SUMMA CANISTER CLEANING PROCEDURES

SOP#: 1703
DATE: 09/01/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is intended for use when cleaning Summa polished stainless steel canisters. Summa canisters provide a medium to sample gas-phase Volatile Organic Compounds (VOCs) on-site at concentrations of one part per billion by volume (ppbv) and greater. This procedure is to assure that canisters have been sufficiently cleaned prior to sampling, to the extent that no VOC contamination is present at concentrations greater than 0.2 ppbv.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

After use, canisters are logged in and physically inspected. These canisters are vented to the outside air under an operating exhaust hood. Canisters are connected to a manifold which is attached to a vacuum pump via a cryogenic trap. The canisters and lines are evacuated and then the canisters are heated to an elevated temperature for a prescribed time period. During the heating period, the canisters are filled with humidified nitrogen and pressurized. The process is repeated. The filling and pressurizing functions are followed by evacuation and heating and are performed a total of three times.

Canisters are confirmed free of VOC contamination by pressurizing the canisters with ultra high purity nitrogen and analyzing on the GC/MS. If no VOC contamination is present at concentrations greater than 0.2 ppbv, the canister is determined clean. Clean canisters are leak-tested by pressurizing with nitrogen for 24 hours. Canisters that have been determined clean and without leaks are evacuated. These canisters are logged in as cleaned and certified and are stored in the evacuated state with brass cap fittings until needed for sampling.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

3.1 Canister Receipt

1. The overall condition of each sample canister is observed. Any canister having physical defects requires corrective action.

2. Each canister should be observed for an attached sample identification number.

3. Each canister is recorded in the dedicated laboratory logbook by its Summa canister number.

3.2 Canister Storage

1. Canisters are stored in an evacuated state of less than 0.05 mm Hg and with a brass cap in place. The canisters remain in this state until needed.

2. An identification tag is attached to the neck of each canister for field notes and to complete the chain of custody record.

3. Each canister is recorded in the dedicated laboratory logbook stating the canister status and storage location. Also noted on the identification tag are the date cleaned and date certified clean, as well as the initials of the operator.

4.0 INTERFERENCE AND POTENTIAL PROBLEMS

Contamination may occur in the sample canisters if they are not properly cleaned before use. All other equipment used in this process must be sufficiently clean. All gases and solvents used must be certified 99.99% pure to avoid contamination. Canisters must be stored with the valve closed and the brass caps in place to avoid vacuum loss.

5.0 EQUIPMENT/APPARATUS

5.1 Canister

Sample canister - Leak-free stainless steel pressure vessels at desired volume (e.g., 6L), with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialists, Inc., P.O. Box 8941, Moscow, ID, 83843 or Anderson Samplers, Inc., 4215-C Wendell Dr., Atlanta, GA, 30336), or equivalent.

5.2 Canister Cleaning System (Figure 1, Appendix A)

Vacuum pump - capable of evacuating sample canister(s) to an absolute pressure of <0.05 mm Hg.

Manifold - stainless steel manifold with connections for simultaneously cleaning several canisters.

Shutoff valve(s) - two on/off toggle valves (Valves A, and B).

Stainless steel vacuum gauge (pressure gauge) - capable of measuring vacuum in the manifold to an absolute pressure of <0.05 mm Hg or less.

Cryogenic trap - stainless steel U-shaped open tubular trap cooled with liquid nitrogen to prevent contamination from back diffusion of oil from vacuum pump.

Stainless steel two-stage pressure regulator 0-690 kPa (0-100 psig) to regulate nitrogen pressure.

Teflon tee with a septum port - an injection port capable of introducing distilled, deionized water to provide moisture to the nitrogen supply line.

Isothermal oven - a system for heating canisters (Fisher Scientific, Pittsburgh, PA, Model 349) or equivalent.

6.0 REAGENTS

Gas cylinders of nitrogen, ultra high purity grade.

Cryogen - liquid nitrogen (bp -195EC).

Distilled, deionized water, ultra high purity.

7.0 PROCEDURE

7.1 System Set-Up

1. All connections in the vacuum system except the canisters and manifold are sealed. All connections, lines, and valves are checked for leaks by pressurizing the line to 30 psig and using a soap solution. The septum is checked for leaks by visual inspection.

2. The liquid nitrogen is added to the cryogenic trap and allowed to equilibrate.

3. Check the pump to assure proper working order by achieving a vacuum of 0.05 mm Hg in the line that normally attaches to the manifold but is now capped. Valve A is open and Valve B is closed. After the vacuum test is completed, turn the pump off and remove the cap to break the vacuum.

4. Check the oven to assure proper working order by heating the oven to 100EC and measuring the internal temperature with a thermometer.

5. Check reagents to assure proper purity.

6. Set the back pressure on the nitrogen to 30 psig.

7.2 Cleaning

1. All canisters are vented to the outside air under an operating exhaust hood.

2. Connect the canisters (with the valves closed on the canisters) to the manifold by the Swagelok fittings. Connect the manifold to

the vacuum system by the Swagelok fitting.

3. Open Valve A, assure Valve B is closed, and start vacuum pump.

4. Once a vacuum (0.05 mm Hg) is obtained in the line and the manifold, Valve A is closed. The system is then examined for leaks by comparing the initial vacuum reading and a second vacuum reading three minutes later. If the vacuum deteriorates more than 5 mm Hg, a leak exists and corrective action, such as tightening all fittings, is necessary.

5. If no leaks are observed, Valve A is opened and the Canister 1 valve is opened. Evacuate Canister 1 to 0.05 mm Hg, then close Canister 1 valve. By evacuating one canister at a time, cross contamination between canisters is minimized.

6. Evacuate all other canisters in the same manner as described in the above step.

7. After all four canisters are evacuated, open all canister valves. Turn on the oven and heat to 100EC.

8. Continue evacuating canisters for one hour at 100EC. Document the time.

9. After one hour, Valve A is closed and Valve B is opened, with the regulator metering the flow of nitrogen.

10. Inject 100 µL of distilled, deionized water via a syringe through the humidity injector port in the nitrogen line.

11. Allow the canisters to pressurize to 30 psig for 15 minutes.

12. Close Valve B.

13. Close canister valves.

14. Repeat steps 5 through 13, twice.

15. Close valves on canisters.

16. Close Valve A.

17. Turn off vacuum pump.

18. Disconnect manifold from cleaning system.

19. Disconnect canisters from the manifold and place a brass cap on each canister.

20. Choose the one canister of this set of four, that was analyzed as being the most highly contaminated previous to cleaning. Fill this canister with ultra high purity nitrogen to a pressure of 30 psig.

21. Analyze the above canister for VOC contamination by GC/MS. If this canister is sufficiently clean to the extent that no VOC contamination is present at concentrations greater than 0.2 ppbv, then all canisters in that set of four are considered clean. Document the results.

22. Evacuate the above canister again to 0.05 mm Hg, cap it with a brass fitting, and store it with the other three of the lot. Document the location.

23. If the above canister is not sufficiently clean (i.e. VOC contamination is present at concentrations greater than 0.2 ppbv), then all canisters in that lot must be cleaned again until the canisters meet the prescribed criteria. Document the results.

7.3 Leak-Testing

1. Once the canister lot is determined as being clean, the canisters are pressurized to 30 psig with nitrogen.

2. The initial pressure is measured via the pressure gauge, the canister valve is closed, and the brass cap is replaced. Document the time and pressure.

3. After 24 hours, the final pressure is checked. Document the time and pressure.

4. If leak tight, the pressure should not vary more than ±13.8 kPa (±2 psig) over the 24-hour period. If this criterion is met, the canister is capped with a brass fitting and stored. If a leak is present, corrective action such as tightening all fittings, is required. Document the results.

8.0 CALCULATIONS

There are no calculations for this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following specific quality assurance/quality control procedures are applicable for Summa canister cleaning:

1. All connections, lines, and valves are checked to assure no leaks are present.

2. The septum is checked, to assure no leaks are present, by removing the septum and visually examining it.

3. The pump is checked to assure proper working order by achieving a vacuum of 0.05 mm Hg prior to cleaning.

4. The oven is checked to assure proper working order by comparing the oven setting at 100EC to the internal temperature with a thermometer.

5. The reagents are checked to assure sufficient purity.

6. All canisters are to be evacuated to 0.05 mm Hg during each cycle of the cleaning process and the results are to be documented.

7. All canisters are to be evacuated at 100EC for one hour during each cycle of the cleaning process. Results are to be documented.

8. All canisters are to be evacuated, heated, and pressurized three times during the cleaning process. Document each cycle.

9. The selected canister from the cleaning lot to be tested must be analyzed by GC/MS as shown to be sufficiently cleaned to the extent that no VOC contamination is present at concentrations greater than 0.2 ppbv for the canister lot to be considered cleaned. If the VOC contamination is greater than 0.2 ppbv, the canister lot must be cleaned again. In either case, the results will be documented.

10. All canisters will be leak-tested for 24 hours and the results will be documented.

11. All canisters will be stored evacuated and capped with a brass fitting. The pressure and location will be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA or corporate health and safety practices. More specifically, liquid nitrogen is used to cool the cryogenic trap. Its boiling point is -196EC. Insulated gloves, lab coat, face shield, and safety glasses must be worn when using this material. Liquid nitrogen must be transported only in properly constructed containers.

Ultra high purity nitrogen is used to clean the canisters and must be labeled properly. All cylinders must be securely fastened to a stationary object. The cylinder valve should only be opened by hand. The proper regulator must be used and set correctly.

The oven is set to a temperature of 100EC. Insulated gloves should be worn when handling items heated to this temperature.

Prior to cleaning, canisters are to be vented to the atmosphere under an operating exhaust hood. The hood must be in proper working order.

Canisters are pressurized during the cleaning operation. No canister is to be pressurized above 30 psig. The maximum pressure limit for the Summa canisters is 40 psig.

12.0 REFERENCES

ASTM Standards D1356-73A - Standard Definitions of Terms and Relating to Atmospheric Sampling and Analysis.

