provided easy access to the building sewer connections (see Figure 2). There are two branches carrying nondomestic wastes, the branch collecting the dentaloperatory areas and the branch from the rest of the clinic including the medical laboratory and x-ray. The discharge from the dental evacuation system enters the dental branch (see the diagram in Figure 3).

U.S. TURBINE
CORPORATION
1000 North Cooness St. El Caim, California 92020
(619) 448-5200

TYPICAL DUPLEX WET VACUUM EQUIPMENT INSTALLATION

DRAWING
A



PARTS LIST

ITEM NO	PART NO	DESCRIPTION	5	EX	AIR DISCHARGE SILENCER	10	LLS-20	ELECTRONIC LIQUID LEVEL SENSOR (OPT)
1	SCP	SIMPLEX ELEC. MOTOR CONTROL PANEL	6	PL	FLEXIBLE PLUMBING ISOLATOR	11	AP-133	AUTO PUMP
2	IP	ISOLATOR PAD	7	CVT	DIRECTIONAL FLOW CHECK VALVE	12	AF-300	SOLID STATE AUTO-FLUSH ASSEMBLY
3	TCOB	TURBO EXHAUSTER	8	IGT	INGESTION VALVE	13	CVS	CHECK VALVE
4	ASV	ANTI-SURGE VALVE	9	SG	CYCLONIC LIQUID SEPARATOR	14	DFV	DIRECTIONAL FLOW VALVE

WHEN ORDERING ACCESSORIES, PLEASE
STATE THE HORSEPOWER OF THE TURBINE

Figure 1

Four sampling points were selected in the basement. Holes were drilled in the sewer pipes to provide access for sampling at each point.

The four points, Sites 1-4, as shown in Figure 3 were:

- (1) Site 1 - Medical x-ray and other areas of the clinic.
- (2) Site 2 - Dental operatories and the dental laboratory.
- (3) Site 3 - Combined waste leaving clinic.
- (4) Site 4 - Dental Clinic evacuation waste line.

Two other points were selected outside the clinic building at points in the interceptor sewer leaving the base (See Figure 4).

(1) Site 5 - Manhole, on perimeter road, last one before sewage leaves base, used as base sampling point.

(2) Site 6 - Manhole, between site 5 and clinic.

Other sampling was performed to determine concentrations of silver before and after silver removal (See Figure 5).

(1) Site 7 - Medical x-ray photoprocessing machine before silver recovery unit.

(2) Site 8 - Medical x-ray photoprocessing machine after silver recovery unit.

(3) Site 9 - Base photo lab waste fixer (Bulk sample).

Sampling was accomplished at sites 1-4 with Isco Model 2700 Wastewater Samplers set up in the sewer connections as shown in Figure 2. Samples were composited hourly. Only grab samples were taken at sites 5-9.

Samples for mercury were collected, preserved and delivered to AFOEHL/SA, Brooks AFB TX and analyzed in accordance with EPA Method 245.1.(4) Samples were split and an aliquot filtered to provide results for both soluble and total mercury.

The wastewater was also analyzed for silver as the photoprocessing waste from the base photo lab and the x-ray processing wastes from the clinic and dental x-ray developers are discharged through a silver recovery unit located at the clinic radiology department. Total silver was analyzed by EPA Method 272.(4)

The results of the samples are presented in Table 1. They indicate that little soluble mercury is leaving the clinic, practically none is coming from any other area of the clinic but the dental area. However, high concentrations of insoluble mercury are being discharged from the HVE. This black sediment material is carried out of the clinic and into the sewer system.

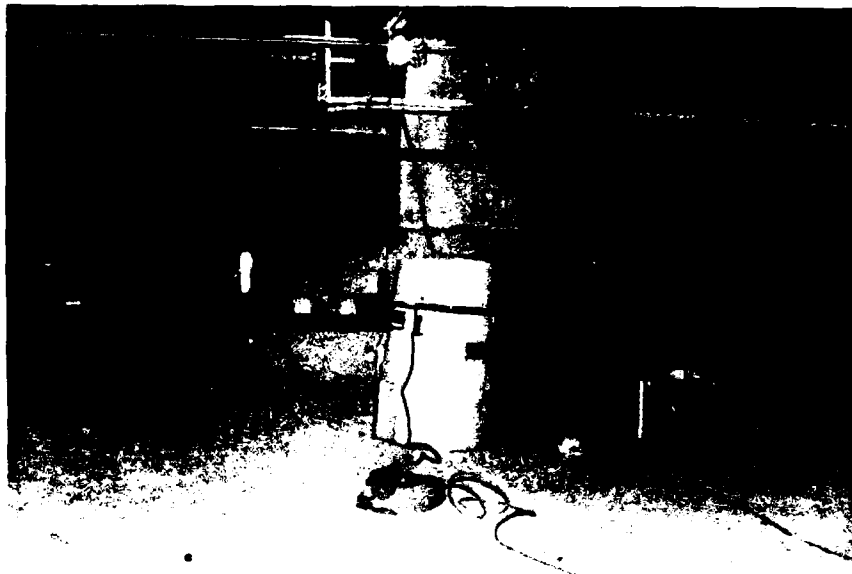
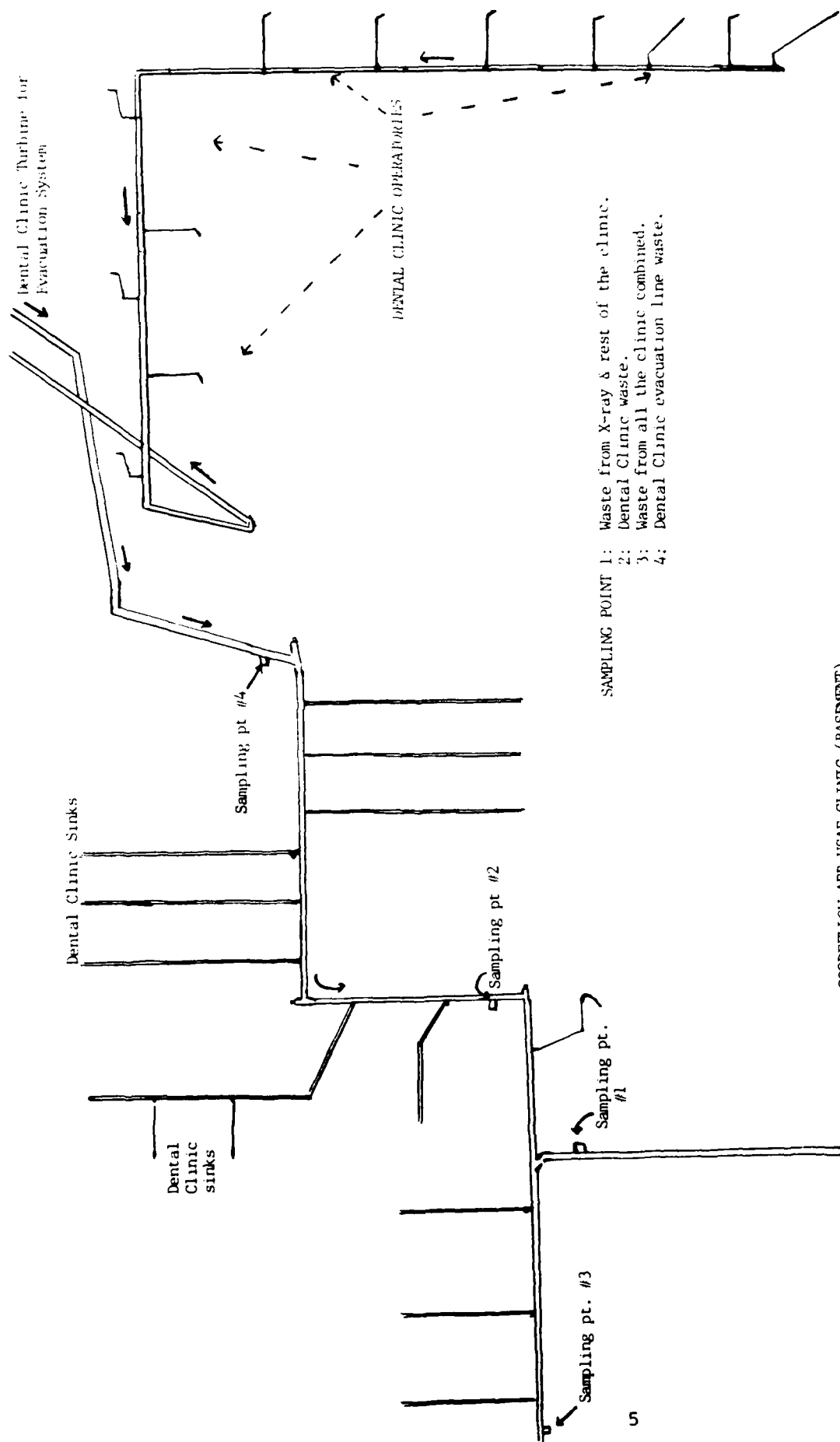


FIGURE 2. Easy Access to the Sewer Connections



SAMPLING POINT 1: Waste from X-ray & rest of the clinic.
 2: Dental Clinic waste.
 3: Waste from all the clinic combined.
 4: Dental Clinic evacuation line waste.

GOODFELLOW AFB USAF CLINIC (BASEMENT)

Figure 3

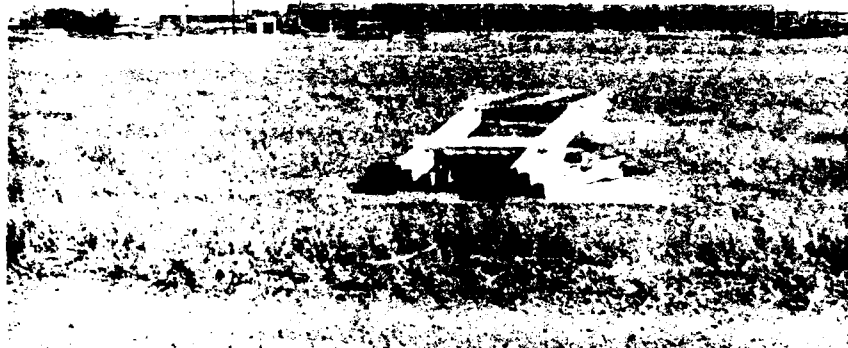


FIGURE 4. Manhole on Perimeter Road

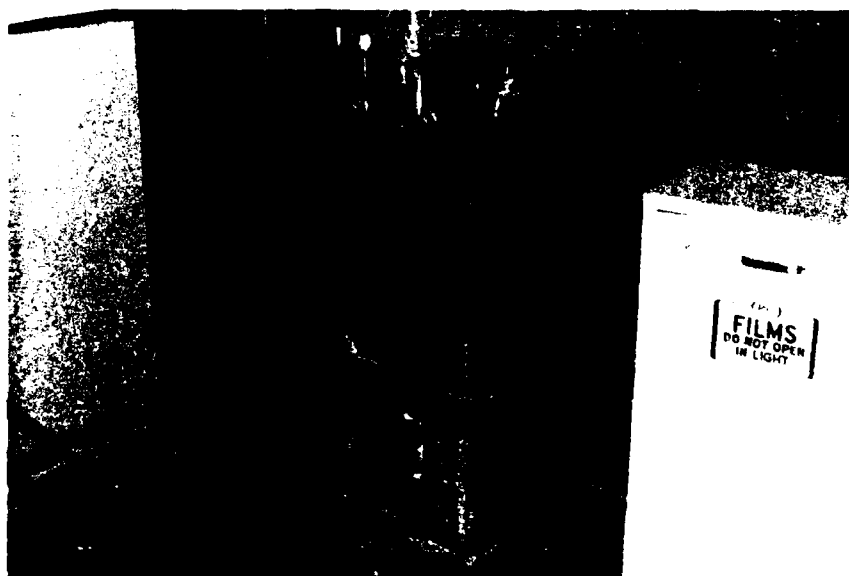


FIGURE 5. Electrolytic Silver Recovery Unit

Generally, silver is leaving in concentrations below the 100 µg/L limit. However, discharge limitations are exceeded when waste fixer is being disposed of due to the high concentrations of silver in the fixer.