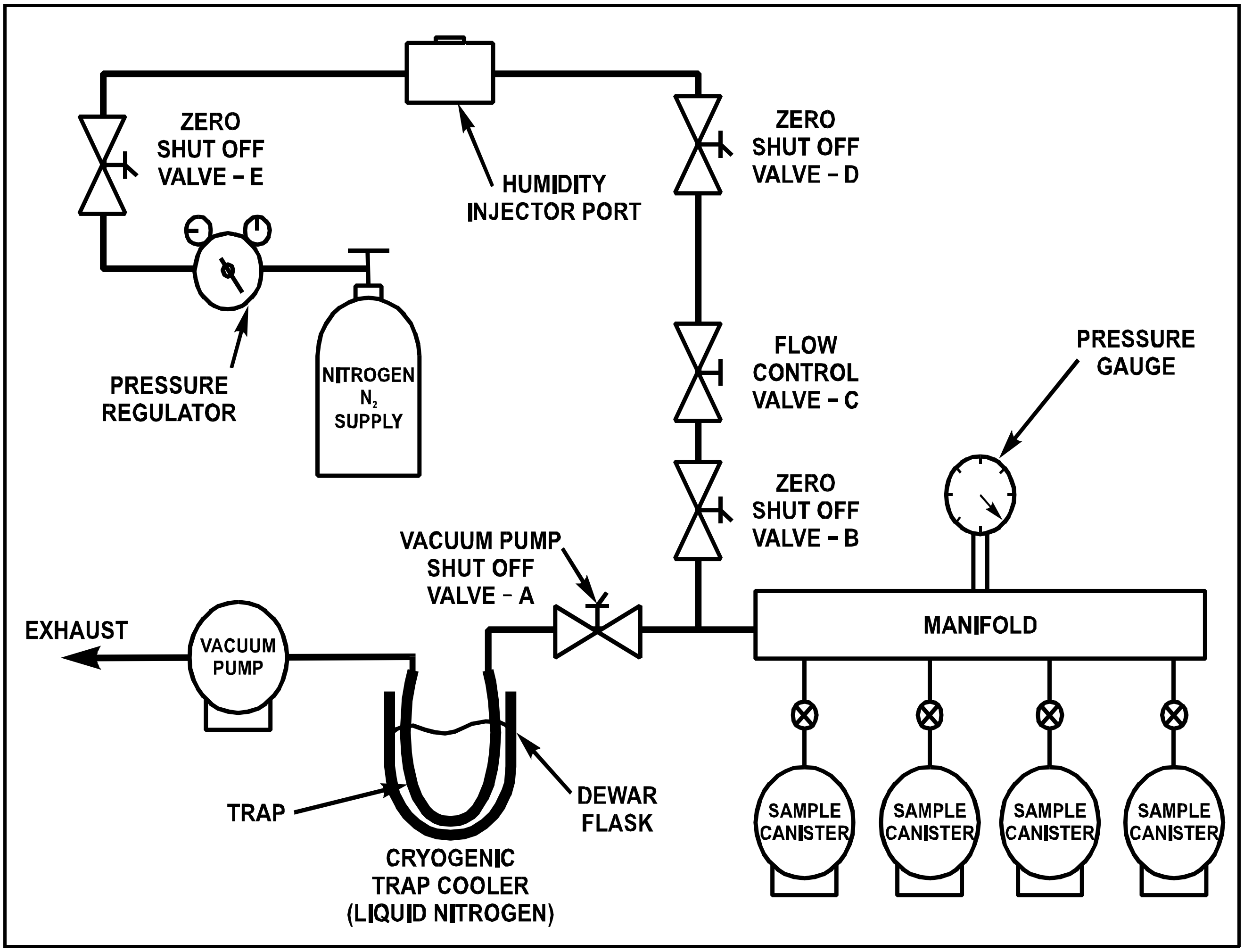
Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air EPA/600/4-87/006, September 1986, Method TO-14

- Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Summa Canister Sampling and Gas Chromatographic Analysis.

APPENDIX A

Figure

FIGURE 1. Canister Cleaning System



SUMMA CANISTER SAMPLING

SOP#: 1704
DATE: 07/27/95
REV. #: 0.1

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe a procedure for sampling of volatile organic compounds (VOCs) in ambient air. The method is based on samples collected as whole air samples in Summa passivated stainless steel canisters. The VOCs are subsequently separated by gas chromatography (GC) and measured by mass-selective detector or multidetector techniques. This method presents procedures for sampling into canisters at final pressures both above and below atmospheric pressure (respectively referred to as pressurized and subatmospheric pressure sampling).

This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. The organic compounds that have been successfully collected in pressurized canisters by this method are listed in the Volatile Organic Compound Data Sheet (Appendix A). These compounds have been measured at the parts per billion by volume (ppbv) level.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Both subatmospheric pressure and pressurized sampling modes use an initially evacuated canister. Both modes may also use a mass flow controller/vacuum pump arrangement to regulate flow. With the above configuration, a sample of ambient air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into a pre-evacuated Summa passivated canister. Alternatively, subatmospheric pressure sampling may be performed using a fixed orifice, capillary, or adjustable micrometering valve in lieu of the mass flow controller/vacuum pump arrangement for taking grab samples or short duration time-integrated samples. Usually, the alternative types of flow controllers are appropriate only in situations where screening samples are taken to assess for future sampling activities.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister, and the canister is transported to a laboratory for analysis. Upon receipt at the laboratory, the canister tag data is recorded. Sample holding times and expiration should be determined prior to initiating field activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g., pump and flow controllers) should be thoroughly cleaned.

5.0 EQUIPMENT/APPARATUS

The following equipment/apparatus (Figure 1, Appendix B) is required:

5.1 Subatmospheric Pressure Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100 or equivalent).

2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).

4. Particulate matter filter - 2-µm sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).

5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. #8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6. Fixed orifice, capillary, or adjustable micrometering valve - used in lieu of the electronic flow controller/vacuum pump for grab samples or short duration time-integrated samples.

5.2 Pressurized Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100).

2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).

4. Particulate matter filter - 2-µm sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).

5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. #8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Subatmospheric Pressure Sampling

7.1.1 Sampling Using a Fixed Orifice, Capillary, or Adjustable Micrometering Valve

1. Prior to sample collection, the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).

2. A canister, which is evacuated to 0.05 mm Hg and fitted with a flow restricting device, is opened to the atmosphere containing the VOCs to be sampled.

3. The pressure differential causes the sample to flow into the canister.

4. This technique may be used to collect grab samples (duration of 10 to 30 seconds) or time-integrated samples (duration of 12 to 24 hours). The sampling duration depends on the degree to which the flow is restricted.

5. A critical orifice flow restrictor will have a decrease in the flow rate as the pressure approaches atmospheric.

6. Upon sample completion at the location, the appropriate information is recorded on the

Canister Sampling Field Data Sheet.

7.1.2 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Andersen Sampler Model 87-100)

1. Prior to sample collection the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).

2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.

3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.

4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.

5. The initially evacuated canister is filled by action of the flow controlled pump to near atmospheric pressure.

6. A digital time-program is used to pre-select sample duration and start and stop times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

7.2 Pressurized Sampling

7.2.1 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Anderson Sampler Model 87-100)

1. Prior to sample commencement at the location, the appropriate information is completed on the Canister Sampling Field Data Sheet.

2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.

3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.

4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.

5. The initially evacuated canister is filled by action of the flow controlled pump to a positive pressure not to exceed 25 psig.

6. A digital time-programmer is used to pre-select sample duration and start and stop times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

8.0 CALCULATIONS

1. A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled to about 88.1 kPa for subatmospheric pressure sampling or to about one atmosphere above ambient pressure for pressurized sampling over the desired sample period. The flow rate can be calculated by:

$$F = \frac{(P)(V)}{(T)(60)}$$

where:

F = flow rate (cm^3/min)
P = final canister pressure, atmospheres absolute
V = volume of the canister (cm^3)
T = sample period (hours)

For example, if a 6-L canister is to be filled to 202 kPa (two atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by:

$$F = \frac{(2)(6000)}{(24)(60)} = 8.3 cm^3/\mathrm{min}$$

2. If the canister pressure is increased, a dilution factor (DF) is calculated and recorded on the sampling data sheet.

$$DF = \frac{Ya}{Xa}$$

where:

Xa = canister pressure (kPa, psia) absolute before dilution.
Ya = canister pressure (kPa, psia) absolute after dilution.

After sample analysis, detected VOC concentrations are multiplied by the dilution factor to determine concentration in the sampled air.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain of custody records, field data sheets, or site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices. Specifically, pressurizing of Summa canisters should be performed in a well ventilated room, or preferably under a fume hood. Care must be taken not to exceed 40 psi in the canisters. Canisters are under pressure, albeit only 20-30 psi, and should not be dented or punctured. They should be stored in a cool dry place and always be placed in their plastic shipping boxes during transport and storage.

12.0 REFERENCES

1. Ralph M. Riggin, Technical Assistance Document for Sampling and Analysis of Toxic Organic Compounds in Ambient Air, EPA-600/4-83-027 U. S. Environmental Protection Agency, Research Triangle Park, NC, 1983.

2. W. A. McClenny, J. D. Pleil, T. A. Lumpkin and K. D. Oliver, "Update on Canister-Based Samplers for VOCs," Proceedings of the 1987 EPA/APCA Symposium on Measurement of Toxic and Related Air Pollutants, May, 1987 APCA Publication VIP-8, EPA 600/9-87-010.

3. J. F. Walling, "The Utility of Distributed Air Volume Sets When Sampling Ambient Air Using Solid Adsorbents," Atmospheric Environ., 18:855-859, 1984.

4. J. F. Walling, J. E. Bumgarner, J. D. Driscoll,C. M. Morris, A. E. Riley, and L. H. Wright, "Apparent Reaction Products Desorbed From Tenax Used to Sample Ambient Air," Atmospheric Environ., 20:51-57, 1986.

5. Portable Instruments User's Manual for Monitoring VOC Sources, EPA-340/1-88-015, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, D.C., June 1986.

6. R. A. Rasmussen and J. E. Lovelock, Atmospheric Measurements Using Canister Technology, J. Geophys. Res., 83: 8369-8378, 1983.

7. R. A. Rasmussen and M. A. K. Khalil, "Atmospheric Halocarbon: Measurements and Analysis of Selected Trace Gases," Proc. NATO ASI on Atmospheric Ozone, BO: 209-23l.

8. EPA Method TO-14 "Determination of Volatile Organic Compounds (VOC's) in Ambient Air Using Summa Passivated Canister Sampling and Gas Chromatographic Analysis", May 1988.