Table 1. Silver and Mercury Results

<u>Sampling Date</u>	<u>Site</u>	<u>Type</u>	<u>Metals µg/L</u>	<u>pH</u>	<u>Temp</u>
10 Jan 89	1	C-3	Hg, total 2.8 soluble 2.3 Ag, total 75.0	7.67	19
10 Jan 89	1	C-24	Hg, total <1.0 soluble <1.0 Ag, total 130.0	7.85	20
11 Jan 89	1	C-18	Hg, total <1.0 soluble <1.0 Ag, total 15.0	7.38	18
10 Jan 89	2	C-3	Hg, total 6.4 soluble <1.0	7.83	19
10 Jan 89	2	C-24	Hg, total <1.0 soluble <1.0	7.68	21
11 Jan 89	2	C-18	Hg, total 10.5 soluble <1.0	7.23	19
10 Jan 89	3	C-3	Hg, total 7.3 soluble 1.7 Ag, total 33.0	8.25	20
10 Jan 89	3	C-24	Hg, total 3.1 soluble <1.0 Ag, total 22.0	7.80	20
11 Jan 89	3	C-18	Hg, total 2.1 soluble 1.5 Ag, total 15.0	7.64	19
10 Jan 89	4	C-6.5	Hg, total 2450.0 soluble 2.4	7.35	22
11 Jan 89	4	C-1.5	Hg, total 760.0 soluble 63.3	7.60	19
11 Jan 89	5	G	Hg, total 1.2 soluble <1.0 Ag, total 2518	6.52	20

<u>Sampling Date</u>	<u>Site</u>	<u>Type</u>	<u>Metals µg/L</u>	<u>pH</u>	<u>Temp</u>
11 Jan 89	6	G	Hg, total 810.0 soluble <1.0 Ag total 17.0	7.70	20
11 Jan 89	7	G	Hg, total (b) soluble (b) Ag, total 407,000	4.49	23
11 Jan 89	8	G	Hg, total (b) soluble (b) Ag, total 214,900	4.41	23
12 Jan 89	8, after G processing 9		Ag, total 9800	4.68	22
11 Jan 89	9	G	Ag, total 565,400	4.88	20

Notes:

(a) Type indicates sampling method, C-3 indicates an hourly composite taken over three hours, G indicates a grab sample was taken.

(b) Evidently high sulfites interfere with mercury analyses.

The Resource Conservation and Recovery Act (RCRA) status of the used amalgam capsules was evaluated. Ten sample capsules were provided and submitted to AFOEHL. The capsules were subjected to SW-846 Extraction Procedure (EP) for toxicity.(5) The results indicated the capsules were not a characteristic EP toxic hazardous waste. Results are as follows:

Table 2. EP Toxicity Testing on Amalgam Capsules

<u>Parameter</u>	<u>Concentrations (mg/L)</u>
Arsenic	<0.1
Barium	<1.0
Cadmium	<0.1
Chromium	<0.1
Lead	<0.3
Mercury	0.027
Selenium	<0.01
Silver	<0.1

III. CONCLUSIONS

Mercury in dental amalgam, mostly in the insoluble form, is being collected by the HVE, then discharged into the sewer system when the HVE separator/collection tank cleans itself once a day. The effluent is high in a black sediment which contains high mercury levels as shown from the sample at site 4. Evidently the slope of the sewer leading from the clinic flattens out between sites 5 and 6 resulting in the black sediment accumulating in the sewer.

Base technicians routinely take grab samples at site 9 by dipping a bottle into the channel. The fluctuation seen in the sampling results probably is related to the varying amounts of sediment captured in the bottle when water is sampled in this manner.

The specifications for the HVE call for an in-line strainer with a 40 mesh screen. The manufacturer, U.S. Turbine, was contacted and provided literature indicating that 80 or 100 mesh strainers were available to capture smaller particles than are being removed now. The strainer is part of the dental aspirating kit connected to the dental operatory unit (brochure is included in the Appendix). Although, replacement with finer screen would lessen the amount of mercury discharged to the HVE, fine materials associated with high speed drilling will still pass through. Since no particle sizing was attempted, it would be speculation to estimate the reduction in mercury levels in the sewers from replacing the strainer with one of finer mesh.

Two samples obtained from the evacuation waste line on 10 and 11 January revealed that from 92 to 99% of the mercury could be removed by filtration. Filtration is problematical, however, in that the filters are subject to plugging and require maintenance (backwash or cartridge replacement).

Gravity and enhanced gravity sedimentation is also effective in removing the sediment and mercury. Though the settling characteristics of this waste was not determined, the fact that sedimentation was occurring in the sewer indicates that gravity separation would be effective. The drawback to this process is that the sediment needs to be periodically removed since it contains putrescible material that could cause malodorous if not dangerous gas production. The sediment should be dewatered (e.g., dried) to reduce hazardous waste disposal costs.

It is possible to install either a filtration or gravity separation unit in the discharge line from the separator/collection tank. Either would be subject to the surge flow when the separator/collection tank is flushed and should be sized accordingly.

The electrolytic silver recovery unit was shown to be 47% efficient in removing silver from the medical x-ray waste fixer and 98% efficient for removing silver from the photo lab waste fixer. Evidently, the current density was too high when the medical x-ray waste was processed and as a result, the thiosulfate in the fixer decomposed to form silver sulfide, interfering with silver recovery. The waste solutions are so concentrated with silver that even when 98% recovery was achieved, a high concentration of

silver was discharged. A grab sample showed that the silver concentration (2518 µg/L) at the manhole leaving the base, site 5, greatly exceeded the effluent limit (100 µg/L).