APPENDIX A

Volatile Organic Compound Data Sheet

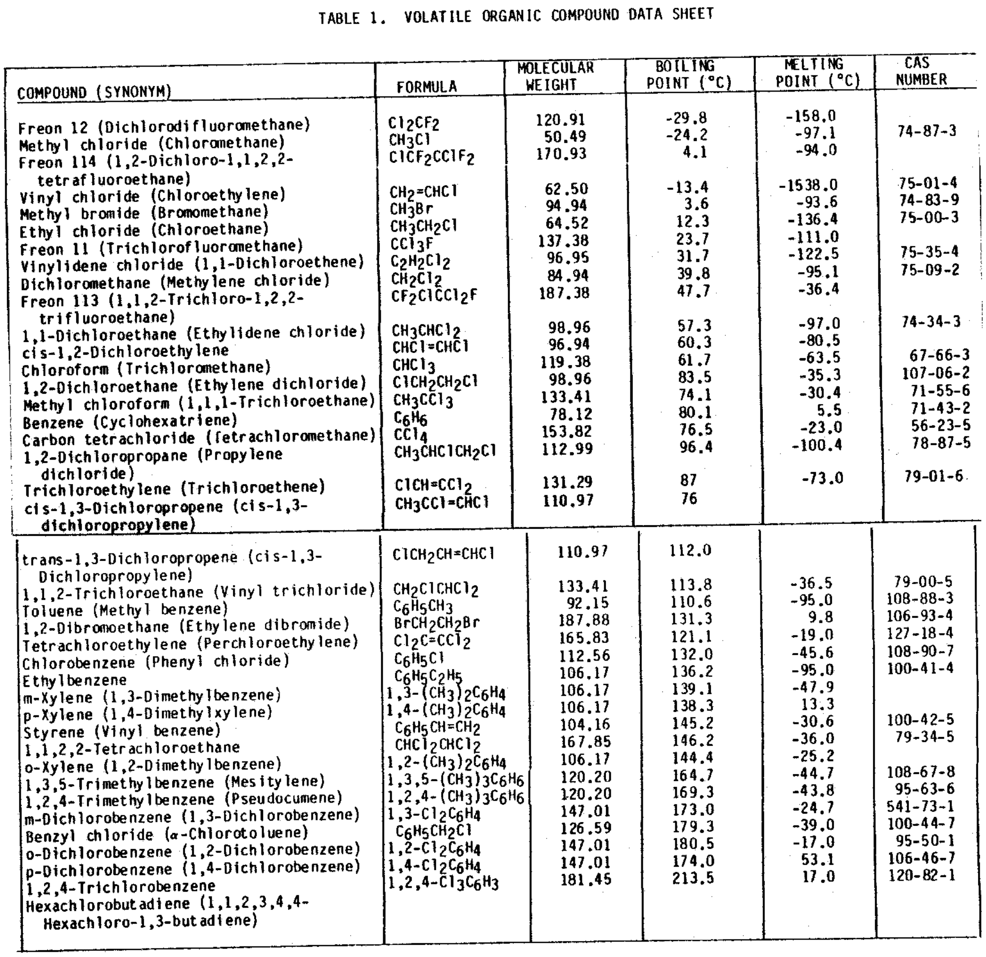
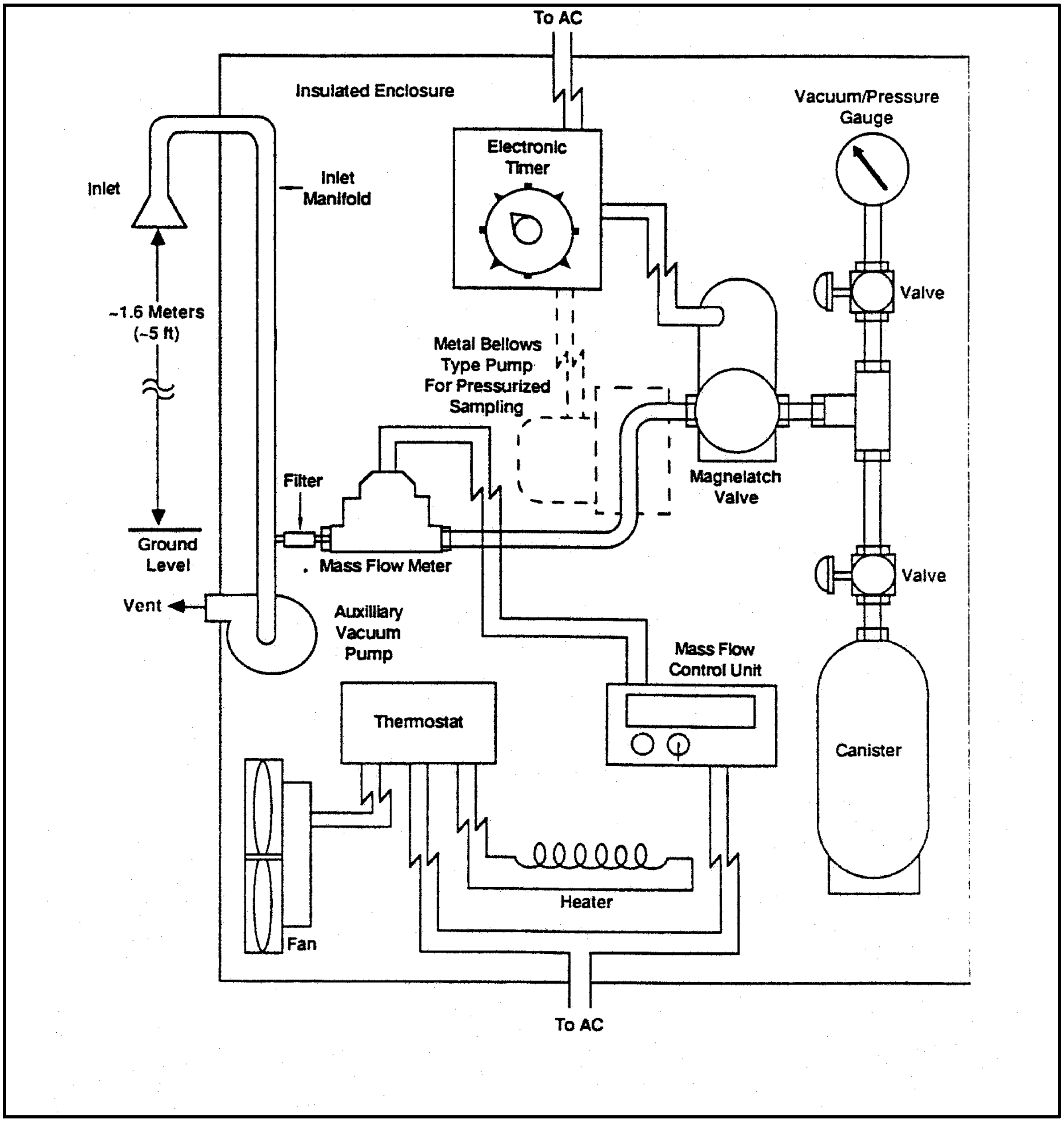


TABLE 1. VOLATILE ORGANIC COMPOUND DATA SHEET

COMPOUND (SYNONYM)	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°C)	MELTING POINT (°C)	CAS NUMBER
Freon 12 (Dichlorodifluoromethane)	Cl_2CF_2	120.91	-29.8	-158.0	
Methyl chloride (Chloromethane)	CH_3Cl	50.49	-24.2	-97.1	74-87-3
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	$ClCF_2CClF_2$	170.93	4.1	-94.0	
Vinyl chloride (Chloroethylene)	$CH_2=CHCl$	62.50	-13.4	-1538.0	75-01-4
Methyl bromide (Bromomethane)	CH_3Br	94.94	3.6	-93.6	74-83-9
Ethyl chloride (Chloroethane)	CH_3CH_2Cl	64.52	12.3	-136.4	75-00-3
Freon 11 (Trichlorofluoromethane)	CCl_3F	137.38	23.7	-111.0	
Vinylidene chloride (1,1-Dichloroethene)	$C_2H_2Cl_2$	96.95	31.7	-122.5	75-35-4
Dichloromethane (Methylene chloride)	CH_2Cl_2	84.94	39.8	-95.1	75-09-2
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	CF_2ClCCl_2F	187.38	47.7	-36.4	
1,1-Dichloroethane (Ethylidene chloride)	CH_3CHCl_2	98.96	57.3	-97.0	74-34-3
cis-1,2-Dichloroethylene	$CHCl=CHCl$	96.94	60.3	-80.5	
Chloroform (Trichloromethane)	$CHCl_3$	119.38	61.7	-63.5	67-66-3
1,2-Dichloroethane (Ethylene dichloride)	$ClCH_2CH_2Cl$	98.96	83.5	-35.3	107-06-2
Methyl chloroform (1,1,1-Trichloroethane)	CH_3CCl_3	133.41	74.1	-30.4	71-55-6
Benzene (Cyclohexatriene)	C_6H_6	78.12	80.1	5.5	71-43-2
Carbon tetrachloride (Tetrachloromethane)	CCl_4	153.82	76.5	-23.0	56-23-5
1,2-Dichloropropane (Propylene dichloride)	$CH_3CHClCH_2Cl$	112.99	96.4	-100.4	78-87-5
Trichloroethylene (Trichloroethene)	$ClCH=CCl_2$	131.29	87	-73.0	79-01-6
cis-1,3-Dichloropropene (cis-1,3-dichloropropylene)	$CH_3CCl=CHCl$	110.97	76		
trans-1,3-Dichloropropene (cis-1,3-Dichloropropylene)	$ClCH_2CH=CHCl$	110.97	112.0		
1,1,2-Trichloroethane (Vinyl trichloride)	$CH_2ClCHCl_2$	133.41	113.8	-36.5	79-00-5
Toluene (Methyl benzene)	$C_6H_5CH_3$	92.15	110.6	-95.0	108-88-3
1,2-Dibromoethane (Ethylene dibromide)	$BrCH_2CH_2Br$	187.88	131.3	9.8	106-93-4
Tetrachloroethylene (Perchloroethylene)	$Cl_2C=CCl_2$	165.83	121.1	-19.0	127-18-4
Chlorobenzene (Phenyl chloride)	C_6H_5Cl	112.56	132.0	-45.6	108-90-7
Ethylbenzene	$C_6H_5C_2H_5$	106.17	136.2	-95.0	100-41-4
m-Xylene (1,3-Dimethylbenzene)	$1,3\text{-}(CH_3)_2C_6H_4$	106.17	139.1	-47.9	
p-Xylene (1,4-Dimethylxylene)	$1,4\text{-}(CH_3)_2C_6H_4$	106.17	138.3	13.3	
Styrene (Vinyl benzene)	$C_6H_5CH=CH_2$	104.16	145.2	-30.6	100-42-5
1,1,2,2-Tetrachloroethane	$CHCl_2CHCl_2$	167.85	146.2	-36.0	79-34-5
o-Xylene (1,2-Dimethylbenzene)	$1,2\text{-}(CH_3)_2C_6H_4$	106.17	144.4	-25.2	
1,3,5-Trimethylbenzene (Mesitylene)	$1,3,5\text{-}(CH_3)_3C_6H_6$	120.20	164.7	-44.7	108-67-8
1,2,4-Trimethylbenzene (Pseudocumene)	$1,2,4\text{-}(CH_3)_3C_6H_6$	120.20	169.3	-43.8	95-63-6
m-Dichlorobenzene (1,3-Dichlorobenzene)	$1,3\text{-}Cl_2C_6H_4$	147.01	173.0	-24.7	541-73-1
Benzyl chloride (α-Chlorotoluene)	$C_6H_5CH_2Cl$	126.59	179.3	-39.0	100-44-7
o-Dichlorobenzene (1,2-Dichlorobenzene)	$1,2\text{-}Cl_2C_6H_4$	147.01	180.5	-17.0	95-50-1
p-Dichlorobenzene (1,4-Dichlorobenzene)	$1,4\text{-}Cl_2C_6H_4$	147.01	174.0	53.1	106-46-7
1,2,4-Trichlorobenzene	$1,2,4\text{-}Cl_3C_6H_3$	181.45	213.5	17.0	120-82-1
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)					

APPENDIX B

FIGURE 1. Subatmospheric/Pressurized Sampling Equipment



APPENDIX C

Canister Sampling Field Data Sheet

Page ___ of ___

SUMMA AIR SAMPLING WORK SHEET

Site: ______________________________ Site#: __________________________

Samplers: _______________ Work Assignment Manager:___________________________

Date: _____________________________ Project Leader:___________________________

Sample #					
Location					
SUMMA ID					
Orifice Used					
Analysis/Method					
Time (Start)					
Time (Stop)					
Total Time					
SUMMA WENT TO AMBIENT	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO
Pressure Gauge					
Pressure Gauge					
Flow Rate (Pre)					
Flow Rate (Post)					
Flow Rate (Average)					

MET Station On-site? Y / N

General Comments:

SUMMA CANISTER FIELD STANDARDS

SOP#: 1706
DATE: 09/12/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this procedure is to establish standard operating practices for the use of Summa canisters. Summa polished canisters are used to store calibration gas standards for transport to field sampling sites. These standards contained in the Summa canisters will be used for calibration of field instrumentation. In addition, a series of different concentrations of gas standards, or dilutions in the field of a single canister, can be used to construct calibration curves and to ascertain minimum detection limits on various field instrumentation currently used by EPA/ERT.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

A clean evacuated Summa canister is obtained. A certified gas standard cylinder is selected and a delivery pressure of 20-30 psi is set. The lines are bled with the gas standard. Then, the Summa canister is opened while still attached to the gas standard line, and is charged to 20-30 psi with the certified gas standard cylinder. The Summa canister is closed and the gas standard lines are removed. A "tee" with a septum is attached onto the Swagelok fitting of the Summa canister. The "tee" is purged with the contents of the Summa canister. The Summa canister valve is opened and samples can be taken via a gas tight syringe through the septum on the "tee". The valve is closed when not in use. Tedlar bags can also be filled from the "tee".