There are more efficient silver recovery processes than electrolytic or metal replacement processes. Chemical precipitation and ion exchange technology can remove almost 100% of mercury. However, chemical precipitation can be dangerous because of the possibility of generating hydrogen sulfide gas. Ion exchange is effective in removing soluble mercury but the high solids content of the wastestream will interfere with the proper operation of the ion exchange column.

Evidently even with careful operation, electrolytic units alone will not meet discharge limits for silver. Recovery using metallic replacement can remove 95% of the silver consistently, thus alleviating the fluctuations in efficiency seen by the electrolytic process. Polishing the effluent from the electrolytic unit with a metallic replacement unit may provide sufficient treatment to meet the 100 µg/L limit.

Another potential problem with fixer disposal is its low pH, around 4.5. The City of San Angelo ordinance (Section 3, para 4c) states that no waste, wastewater, or other substance may be discharged to public sewers with a pH lower than 5.5. A legal determination indicated that this would apply to wastewater at the point where it enters the city sewer system, not at the clinic itself. At this point, site 5, the pH is well above this level. The only other problem is the corrosive nature of the waste, and the need for corrosion resistant drains and connecting pipe.

From the results of the grab samples taken at the manholes, silver apparently is also caught up in the sediments. Levels of silver in samples will fluctuate with the amount of sediment collected. Care must be taken in sampling to not introduce sediment into the sample containers, as it would not be necessarily representative of the wastestream.

Based on the EP toxicity analysis of the amalgam capsules, the capsules are not hazardous waste. The present method of disposal through normal trash is acceptable under current regulations.

IV. RECOMMENDATIONS

1. Finer mesh screens (80 mesh) should be used in the strainers attached to the dental aspirator units.

2. Either a gravity separation or filtration unit should be installed to remove the mercury from the HVE system. The unit needs to be installed after the separation tank but before any connection with pipes carrying sanitary wastes. The best location appears to be in the equipment room containing the HVE turbines and separator tank.

3. A study comparing the cost-benefit of recovering silver on base to the cost-benefit of having a contractor do it should be performed. The cost of upgrading the recovery units to add on metal substitution treatment after the electrolytic recovery unit should be weighed with the loss of revenue from having a contractor pick up the fixer and letting the contractor recover the silver.

4. If on base silver recovery continues, a metallic replacement unit should be installed after the electrolytic unit to improve efficiency of silver recovery.

5. Samples for metals should be obtained carefully with an Isco or comparable sampler to exclude introducing sediment into the sampling container.

REFERENCES

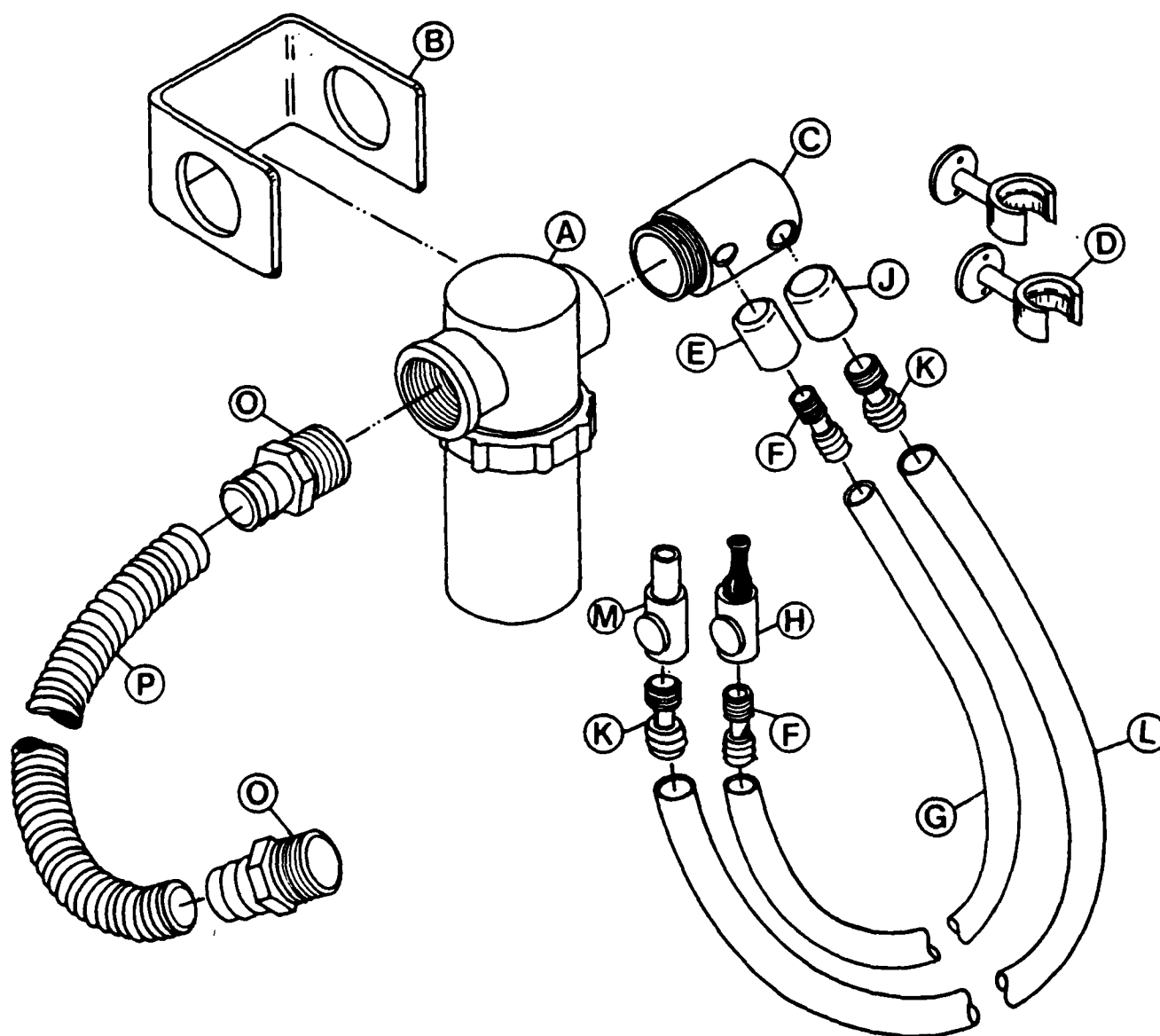
1. Marcel Pourbaix, Atlas of Electrochemical Equilibria in Aqueous Solutions, Pergamon Press, Oxford, 1966.
2. Eastman Kodak Co., Information for a Cleaner Environment, Recovering Silver from Photographic Materials, J-10, 1976.
3. Harry Fowler, Eastman Kodak Co. Technical Advisor, phone conversation, May 89
4. USEPA, Method for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Cincinnati, OH, 1983.
5. USEPA, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, 1986.
6. Beverly Brown, U.S. Turbine Corp. Technical Representative, phone conversation, Feb 89.
7. Powell, Joseph M, Foster, Carl D. and Kirk D. Satrom, Central Dental High Volume Oral Evacuation (HVE) Systems, USAFSAM-TR-86-9, Brooks AFB, May 1986.