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples and gas standards can be kept several months in the Summa polished canisters. Care must be taken to ensure no leaks occur when the "tee" and septum are used. In addition, the needle valve on the Summa canister must be completely closed when not in use. When transporting and storing, the Summa canister is placed in a plastic shipping container. This will protect the canister from accidental punctures or dents.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

As long as the gas standards and all transfer lines are clean, no interferences are expected. The initial pressure of the Summa canister should be recorded after filling. In addition, the pressure should be recorded after each use. A dramatic drop in pressure (i.e., five psi or more) may invalidate the use of that canister.

5.0 EQUIPMENT/APPARATUS

C Summa Canister, 6-liter total volume
Cat # 87-300, Anderson Samplers, Inc.
4215 Wendell Drive, Atlanta, GA 30376
PN # 0650, SIS, P.O. Box 8941, 815 Courtney St., Moscow, Idaho 83843

C Certified gas standard from Scott Gas, Matheson or other reliable manufacturer

C Hamilton gas tight syringe with Teflon seal plugs in various sizes

C Clean Teflon tubing, 1/4" O.D.

C Swagelok "tee" 1/4" O.D. Teflon

C 1/4" Teflon swagelok nuts & ferrules

C 9-mm septa, preferably Teflon backed

C Swagelok on/off or needle valve, 1/4" O.D. stainless steel

6.0 REAGENTS

All standards must be vapor phase pressurized gas cylinders, certified by the manufacturer to be within ±2% accuracy, and to be NBS traceable. Scott Specialty Gas or Matheson Gas can provide these standards. If field dilution is required, a cylinder of ultra high purity air is required.

7.0 PROCEDURES

1. Obtain a Summa polished canister that has been cleaned and evacuated and select a compressed gas cylinder of a certified standard. This standard should be certified by the manufacturer to be within ±2% for the accuracy of the concentration level and be NBS traceable.

2. A high purity dual stage regulator is attached to the standard cylinder. This must deliver 20-30 psi pressure at an accuracy of ±10% or better.

3. A section of clean, unused 1/4" O.D. Teflon tubing is attached to the Teflon "tee".

4. The side port of the "tee" has an on/off valve or needle valve connected to it (Figure 1, Appendix A).

5. A vent line is temporally connected to the outlet port of the side valve and placed in a fume hood or on an outside vent. The Summa canister charging system appears in Figure 2 (Appendix A).

6. The standard cylinder is opened at 20-30 psi from the outlet of the cylinder regulator.

7. The needle valve on the Summa canister is still closed at this point. The side valve on the "tee" is opened and the standard cylinder's 1/4" Teflon feed lines are allowed to vent for one-two minutes.

8. The valve is then closed tightly and the needle valve on the Summa canister is slowly opened. A hissing noise should be heard. Do not fill the Summa canisters too rapidly. Allow the canister to continue filling.

9. Periodically check the pressure on the dual stage regulator attached to the standard cylinder to ensure 20-30 psi is being delivered.

10. Once the hissing stops, the canister should be filled to approximately the same pressure as the line delivery pressure.

11. Close the needle valve on the Summa canister tightly.

12. Close the standard cylinder and vent the feed lines.

13. Remove the feed line from the top of the Teflon "tee".

14. Place a Swagelok back ferrule, in the inverted position, on the top of the "tee". This will provide a flat surface on which a Teflon-backed septum can be placed.

15. Place the Teflon-backed septum, Teflon side down. The septum should create a gas tight fit once a 1/4" Swagelok nut is tightened onto the top of the "tee" (Figures 3 and 4, Appendix A).

16. Open the needle valve on the Summa canister to check for leaks throughout the "tee", particularly in the septum fitting. Do this with the valve on the side of the "tee" closed.

17. Afterwards, slowly open the side valve of the "tee" and vent for 1/2 minute and re-close. The septum "tee" is now ready for sampling from the canister using a gas tight syringe through the septum seal.

18. Close the Summa canister needle valve between sample taking with the gas tight syringe.

19. Periodically, vent or flush the "tee" to provide fresh standard for sampling. The side valve can also be used, after flushing, to fill Tedlar bags with the standard from the Summa canister.

8.0 CALCULATIONS

The procedure for performing field dilutions of the standards from the Summa canisters must be documented. This allows for the recalculation of concentrations of standards if any discrepancies arise in the calibration of the field instrumentation. Simple volumetric dilutions using Hamilton gas tight syringes, are performed using Tedlar bags with ultra high purity air as the diluent.

9.0 QUALITY ASSURANCE/ QUALTIY CONTROL

The concentration levels of the certified gas standards must be recorded. The vendor typically provides the analysis of certification with each standards cylinder; a copy should be provided with the Summa canister.

As previously stated, the pressure of the canister along with the date and time, should be recorded at the initial filling and at the end of each use of the canister. A drop in pressure of 5-10 psi in between usages may invalidate the canister for use as a calibration standard. Certification of canister cleaning and evacuation should be noted prior to filling with standards.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

Pressurizing of Summa canisters should be performed in a well ventilated room, or preferably under a fume hood. Care must be taken not to exceed 40 psi in the canisters. Canisters are under pressure, albeit only 20-30 psi, and should not be dented or punctured. They should be stored in a cool dry place and always be placed in their plastic shipping boxes during transport and storage.

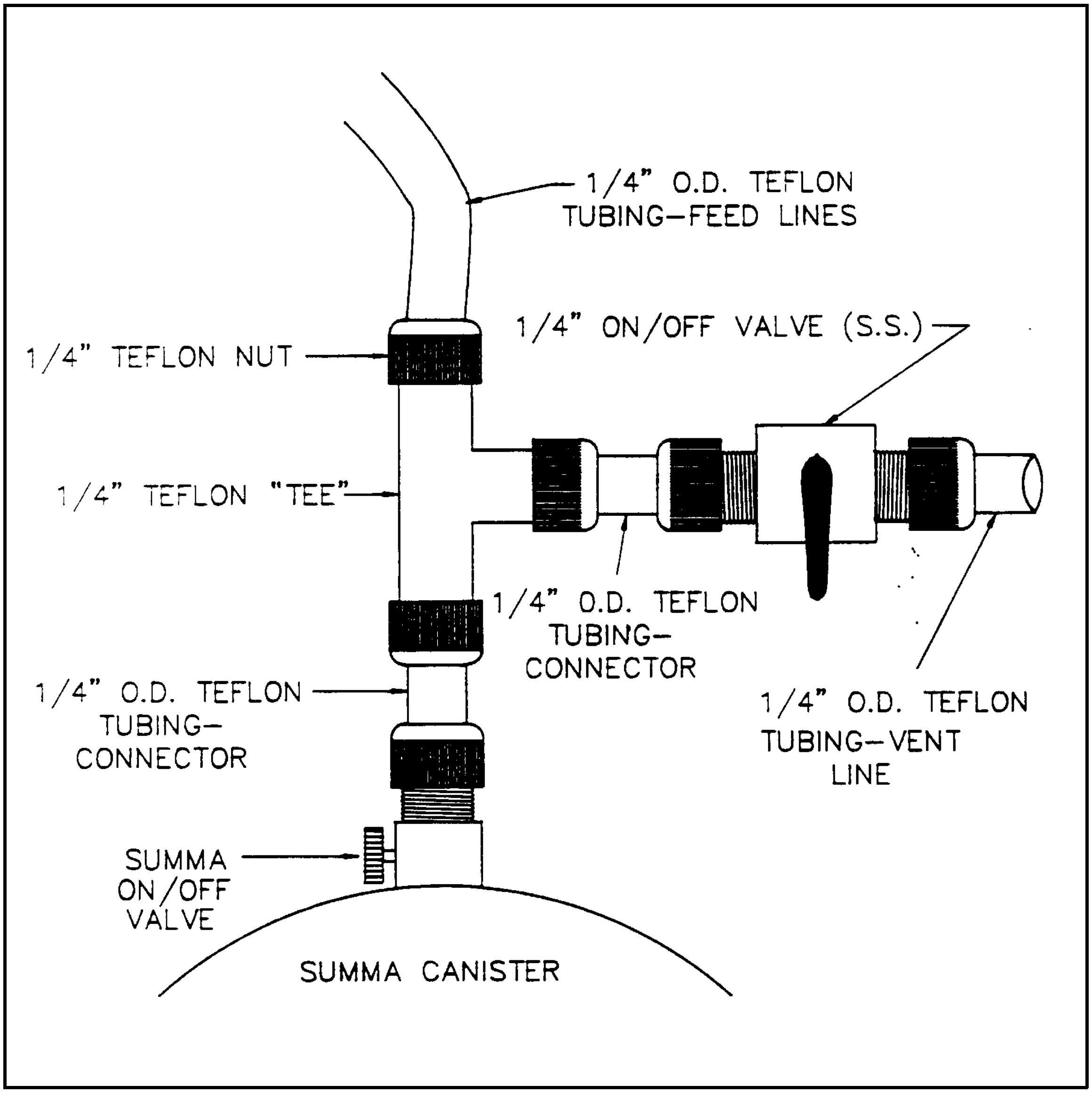
12.0 REFERENCES

This section is not applicable to this SOP.