APPENDIX
Dental Aspiration Kit

(This page left blank)

DENTAL ASPIRATING KIT OK-100

U.S. TURBINE CORPORATION
1009 N. CUYAMACA ST. • EL CAJON, CALIF. 92020
PHONE (619) 448-5200



OK-100 DENTAL ASPIRATING KIT CONSISTING OF:

NO.	AMT.	PART NO.	ITEM
A	1	IV-4	IN-UNIT FILTER ASSEMBLY.
B	1	LB-4	MOUNTING BRACKET
C	1	HJ-75	HOSE JUNCTION
D	2	W-5B	STATIONARY HOSE HANGERS
E	1	F-11	CUFF
F	2	G-11	HOSE INSERT
G	1	N-500B	SALIVA EJECTOR HOSE ASSEMBLY @ 6 FT
H	1	N-600	SALIVA EJECTOR CONTROL HANDLE
J	1	A-11	CUFF
K	2	B-11	HOSE INSERT
L	1	DC-100B	HI-VOLUME HOSE ASSEMBLY @ 6 FT
M	1	DC-200	HI-VOLUME CONTROL HANDLE
O	2	HA-75	HOSE ADAPTOR 3/4" mpt X 3/4" slip
P	1	FK-36	FLEX KIT

PARTS LIST

1/4" REF. NO. 1

Model 3350-0084

No 3351-0021 Cap
No 1700-0064 Gasket
No 3800-0048 Screen
No 3351-0020 Bowl

Model 3350-0084F

Same as above except
No 1700-0065 Gasket

Model 3350-0078

No 3351-0021 Cap
No 1700-0064 Gasket
No 3800-0048 Screen
No 3351-0020 Bowl

Model 3350-0078F

Same as above except
No 1700-0065 Gasket

Model 3350-0081

No 3351-0021 Cap
No 1700-0064 Gasket
No 3800-0047 Screen
No 3351-0020 Bowl

Model 3350-0081F

Same as above except
No 1700-0065 Gasket

3/8" REF. NO. 1

Model 3350-0086

No 3351-0023 Cap
No 1700-0064 Gasket
No 3800-0048 Screen
No 3351-0020 Bowl

Model 3350-0086F

Same as above except
No 1700-0065 Gasket

Model 3350-0080

No 3351-0023 Cap
No 1700-0064 Gasket
No 3800-0046 Screen
No 3351-0020 Bowl

Model 3350-0080F

Same as above except
No 1700-0065 Gasket

Model 3350-0083

No 3351-0023 Cap
No 1700-0064 Gasket
No 3800-0047 Screen
No 3351-0020 Bowl

Model 3350-0083F

Same as above except
No 1700-0065 Gasket

1/2" REF. NO. 1

Model 3350-0085

No 3351-0022 Cap
No 1700-0064 Gasket
No 3800-0048 Screen
No 3351-0020 Bowl

Model 3350-0085F

Same as above except
No 1700-0065 Gasket

Model 3350-0079

No 3351-0022 Cap
No 1700-0064 Gasket
No 3800-0046 Screen
No 3351-0020 Bowl

Model 3350-0079F

Same as above except
No 1700-0065 Gasket

Model 3350-0082

No 3351-0022 Cap
No 1700-0064 Gasket
No 3800-0047 Screen
No 3351-0020 Bowl

Model 3350-0082F

Same as above except
No 1700-0065 Gasket

1/2" REF. NO. 2

Model numbers with
suffix letter "P" use
No 3351-0015 Clear
Polyamide Bowl

Model 3350-0056

No 3351-0007 Cap
No 1700-0044 Gasket
No 3800-0029 Screen
No 3351-0005 Bowl
(No 1700-0045 Viton Gsk.)

Model 3350-0046

No 3351-0007 Cap
No 1700-0044 Gasket
No 3800-0025 Screen
No 3351-0005 Bowl

Model 3350-0042

Same as above except
No 1700-0045 Gasket

Model 3350-0043

No 3351-0007 Cap
No 1700-0044 Gasket
No 3800-0026 Screen
No 3351-0005 Bowl

Model 3350-0068

Same as above except
No 1700-0045 Gasket

Model 3350-0036

No 3351-0007 Cap
No 1700-0044 Gasket
No 3800-0027 Screen
No 3351-0005 Bowl

Model 3350-0041

Same as above except
No 1700-0045 Gasket

Model 3350-0098

No 3351-0007 Cap
No 1700-0044 Gasket
No 3800-0052 Screen
No 3351-0005 Bowl

Model 3350-0099

Same as above except
No 1700-0045 Gasket

Model 3350-0096

No 3351-0007 Cap
No 1700-0044 Gasket
No 3800-0051 Screen
No 3351-0005 Bowl

Model 3350-0097

Same as above except
No 1700-0045 Gasket

3/4" REF. NO. 2

Model numbers with
suffix letter "P" use
No 3351-0015 Clear
Polyamide Bowl

Model 3350-0040

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0029 Screen
No 3351-0005 Bowl
(No 1700-0045 Viton Gsk.)