APPENDIX A

Figures

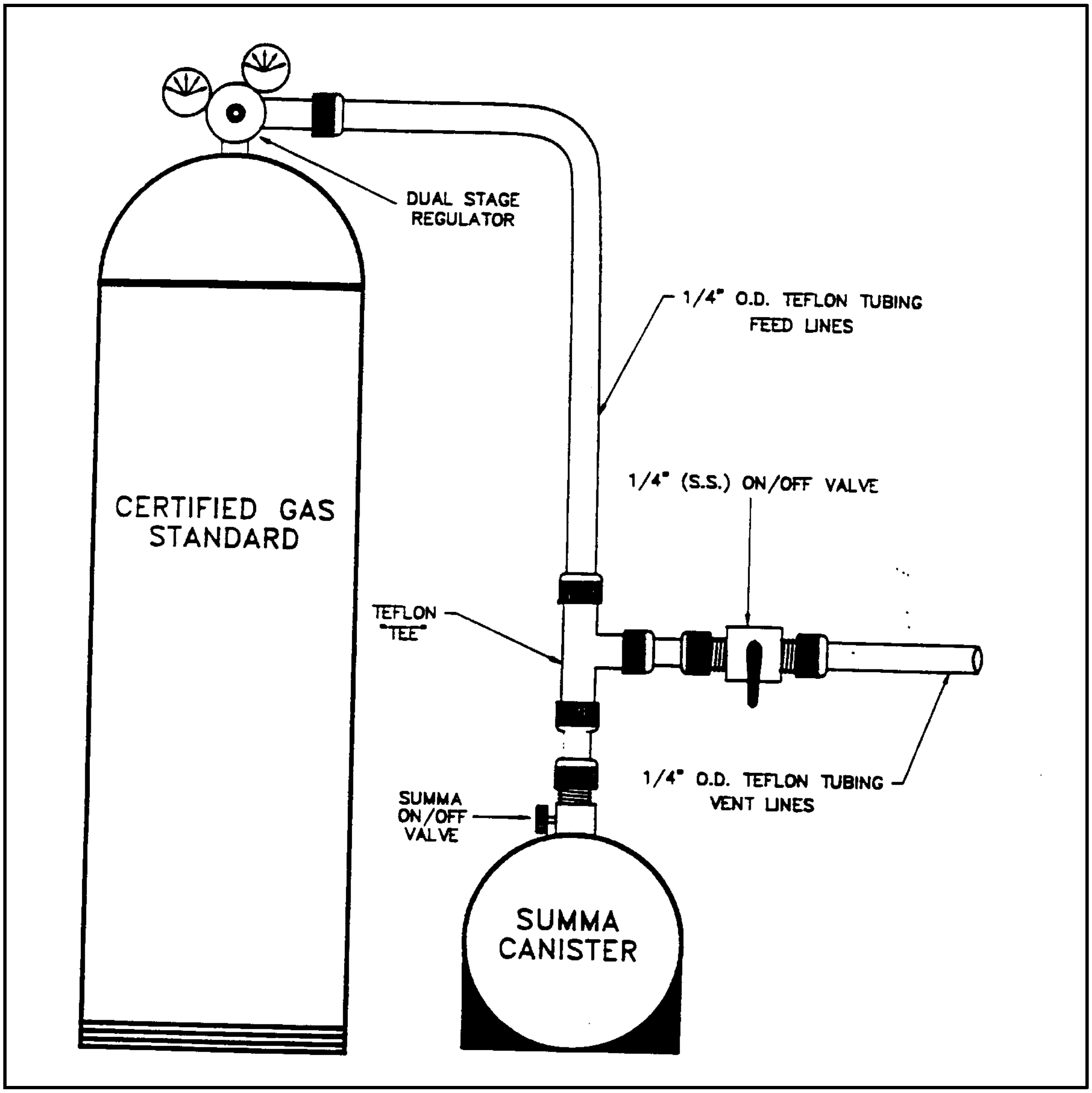
FIGURE 1. Teflon "Tee" Setup



APPENDIX A - (Con't)

Figures

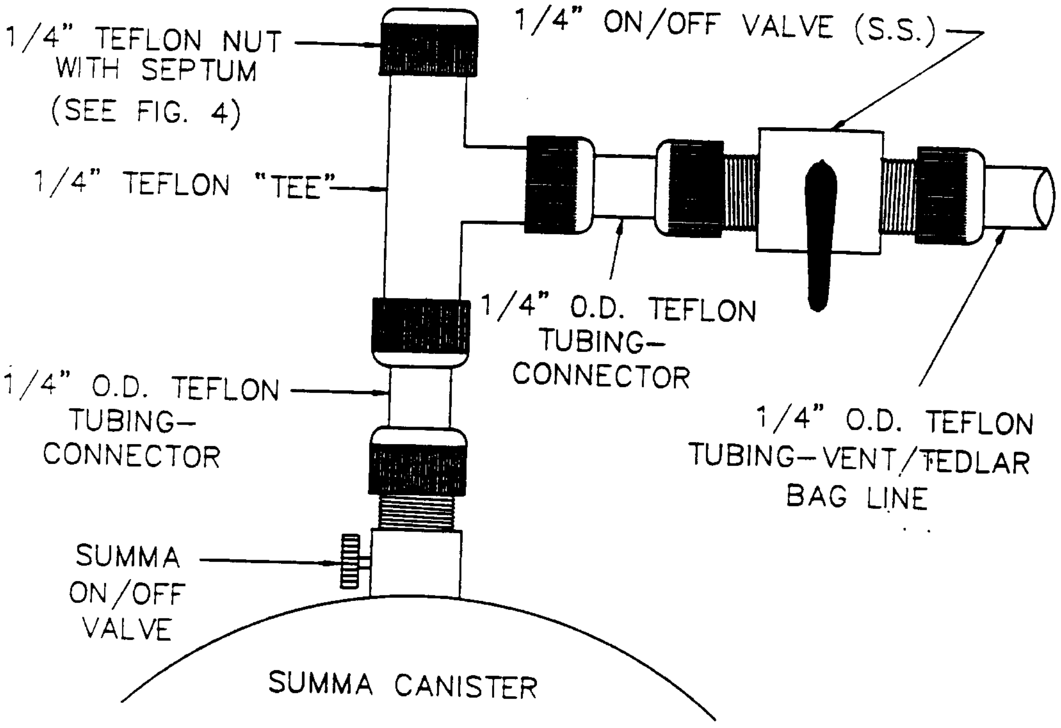
FIGURE 2. Summa Canister Charging System



APPENDIX A - (Con't)

Figures

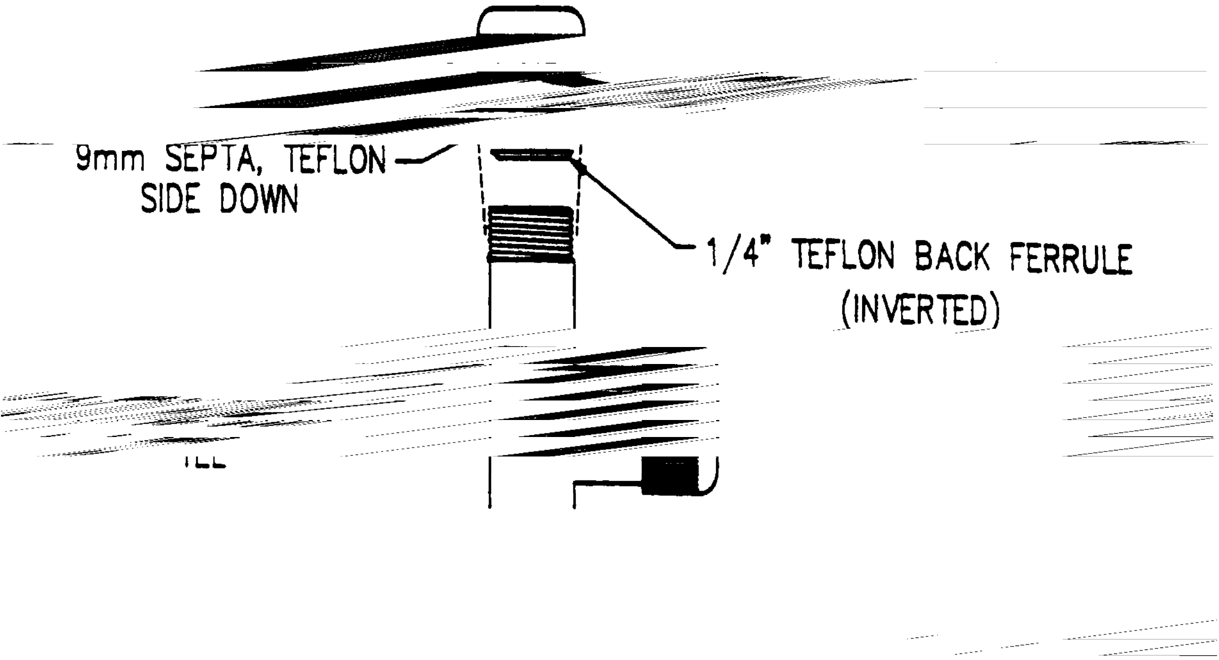
FIGURE 3. Septum "Tee" Setup



APPENDIX A - (Con't)

Figures

FIGURE 4. Teflon Nut with Septum



GENERAL FIELD SAMPLING GUIDELINES

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation.
- Basis upon which data will be evaluated.
- Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.
More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- Non-phosphate detergent
- Selected solvents (acetone, hexane, nitric acid, etc.)
- Tap water
- Distilled or deionized water

5.2 Decontamination Tools/Supplies

- Long and short handled brushes
- Bottle brushes
- Drop cloth/plastic sheeting
- Paper towels
- Plastic or galvanized tubs or buckets
- Pressurized sprayers (H_2O)
- Solvent sprayers
- Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

- 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- Acetone (pesticide grade)(1)
- Hexane (pesticide grade)(1)
- Methanol(1)

(1) - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.

- Decontamination equipment needed.

- Appropriate decontamination methods.

- Methods for disposal of contaminated clothing, equipment, and solutions.

- Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.
Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 : Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1
Soluble Contaminants and Recommended Solvent Rinse

SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

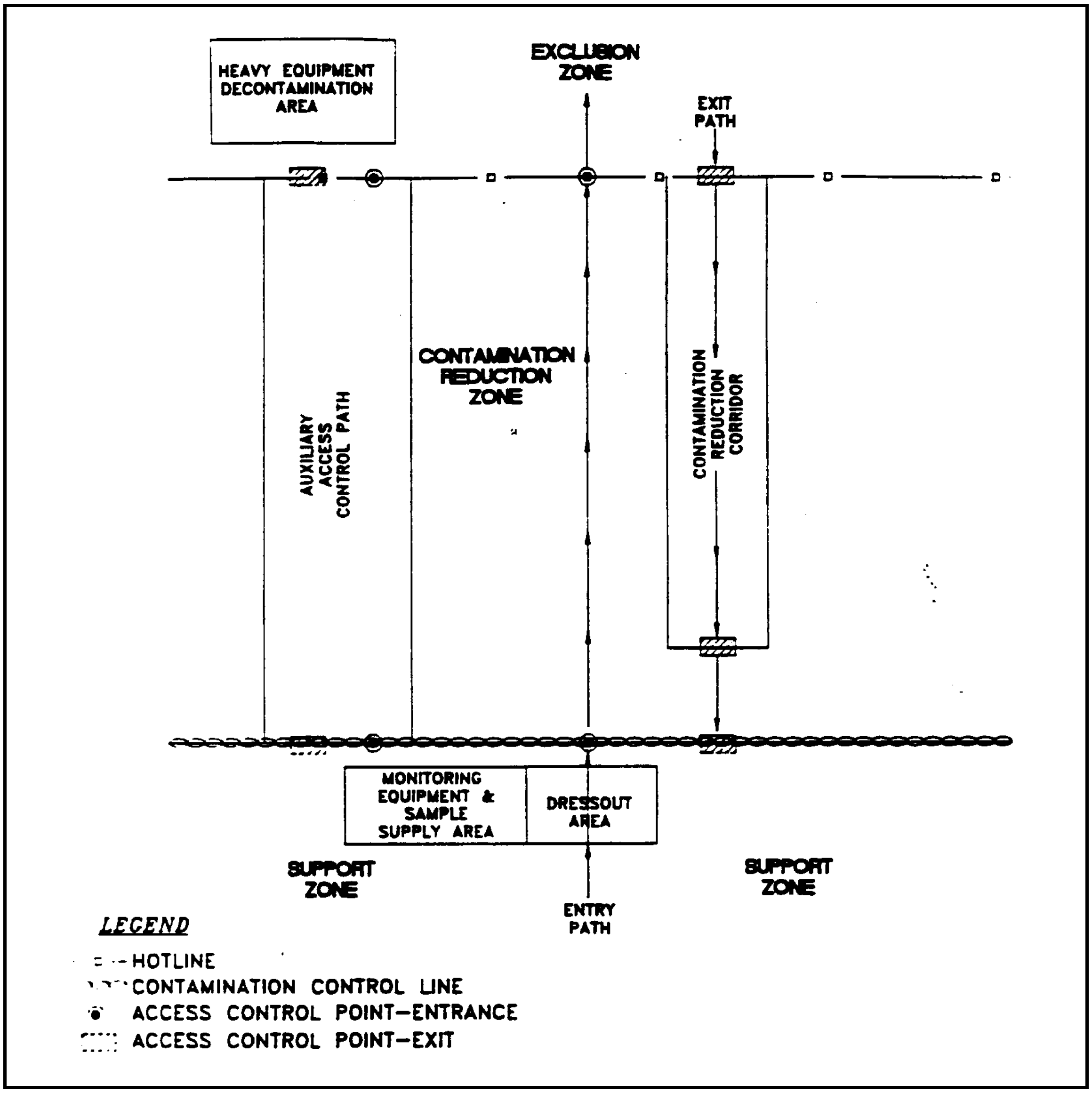
[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