Model 3350-0034

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0025 Screen
No 3351-0005 Bowl

Model 3350-0044

Same as above except
No 1700-0045 Gasket

Model 3350-0035

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0026 Screen
No 3351-0005 Bowl

Model 3350-0045

Same as above except
No 1700-0045 Gasket

Model 3350-0037

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0027 Screen
No 3351-0005 Bowl

Model 3350-0047

Same as above except
No 1700-0045 Gasket

Model 3350-0094

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0052 Screen
No 3351-0005 Bowl

Model 3350-0095

Same as above except
No 1700-0045 Gasket

Model 3350-0092

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0051 Screen
No 3351-0005 Bowl

Model 3350-0093

Same as above except
No 1700-0045 Gasket

Model 3350-0101P

No 3351-0006 Cap
No 1700-0044 Gasket
No 3800-0058 Screen
No 3351-0015 Bowl

1" REF. NO. 2

Model numbers with
suffix letter "P" use
No 3351-0024 Clear
Polyamide Bowl

Model 3350-0057

No 3351-0014 Cap
No 1700-0057 Gasket
No 3800-0040 Screen
No 3351-0013 Bowl

Model 3350-0060

Same as above except
No 1700-0058 Gasket

Model 3350-0058

No 3351-0014 Cap
No 1700-0057 Gasket
No 3800-0041 Screen
No 3351-0013 Bowl

Model 3350-0061

Same as above except
No 1700-0058 Gasket

Model 3350-0059

No 3351-0014 Cap
No 1700-0057 Gasket
No 3800-0042 Screen
No 3351-0013 Bowl

Model 3350-0062

Same as above except
No 1700-0058 Gasket

Model 3350-0088

No 3351-0014 Cap
No 1700-0057 Gasket
No 3800-0050 Screen
No 3351-0013 Bowl

Model 3350-0089

Same as above except
No 1700-0058 Gasket

Model 3350-0065

No 3351-0014 Cap
No 1700-0057 Gasket
No 3800-0055 Screen
No 3351-0013 Bowl

Model 3350-0066

Same as above except
No 1700-0058 Gasket

Model 3350-0102P

No 3351-0012 Cap
No 1700-0057 Gasket
No 3800-0059 Screen
No 3351-0024 Bowl

1 1/2" REF. NO. 2

Model numbers with
suffix letter "P" use
No 3351-0024 Clear
Polyamide Bowl

Model 3350-0071

No 3351-0016 Cap
No 1700-0057 Gasket
No 3800-0043 Screen
No 3351-0013 Bowl

Model 3350-0074

Same as above except
No 1700-0058 Gasket

Model 3350-0072

No 3351-0016 Cap
No 1700-0057 Gasket
No 3800-0044 Screen
No 3351-0013 Bowl

Model 3350-0075

Same as above except
No 1700-0058 Gasket

Model 3350-0073

No 3351-0016 Cap
No 1700-0057 Gasket
No 3800-0045 Screen
No 3351-0013 Bowl

Model 3350-0076

Same as above except
No 1700-0058 Gasket

Model 3350-0090

No 3351-0016 Cap
No 1700-0057 Gasket
No 3800-0053 Screen
No 3351-0013 Bowl

Model 3350-0091

Same as above except
No 1700-0058 Gasket

Model 3350-0063

No 3351-0016 Cap
No 1700-0057 Gasket
No 3800-0054 Screen
No 3351-0013 Bowl

Model 3350-0064

Same as above except
No 1700-0058 Gasket

1 1/4" REF. NO. 3

Model 3350-0053

No 3351-0011 Cap
No 1700-0051 Gasket
No 3800-0036 Screen
No 3351-0010 Bowl

Model 3350-0053E

Same as above except
No 1700-0063 Gasket

Model 3350-0050

No 3351-0011 Cap
No 1700-0051 Gasket
No 3800-0031 Screen
No 3351-0010 Bowl

Model 3350-0050E

Same as above except
No 1700-0063 Gasket

Model 3350-0051

No 3351-0011 Cap
No 1700-0051 Gasket
No 3800-0032 Screen
No 3351-0010 Bowl

Model 3350-0051E

Same as above except
No 1700-0063 Gasket

Model 3350-0052

No 3351-0011 Cap
No 1700-0051 Gasket
No 3800-0033 Screen
No 3351-0010 Bowl

Model 3350-0052E

Same as above except
No 1700-0063 Gasket

Model 3350-0087

No 3351-0011 Cap
No 1700-0051 Gasket
No 3800-0049 Screen
No 3351-0010 Bowl

Model 3350-0087E

Same as above except
No 1700-0063 Gasket

1 1/2" REF. NO. 4

Model numbers with
suffix letter "P" use
No 3351-0024 Clear
Polyamide Bowl

Model 3350-0112

No 3351-0026 Cap
No 3351-0013 Bowl
No 1700-0057 Gasket
No 3800-0065 Screen

Model 3350-0115

Same as above except
No 1700-0058 Gasket

Model 3350-0113

No 3351-0026 Cap
No 3351-0013 Bowl
No 1700-0057 Gasket
No 3800-0066 Screen

Model 3350-0116

Same as above except
No 1700-0058 Gasket

Model 3350-0114

No 3351-0026 Cap
No 3351-0013 Bowl
No 1700-0057 Gasket
No 3800-0067 Screen

Model 3350-0117

Same as above except
No 1700-0058 Gasket

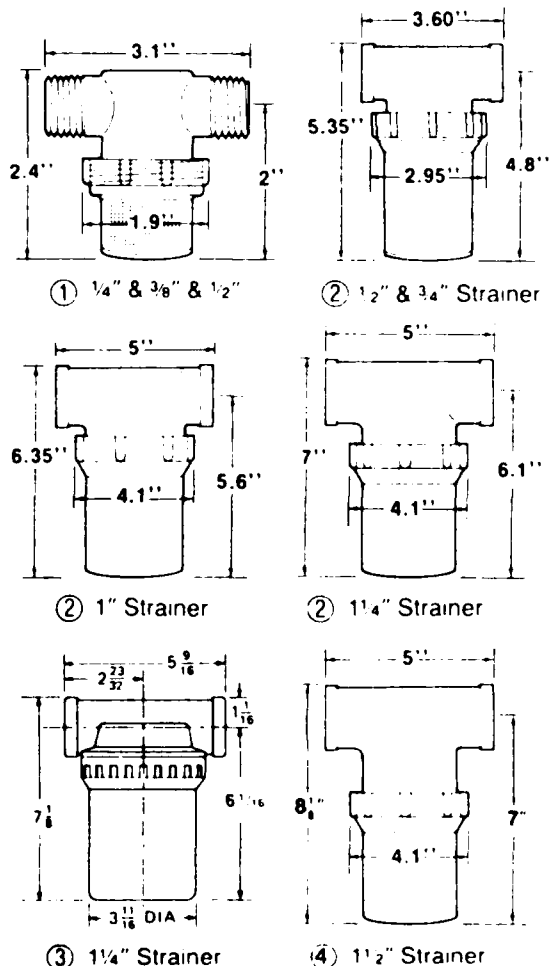
INSTALLATION

The line strainer is normally installed on the inlet side of the pump. However, with centrifugal pumps, a strainer can be installed on either the inlet or discharge side, depending on strainer flow capacity, strainer pressure rating and other installation factors. The arrow molded in the strainer cap indicates flow of liquid. A shut-off valve should be installed between the strainer and liquid source for convenience when cleaning the strainer. NOTE: Clear polyamide bowl not recommended for use with alcohol.

CLEANING

Cleaning is accomplished easily without removing the strainer from the line. Simply unscrew bowl from cap and take out screen. Flush sediment from screen with water and re-assemble strainer by first fitting the screen to the flange in the bowl. Replace gasket if it is cut or showing excessive wear. Align gasket to assure proper seal before tightening bowl. Turning bowl hand tight provides sufficient seal against cap.

DIMENSIONS (In Inches)



U.S. TURBINE CORPORATION

1099 N. CHYAMACA ST. • EL CAJON, CALIF. 92020

LINE STRAINERS

1/4" through 1 1/2" sizes



Durable Type 6 Nylon Cap and Bowls connected by National Buttress Threads (NBT).

Ref. No. 1 Strainer — Male threaded ports, 1/4", 3/8" and 1/2" NPT port sizes. Clear polyamide bowl allows for visual inspection without disassembly. Buna-N or Viton gasket. 20, 40, or 80 mesh stainless steel screens.
Rating: 150 psi at 70° F./100 psi at 125° F.

Ref. No. 2 Strainer — Female ports with stainless steel ferrule reinforcements. 1/2", 3/4", 1" and 1 1/2" NPT port sizes. Buna-N or Viton gasket. Heavy duty stainless steel and Monel screens available. Clear polyamide bowl available.
Rating: 150 psi at 70° F./100 psi at 125° F.

NOTE: Clear polyamide bowl not recommended for use with alcohol.

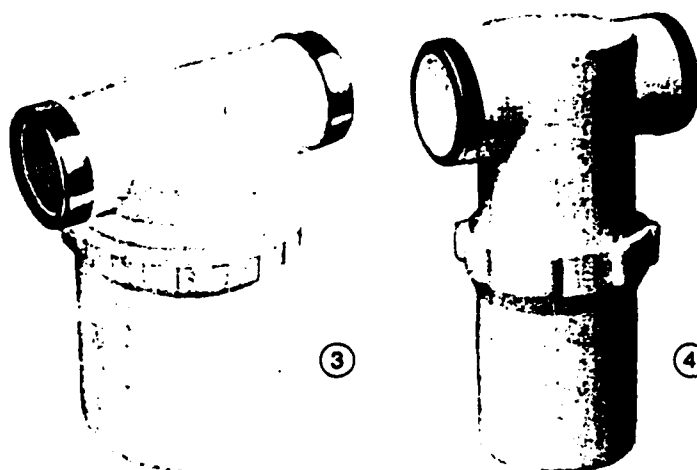
Ref. No.	Model Number	Screen	Gasket	Open Area
1/4"	1 3350-0084	20 SS	Buna-N	2.17 Sq In
	1 3350-0084F	20 SS	Viton	2.17 Sq In
	1 3350-0078	40 SS	Buna-N	1.75 Sq In
	1 3350-0078F	40 SS	Viton	1.75 Sq In
	1 3350-0081	80 SS	Buna-N	1.34 Sq In
	1 3350-0081F	80 SS	Viton	1.34 Sq In
3/8"	1 3350-0086	20 SS	Buna-N	2.17 Sq In
	1 3350-0086F	20 SS	Viton	2.17 Sq In
	1 3350-0080	40 SS	Buna-N	1.75 Sq In
	1 3350-0080F	40 SS	Viton	1.75 Sq In
	1 3350-0083	80 SS	Buna-N	1.34 Sq In
	1 3350-0083F	80 SS	Viton	1.34 Sq In
1/2"	1 3350-0085	20 SS	Buna-N	2.17 Sq In
	1 3350-0085F	20 SS	Viton	2.17 Sq In
	1 3350-0079	40 SS	Buna-N	1.75 Sq In
	1 3350-0079F	40 SS	Viton	1.75 Sq In
	1 3350-0082	80 SS	Buna-N	1.34 Sq In
	1 3350-0082F	80 SS	Viton	1.34 Sq In

1/2"	2 3350-0056	20 SS	Buna-N	9.6 Sq In
	2 3350-0046	40 SS	Buna-N	7.7 Sq In
	2 3350-0042	40 SS	Viton	7.7 Sq In
	2 3350-0043	80 SS	Buna-N	5.9 Sq In
	2 3350-0068	80 SS	Viton	5.9 Sq In
	2 3350-0036	80 Monel	Buna-N	5.9 Sq In
	2 3350-0041	80 Monel	Viton	5.9 Sq In
	2 3350-0098	50 SS Heavy Duty	Buna-N	7 Sq In
	2 3350-0099	50 SS Heavy Duty	Viton	7 Sq In
	2 3350-0096	100 SS Heavy Duty	Buna-N	5 Sq In
	2 3350-0097	100 SS Heavy Duty	Viton	5 Sq In