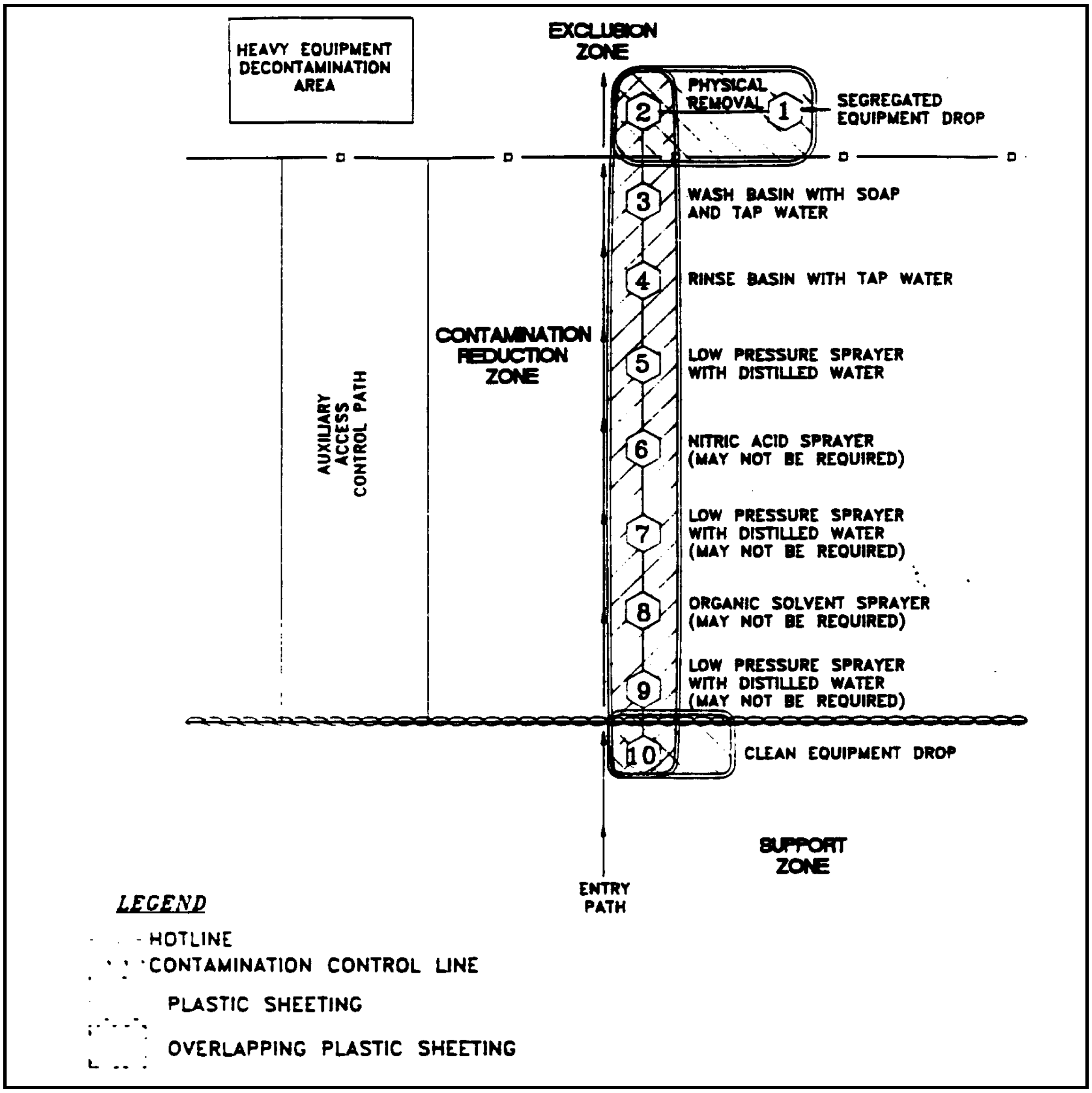
Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout



GROUNDWATER WELL SAMPLING

SOP#: 2007
DATE: 01/26/95
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of ground water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground water contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples shall be appropriately preserved, labelled, logged, and placed in a cooler to be maintained at 4EC. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water.

Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact.

For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 General

The primary goal in performing ground water sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

4.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding ground water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.

2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.

3. The well should be sampled as soon as possible after purging.

4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.

5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to

recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.

6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the ground water formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

4.3 Materials

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon^{R}, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling Volatile Organic Samples should be limited to stainless steel, Teflon and glass in areas which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics, e.g., PVC etc., should be avoided. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utlization of trained personnel.

4.4 Advantages/Disadvantages of Certain Equipment

4.4.1 Bailers

Advantages

- Only practical limitations on size and materials
- No power source needed
- Portable
- Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination
- Minimal outgassing of volatile organics while sample is in bailer
- Readily available
- Removes stagnant water first
- Rapid, simple method for removing small volumes of purge water

Disadvantages

- Time-consuming to flush a large well of stagnant water
- Transfer of sample may cause aeration
- Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly
- If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water

4.4.2 Submersible Pumps

Advantages

- Portable and can be transported to several wells
- Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible
- Generally very reliable and does not require priming

Disadvantages

- Potential for effects on analysis of trace organics
- Heavy and cumbersome to deal with, particularly in deeper wells
- Expensive
- Power source needed
- Sediment in water may cause problems with the pumps
- Impractical in low yielding or shallow wells

4.4.3 Non-Contact Gas Bladder Pumps

Advantages

- Maintains integrity of sample
- Easy to use
- Can sample from discrete locations within the monitor well

Disadvantages

- Difficulty in cleaning, though dedicated tubing and bladder may be used
- Only useful to about 100 feet
- Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome
- Relatively low pumping rates
- Requires air compressor or pressurized gas source and control box

4.4.4 Suction Pumps

Advantages

- Portable, inexpensive, and readily available

Disadvantages

- Restricted to areas with water levels within 20 to 25 feet of the ground surface
- Vacuum can cause loss of dissolved gasses and volatile organics
- Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping

4.4.5 Inertia Pumps

Advantages

- Portable, inexpensive, and readily available
- Offers a rapid method for purging relatively shallow wells

Disadvantages

- Restricted to areas with water levels within 70 feet of the ground surface
- May be time consuming to purge wells with these manual pumps
- Labor intensive
- WaTerra pumps are only effective in 2-inch diameter wells

5.0 EQUIPMENT APPARATUS

5.1 Equipment Checklist

5.1.1 General

- Water level indicator
  - electric sounder
  - steel tape
  - transducer
  - reflection sounder
  - airline
- Depth sounder
- Appropriate keys for well cap locks
- Steel brush
- HNU or OVA (whichever is most appropriate)
- Logbook
- Calculator
- Field data sheets and samples labels

- Chain of custody records and seals
- Sample containers
- Engineer's rule
- Sharp knife (locking blade)
- Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- Leather work gloves
- Appropriate Health & Safety gear
- 5-gallon pail
- Plastic sheeting
- Shipping containers
- Packing materials
- Bolt cutters
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non phosphate soap
- Several brushes
- Pails or tubs
- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator for your power source)

5.1.2 Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Nylon line, enough to dedicate to each well
- Teflon coated bailer wire
- Sharp knife
- Aluminum foil (to wrap clean bailers)
- Five gallon bucket

5.1.3 Submersible Pump

- Pump(s)
- Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
- 1" black PVC coil tubing - enough to dedicate to each well
- Hose clamps
- Safety cable
- Tool box supplement
    - pipe wrenches
    - wire strippers
    - electrical tape
    - heat shrink
    - hose connectors
    - Teflon tape
- Winch, pulley or hoist
- Gasoline for generator/gas can
- Flow meter with gate valve
- 1" nipples and various plumbing (i.e., pipe connectors)
- Control box (if necessary)

5.1.4 Non-Gas Contact Bladder Pump

- Non-gas contact bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting
- Toolbox supplements - same as submersible pump
- Control box (if necessary)

5.1.5 Suction Pump

- Pump
- 1" black PVC coil tubing - enough to dedicate to each well
- Gasoline - if required
- Toolbox
- Plumbing fittings
- Flow meter with gate valve

5.1.6 Inertia Pump

- Pump assembly (WaTerra pump, piston pump)
- Five gallon bucket

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e, diameter and depth of wells to be sampled).

2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.

2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.

3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.

4. Remove well casing cap.

5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.

6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.

7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.

   If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.

8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.

9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.

10. Select the appropriate purging and sampling equipment.

11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

7.3 Purging

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is a collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in 8.0, calculations.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line with foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.

5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.

6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.

7.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump, however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

7.3.2.1 Operation

1. Determine the volume of water to be purged as described in 8.0 Calculations.

2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.

3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage.)

4. Attach flow meter to the outlet hose to measure the volume of water purged.

5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.

6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.

7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

7.3.3.1 Operation

1. Assemble Teflon tubing, pump and charged control box.

2. Procedure for purging with a bladder pump is the same as for a submersible pump (Section 7.3.2.1).

3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.

2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2.1).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in 8.0, Calculations.

2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.

3. Assemble pump and lower to the appropriate depth in the well.

4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH,

conductivity, etc. have stabilized).

5. Collect and dispose of purge waters as specified in the site specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

7.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

7.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.

2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples, once at the surface, remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.

5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 7.7 for special considerations on VOA samples.

6. Begin slowly pouring from the bailer.

7. Filter and preserve samples as required by sampling plan.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.

9. Replace the well cap.

10. Log all samples in the site logbook and on field data sheets and label all samples.

11. Package samples and complete necessary paperwork.

12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.4.2, there are some situations where they may be used.

7.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.

2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.

3. Assemble the appropriate bottles.

4. If no gate valve is available, run the water

down the side of a clean jar and fill the sample bottles from the jar.

5. Cap the sample container tightly and place prelabeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on the field data sheets and label all samples.

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

7.4.3.1 Operation

1. Allow well to recharge after purging.

2. Assemble the appropriate bottles.

3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.

5. Replace the well cap.

6. Log all samples in the site logbook and on field data sheets and label all samples.

7. Package samples and complete necessary paperwork.

8. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

9. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.