Add suffix letter "P" to model number for clear polyamide bowl

3/4"	2 3350-0040	20 SS	Buna-N	9.6 Sq In
	2 3350-0034	40 SS	Buna-N	7.7 Sq In
	2 3350-0044	40 SS	Viton	7.7 Sq In
	2 3350-0035	80 SS	Buna-N	5.9 Sq In
	2 3350-0045	80 SS	Viton	5.9 Sq In
	2 3350-0037	80 Monel	Buna-N	5.9 Sq In
	2 3350-0047	80 Monel	Viton	5.9 Sq In
	2 3350-0094	50 SS Heavy Duty	Buna-N	7 Sq In
	2 3350-0095	50 SS Heavy Duty	Viton	7 Sq In
	2 3350-0092	100 SS Heavy Duty	Buna-N	5 Sq In
	2 3350-0093	100 SS Heavy Duty	Viton	5 Sq In
	2 3350-0101P	70 Micron	Buna-N	6.8 Sq In

Add suffix letter "P" to model number for clear polyamide bowl



Ref. No. 3 Strainer — Female ports with stainless steel ferrule reinforcements. 1/4" NPT port size only. Buna-N or EPDM gasket. 10, 20, 40, 80 mesh with 20 mesh external reinforcement and 50 mesh heavy duty stainless steel screens.
Rating: 50 psi at 70° F.

Ref. No. 4 Strainer — Female ports with stainless steel ferrule reinforcements. 1/2" NPT port size only. Buna-N or Viton gasket. Clear polyamide bowl available.
Rating: 150 psi at 70° F./100 psi at 125° F.

Ref. No.	Model Number	Screen	Gasket	Open Area
1"	2 3350-0057	20 SS	Buna-N	16.8 Sq In
	2 3350-0060	20 SS	Viton	16.8 Sq In
	2 3350-0058	40 SS	Buna-N	13.5 Sq In
	2 3350-0061	40 SS	Viton	13.5 Sq In
	2 3350-0059	80 on 20 SS	Buna-N	10 Sq In
	2 3350-0062	80 on 20 SS	Viton	10 Sq In
	2 3350-0088	50 SS Heavy Duty	Buna-N	12 Sq In
	2 3350-0089	50 SS Heavy Duty	Viton	12 Sq In
	2 3350-0065	100 SS Heavy Duty	Buna-N	9 Sq In
	2 3350-0066	100 SS Heavy Duty	Viton	9 Sq In
	2 3350-0102P	70 Micron	Buna-N	11.5 Sq In

Add suffix letter "P" to model number for clear polyamide bowl

1 1/4"	2 3350-0071	20 SS	Buna-N	18 Sq In
	2 3350-0074	20 SS	Viton	18 Sq In
	2 3350-0072	40 SS	Buna-N	14.5 Sq In
	2 3350-0075	40 SS	Viton	14.5 Sq In
	2 3350-0073	80 on 20 SS	Buna-N	11 Sq In
	2 3350-0076	80 on 20 SS	Viton	11 Sq In
	2 3350-0090	50 SS Heavy Duty	Buna-N	13 Sq In
	2 3350-0091	50 SS Heavy Duty	Viton	13 Sq In
	2 3350-0063	100 SS Heavy Duty	Buna-N	9.75 Sq In
	2 3350-0064	100 SS Heavy Duty	Viton	9.75 Sq In

Add suffix letter "P" to model number for clear polyamide bowl

1 1/4"	3 3350-0053	10 SS	Buna-N	24 Sq In
	3 3350-0053E	10 SS	EPDM	24 Sq In
	3 3350-0050	20 SS	Buna-N	21 Sq In
	3 3350-0050E	20 SS	EPDM	21 Sq In
	3 3350-0051	40 SS	Buna-N	17.5 Sq In
	3 3350-0051E	40 SS	EPDM	17.5 Sq In
	3 3350-0052	80 on 20 SS	Buna-N	13.5 Sq In
	3 3350-0052E	80 on 20 SS	EPDM	13.5 Sq In
	3 3350-0087	50 SS Heavy Duty	Buna-N	15 Sq In
	3 3350-0087E	50 SS Heavy Duty	EPDM	15 Sq In

1 1/2"	4 3350-0112	20 SS	Buna-N	20.8 Sq In
	4 3350-0115	20 SS	Viton	20.8 Sq In
	4 3350-0113	40 SS	Buna-N	16.4 Sq In
	4 3350-0116	40 SS	Viton	16.4 Sq In
	4 3350-0114	80 SS	Buna-N	12.4 Sq In
	4 3350-0117	80 SS	Viton	12.4 Sq In

Add suffix letter "P" to model number for clear polyamide bowl

(This page left blank)

Distribution List

	Copies
HQ USAF/SGPA Bolling AFB DC 20332-6188	2
HQ AFSC/SGPB Andrews AFB DC 20334-5000	2
USAF Clinic Goodfellow/SGPB Goodfellow AFB TX 76908-5300	3
3480 CES/DEEV Goodfellow AFB TX 76908-5000	2
HQ ATC/DEEV Randolph AFB TX 78150-5001	2
HQ ATC/SGPB Randolph AFB TX 78150-5001	2
AAMRL/TH Wright-Patterson AFB OH 45433-6573	2
USAF Regional Medical Center Weisbaden/SGB APO New York 09220-5300	1
OL AD, AFOEHL APO San Francisco 96274-5000	1
USAFSAM/TSK Brooks AFB TX 78235-5301	1
Defense Technical Information Center (DTIC) Cameron Station Alexandria VA 22304-6145	2
HQ USAF/LEEV Bolling AFB DC 20330-5000	2
HQ AFESC/RDV Tyndall AFB FL 32403-6001	2
HQ HSD/XAE Brooks AFB TX 78235-5000	1
USAFSAM/EDH Brooks AFB TX 78235-5301	1