10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.

11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

7.4.4 Suction Pumps

In view of the limitations of these type pumps, they are not recommended for sampling purposes.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

7.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.

2. Assemble the appropriate bottles.

3. Since these pumps are manually operated,

the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.

5. Replace the well cap.

6. Log all samples in the site logbook and on field data sheets and label all samples.

7. Package samples and complete necessary paperwork.

8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.4.6. Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available, (IEA, TIMCO, etc.) some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severly limited in sample volume and are specific to sampling for volatiles. Essentially, they operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.

2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.

3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

7.5 Filtering

For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 µm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 lbs/in^2 by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 µm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.

2. Replace sampling equipment in storage containers.

3. Prepare and transport ground water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for VOA Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.

2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.

3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.

4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.

5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.

6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4°C, but do not allow them to freeze.

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, utilize the following equation:

$$\textit{Well volume} = n r^2 h\ (cf) \qquad [\textit{Equation } 1]$$

where:

n = pi
r = radius of monitoring well (feet)
h = height of the water column (feet) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2", 3", 4", or 6". Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$v(gal/ft) = n r^2\ (cf) \qquad [\textit{Equation } 2]$$

where:

n = pi
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For a 2" diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} vol/linear\ ft &= n r^2\ (cf) \qquad [\textit{Equation } 2] \\ &= 3.14\ (1/12\ ft)^2\ \ 7.48\ gal/ft^3 \\ &= 0.1632\ gal/ft \end{aligned}$$

Remember that if you have a 2" diameter well, you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

Well diameter	2"	3"	4"	6"
Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

If you utilize the conversion factors above, Equation

1 should be modified as follows:

$$\textbf{\textit{Well volume}} = (\boldsymbol{h})(\boldsymbol{cf}) \qquad [\textit{Equation } 3]$$

where:

h = height of water column (feet)
cf = the conversion factor calculated from Equation 2

The well volume is typically tripled to determine the volume to be purged.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.

4. Trip blanks are required if analytical parameters include VOAs.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA or REAC health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.

2. Pre-survey the well head-space with an FID/PID prior to sampling.

3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.

2. Use of pocket knives for cutting discharge hose.

3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.

4. Slip, trip, fall conditions as a result of pump discharge.

5. Restricted mobility due to the wearing of protective clothing.

6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

12.0 REFERENCES

Barcelona, M.J., Helfrich, J.A., Garske, E.E., and J.P. Gibb, Spring 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms," Groundwater

Monitoring Review, 1984 pp. 32-41.

Barcelona, M.J., Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples", Analy. Chem., Vol. 57, 1985 pp. 460-463.

Driscoll, F.G., Groundwater and Wells (2nd ed.) Johnson Division, UOP Inc., St. Paul, Minnesota, 1986, 1089 pp.

Gibb, J.P., R.M. Schuller, and R.A. Griffin,. Monitoring Well Sampling and Preservation Techniques, EPA-600/9-80-010, 1980. March, 1980.

Instrument Specialties Company, (January). Instruction Manual, Model 2100 Wastewater Sampler, Lincoln, Nebraska, 1980.

Keely, J.F. and Kwasi Boateng, Monitoring Well Installation, Purging and Sampling Techniques - Part I: Conceptualizations, Groundwater V25, No. 3, 1987 pp. 300-313.

Keith, Lawrence H., Principles of Environmental Sampling, American Chemical Society, 1988.

Korte, Nic, and Dennis Ealey,. Procedures for Field Chemical Analyses of Water Samples, U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, 1983.

Korte, Nic, and Peter Kearl,. Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, 1985.

National Council of the Paper Industry for Air and Stream Improvement, Inc.,. A Guide to Groundwater Sampling, Technical Bulletin No. 362, Madison, New York. January, 1982.

Nielsen, David M. and Yeates, Gillian L., Spring. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, 1985 pp. 83-99.

Scalf, et al. (M.J. Scalf, McNabb, W. Dunlap, R. Crosby, and J. Fryberger),. Manual for Groundwater Sampling Procedures. R.S. Kerr Environmental Research Laboratory, Office of Research and Development. 1980, Ada, OK.

Sisk, S.W. NEIC Manual for Ground/Surface Investigations at Hazardous Waste Sites, EPA-330/9-81-002, 1981.

U.S. Department of the Interior, National Handbook of Recommended Methods for Water-Data Acquisition, Reston, Virginia.

U.S. Environmental Protection Agency, 1977. Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities. EPA-530/SW-611. August, 1977.

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation revised November 1, 1985.

U.S. Environmental Protection Agency, 1982. Handbook for Chemical and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, Washington, D.C.

U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Waste, EPA-600/4-79-020, Washington, D.C.

U.S. Environmental Protection Agency, 1984. Test Methods for Evaluation of Solid Waste, EPA-SW-846, Second Edition, Washington, D.C.

U.S. Environmental Protection Agency, 1981. Manual of Groundwater Quality Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

U.S. Environmental Protection Agency, 1985. Practical Guide for Groundwater Sampling, EPA-600/2-85/104, September, 1985.

U.S. Environmental Protection Agency, 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950-1, September, 1986.

Weston, 1987. Standard Operations Procedures for Monitor Well Installation. MOUND IGMP/RIP.

U.S. Environmental Protection Agency, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, Washington, D.C.

--- 1981. Manual of Groundwater Quality

Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

--- 1985. Practice Guide for Groundwater Sampling, EPA-600/2/85-104, September 1985.

Nielsen, David M. and Yeates, Gillian L., Spring 1985. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, pp. 83-99.

WESTON, 1987. Standard Operating Procedures for Monitor Well Installation. MOUND IGMP/RIP

Barcelona, M.J. Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples". 1985, Analy. Chem., Vol. 57, pp. 460-463.

GENERAL AIR SAMPLING GUIDELINES

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) provides guidance in developing and implementing sampling plans to assess the impact of hazardous waste sites on ambient air. It presents the United States Environmental Protection Agency/Environmental Response Team's (U.S. EPA/ERT's) approach to air sampling and monitoring and identifies equipment requirements. It is not within the scope of this SOP to provide a generic air sampling plan. Experience, objectives, site characteristics, and chemical characteristics will dictate sampling strategy. This SOP does not address indoor air sampling.

Two basic approaches can be used to assess ambient air (also referred to as air pathway assessments): modeling and measurements. The modeling approach initially estimates or measures the overall site emission rate(s) and pattern(s). These data are input into an appropriate air dispersion model, which predicts either the maximum or average air concentrations at selected locations or distances during the time period of concern. This overall modeling strategy is presented in the first three volumes of the Air Superfund National Technical Guidance Series on Air Pathway Assessments(1,2,3). Specific applications of this strategy are presented in several additional Air Superfund Technical Guidance documents(4).

The measurement approach involves actually measuring the air impact at selected locations during specific time periods. These measurements can be used to document actual air impacts during specific time intervals (i.e., during cleanup operations) or to extrapolate the probable "worst case" concentrations at that and similar locations over a longer time period than was sampled.

This SOP addresses issues associated with this second assessment strategy. This SOP also discusses the U.S. EPA/ERT's monitoring instruments, air sampling kits, and approach to air sampling and monitoring at hazardous waste sites.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Air monitoring is defined as the use of direct-reading instruments and other screening or monitoring equipment and techniques that provide instantaneous (real-time) data on the levels of airborne contaminants. The U.S. EPA/ERT maintains numerous monitors for real-time measurements. Examples of air monitoring equipment are hand-held photoionization detectors (PID), flame ionization detectors (FID), oxygen/combustible gas detectors, and remote optical sensors.

Air sampling is defined as those sampling and analytical techniques that require either off- or on-site laboratory analysis and therefore do not provide immediate results. Typically, air sampling occurs after use of real-time air monitoring equipment has narrowed the number of possible contaminants and has provided some qualitative measurement of contaminant concentration. Air sampling techniques are used to more accurately detect, identify and quantify specific chemical compounds relative to the majority of air monitoring technologies.

In the Superfund Removal Program, On-Scene Coordinators (OSCs) may request the U.S. EPA/ERT to conduct air monitoring and sampling during the following situations: emergency responses, site assessments, and removal activities. Each of these activities has a related air monitoring/sampling objective that is used to determine the potential hazards to workers and/or the community.

- Emergency Response

  Emergency responses are immediate responses to a release or threatened release of hazardous substances presenting an imminent danger to public health, welfare, or the environment (i.e., chemical spills, fires, or chemical process failures resulting in a controlled release of hazardous substances). Generally these situations require rapid on-site investigation and response. A major part of this investigation consists of assessing the air impact of these releases.

- Removal Site Assessment

  Removal site assessments (referred to as site assessments) are defined as any of several activities undertaken to determine the extent of contamination at a site and which help to formulate the appropriate response to a release or threatened release of hazardous substances. These activities may include a site inspection, multimedia sampling, and other data collection.

- Removal Actions

  Removal actions clean up or remove hazardous substances released into the environment. Removal actions include any activity conducted to abate, prevent, minimize, stabilize, or eliminate a threat to public health or welfare, or to the environment.

Personal risk from airborne contaminants can be determined by comparing the results of on-site monitoring and sampling to health-based action levels such as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). Residential risk can be determined by comparing the results of off-site monitoring or sampling to health-based action levels such as those developed by the Agency for Toxic Substance and Disease Registry (ATSDR).

The extent to which valid inferences can be drawn from air monitoring/sampling depends on the degree to which the monitoring/sampling effort conforms to the objectives of the event. Meeting the project's objectives requires thorough planning of the monitoring/sampling activities, and implementation of the most appropriate monitoring/sampling and analytical procedures. These issues will be discussed in this SOP.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Preservation, containers, handling and storage for air samples are discussed in the specific SOPs for the technique selected. In addition, the analytical method (i.e., U.S. EPA, National Institute for Occupational Safety and Health [NIOSH], and OSHA Methods) may be consulted for storage temperature, holding times and packaging requirements. After sample collection, the sampling media (i.e., cassettes or tubes) are immediately sealed. The samples are then placed into suitable containers (i.e., whirl bags, resealable bagsor culture tubes) which are then placed into a shipping container.

Use bubble wrap or styrofoam peanuts when packing air samples for shipment. DO NOT USE VERMICULITE.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Upwind sources can contribute to sample concentration. Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing sources.

Photoreactivity or reaction of the parameters of concern may occur with nonrelated compounds [i.e., nitrogen compounds and polyaromatic hydrocarbons

(PAHs)]. Some sorbent media/samples should not be exposed to light during or after sampling due to photochemical effects (i.e., PAHs).

Various environmental factors, including humidity, temperature and pressure, also impact the air sampling methodology, collection efficiency and detection limit. Since the determination of air contaminants is specifically dependent on the collection parameters and efficiencies, the collection procedure is an integral part of the analytical method.

Detection limits depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the detection limits are adequate for the intended use of the final results.

Some equipment may be sensitive to humidity and temperature extremes.

5.0 EQUIPMENT/APPARATUS

5.1 Direct Reading Instruments (Air Monitoring Instruments)

There are two general types of direct reading instruments: portable screening devices and specialized analytical instruments. Generally all these techniques involve acquiring, for a specific location or area, continuous or sequential direct air concentrations in either a real-time or semi-real-time mode. None of these instruments acquires true time-weighted average concentrations. In addition, these instruments are not capable of acquiring simultaneous concentration readings at multiple locations, although several are able to sequentially analyze samples taken remotely from different locations. The document, "Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Waste Sites(5)," provides additional information about air sampling and monitoring. The hazard levels for airborne contaminants vary. See the ACGIH TLVs and the OSHA PELs for safe working levels. Common screening devices and analytical instruments are described in Appendix A.

5.2 Air Sampling Equipment and Media/Devices

The U.S. EPA/ERT uses the following analytical methods for sampling: *NIOSH Manual of Analytical Methods*(6), *American Society for Testing and Materials (ASTM) Methods*(7), *U.S. EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*(8,9), and *OSHA Methods*(10). Additional air sampling references include *Industrial Hygiene and Toxicology* (3rd Ed.)(11) and *Air Sampling Instruments for Evaluation of Atmospheric Contaminants*(12). These methods typically specify equipment requirements for sampling. Since air sampling is such a diverse technology, no single method or reference is best for all applications. Common sampling equipment and media/devices are described in Appendix B.

5.3 Tools/Material and Equipment List

In addition to equipment and materials identified in Appendices A and B, the following equipment and materials may be required to conduct air sampling and monitoring at hazardous waste sites:

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Sample labels
- Small screwdriver set
- Aluminum foil
- Extension cords
- Glass cracker
- Multiple plug outlet
- Whirl bags or culture tubes
- Teflon tape
- Calibration devices
- Tygon and/or Teflon^{R} tubing
- Surgical gloves
- Lint-free gloves
- Ice
- Sample container

Use the following additional equipment when decontaminating glassware on site:

- Protective equipment (i.e., gloves, splash goggles, etc.)
- Appropriate solvent(s)
- Spray bottles
- Liquinox (soap)
- Paper towels

- Distilled/deionized water
- Five-gallon buckets
- Scrub brushes and bottle brushes

6.0 REAGENTS

Impinger sampling involves using reagents contained in a glass vial to absorb contaminants of concern (for example, NIOSH Method 3500 for formaldehyde uses 1% sodium bisulfite solution). Impinger solutions vary and are method-dependent.

Reagents such as acetone and hexane are required to decontaminate glassware and some air sampling equipment. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP.

7.0 PROCEDURES

7.1 Air Monitoring Design

7.1.1 Initial Surveys

In general, the initial survey is considered to be a relatively rapid screening process for collecting preliminary data at hazardous waste sites. However, initial surveys may require many hours to complete and may consist of more than one entry.

Some information is generally known about the site; therefore, real-time instrumentation for specific compounds (i.e., detector tubes and electrochemical sensors) can be used to identify hot spots. Sufficient data should be obtained with real-time instruments during the initial entry to screen the site for various contaminants. When warranted, intrinsically safe or explosion-proof instruments should be used. An organic vapor analyzer (OVA) is typically used during this survey. These gross measurements may be used on a preliminary basis to (1) determine levels of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.

In some situations, the information obtained may be sufficient to preclude additional monitoring. Materials detected during the initial survey may call for a more comprehensive evaluation of hazards and analyses for specific compounds. Since site activities and weather conditions change, a continuous program to monitor the ambient atmosphere must be established.

7.1.2 Off-Site Monitoring

Typically, perimeter monitoring with the same instruments employed for on-site monitoring is utilized to determine site boundaries. Because air is a dynamic matrix, physical boundaries like property lines and fences do not necessarily delineate the site boundary or area influenced by a release. Whenever possible, atmospheric hazards in the areas adjacent to the on-site zone should be monitored with direct-reading instruments. Monitoring at the fenceline or at varying locations off site provides useful information regarding pollutant migration. Three to four locations downwind of the source (i.e., plume) at breathing-zone height, provide a basic fingerprint of the plume. Negative instrument readings off site should not be interpreted as the complete absence of airborne toxic substances; rather, they should be considered another piece of information to assist in the preliminary evaluation. The interpretation of negative readings is instrument-dependent. The lack of instrument readings off site should not be interpreted as the complete absence of all airborne toxic substances; rather, it is possible that the particular compound or class of compounds to which the monitoring instrument responds is not present or that the concentration of the compound(s) is below the instrument's detection limit.

7.2 Air Sampling Design

7.2.1 Sampling Plan Design

The goal of air sampling is to accurately assess the impact of a contaminant source(s) on ambient air quality. This impact is expressed in terms of overall average and/or maximum air concentrations for the time period of concern and may be affected by the transport and release of pollutants from both on- and off-site sources. The location of these sources must be taken into account as they impact the selection of sampling locations. Unlike soil and groundwater concentrations, air concentrations at points of interest can easily vary by orders of magnitude over the period of concern. This variability plays a major role in designing an air sampling plan.

Downwind air concentration is determined by the amount of material being released from the site into the air (the emission rate) and by the degree that the contamination is diluted as it is transported. Local meteorology and topography govern downwind dilution. Contaminant emission rates can also be heavily influenced by on-site meteorology and on-site activities. All of these concerns must be incorporated into an air sampling plan.

A sampling strategy can be simple or complex, depending on the sampling program objectives. Programs involving characterization of the pollutant contribution from a single point source tend to be simple, whereas sampling programs investigating fate and transport characteristics of components from diverse sources require a more complex sampling strategy. In addition, resource constraints may affect the complexity of the sampling design.

An optimal sampling strategy accounts for the following site parameters:

- Location of stationary as well as mobile sources
- Analytes of concern
- Analytical detection limit to be achieved
- Rate of release and transport of pollutants from sources
- Availability of space and utilities for operating sampling equipment
- Meteorological monitoring data
- Meteorological conditions in which sampling is to be conducted

The sampling strategy typically requires that the concentration of contaminants at the source or area of concern as well as background contributions be quantified. It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks, as well as various other types of QA/QC samples, can be utilized to determine other sources. The impact of extraneous sources on sampling results can frequently be accounted for by placing samplers upwind, downwind and crosswind from the subject source. The analytical data from these different sampling locations may be compared to determine statistical differences.

7.2.2 Sampling Objectives

The objectives of the sampling must be determined prior to developing the sampling plan. Does the sampling plan verify adequate levels of protection for on-site personnel, or address potential off-site impacts associated with the site or with site activities? In addition, the assumptions associated with the sampling program must be defined. These assumptions include whether the sampling is to take place under "typical," "worst case," or "one-time" conditions. If the conditions present at the time of sampling are different from those assumed during the development of the sampling plan, then quality of the data collected may be affected. The following definitions have been established:

- Typical: routine daily sampling or routine scheduled sampling at pre-established locations.

- Worst case: sampling conducted under the worst meteorological and/or site conditions which would result in elevated ambient concentrations.

- One-time: only one chance is given to collect a sample without regard to time or conditions.

Qualitative data acquired under these conditions are usually applicable only to the time period during which the data were collected and may not provide accurate information to be used in estimating the magnitude of an air impact during other periods or over a long time interval.

The sampling objectives also dictate the detection limits. Sampling methods for airborne contaminants will depend upon the nature and state (solid, liquid or gas) of the contaminant. Gases and vapors may be collected in aqueous media or adsorbents, in molecular sieves, or in suitable containers. Particulates are collected by filters or impactors. The volume of sample to be collected is dependent upon an estimate of the contaminant concentration in the air, the sensitivity of the analytical method, and the standard or desired detection limit. A sufficient amount of sample must be collected to achieve the desired detection limit without interference from other contaminants. In addition, the selected method must be able to detect the target compound(s).

7.2.3 Location and Number of Individual Sampling Points

Choose the number and location of sampling points according to the variability, or sensitivity, of the sampling and analytical methods being utilized, the variability of contaminant concentration over time at the site, the level of precision required and costlimitations. In addition, determine the number of locations and placement of samplers by considering the nature of the response, local terrain, meteorological conditions, location of the site (with respect to other conflicting background sources), size of the site, and the number, size, and relative proximity of separate on-site emission sources and upwind sources. The following are several considerations for sampler placement:

- Location of potential on-site emission sources, as identified from the review of site background information or from preliminary on-site inspections.

- Location of potential off-site emission sources upwind of the sampling location(s). Review local wind patterns to determine the location of off-site sources relative to wind direction.

- Topographic features that affect the dispersion and transport of airborne toxic constituents.

Avoid natural obstructions when choosing air sampling station locations, and account for channelization around those obstructions.

- Large water bodies, which affect atmospheric stability and the dispersion of air contaminants.

- Roadways (dirt or paved), which may generate dust that could mask site contaminants.

- Vegetation, such as trees and shrubs, which stabilizes soil and retards subsurface contaminants from becoming airborne. It also affects air flow and scrubs some contaminants from the air. Sometimes thick vegetation can make an otherwise ideal air monitoring location inaccessible.

Consider the duration of sampling activities when choosing the location and number of samples to be collected. For example, if the sampling period is limited to a few hours, one or two upwind and several downwind samples would typically be adequate, especially around major emission sources.

A short-term monitoring program ranges from several days to a few weeks and generally includes gathering data for site assessments, removal actions, and source determination data (for further modeling). Activities involved in a short-term sampling strategy must make the most of the limited possibilities for data collection. Consider moving upwind/downwind locations daily based on National Oceanic and Atmospheric Administration (NOAA) weather forecasts. Weather monitoring becomes critical where complex terrain and local meteorological effects frequently change wind direction. Often, a number of alternatives can fulfill the same objective.

Prevailing winds running the length of a valley usually require a minimum number of sampler locations; however, a complex valley may require more sampler locations to account for the wide variety of winds. Ocean/lake effects may require a radical plan to collect enough samples to reach a low detection limit. Two sets of samplers may be placed next to each other: one set would be activated during the sea breeze while the other set is turned off, and vice versa when there is no sea breeze. After the sampling event, the respective upwind and downwind samples would be combined. Another alternative for sampling near a large body of water may be to use automatic, wind-vector-operated samplers, which turn the sampler on only when the wind comes from a specified vector. At sites located on hillsides, wind will move down a valley and produce an upward fetch at the same time. Sampling locations may have to ring the site to measure the wind's impact.

Off-site sources may affect on-site monitoring. In this case, on-site meteorological data, concurrent with sampling data, is essential to interpreting the acquired data. Also, additional upwind sampling sites may be needed to fully characterize ambient background contaminant levels. Multiple off-site sources may require several monitoring locations, but if the sources are at a sufficient distance, only one monitoring location is needed.

Topography and weather are not the only factors in sampler location; the sampling sites must be secure from vandals and mishap. Secure all sampling locations to maintain chain of custody, and to prevent tampering with samples or loss of sampling units. High-volume sampling methods often require the use of 110 VAC electric power. When portable generators are used, the power quality may affect sampler operation. Also, be aware that the generators themselves could be a potential pollution source if their placement is not carefully considered.

Air quality dispersion models can be used to place samplers. The models incorporate source information, surrounding topography, and meteorological data to predict the general distance and directions of maximum ambient concentrations. Modeling results should be used to select sampling locations in areas of maximum pollutant concentrations.

7.2.4 Time, Duration and Frequency of Sampling Events

After choosing appropriate sampling or monitoring locations, determine the sampling frequency and the number of samples to be collected. The time of day, duration and frequency of sampling events is governed by:

- The effects of site activities and meteorology on emission rates
- The diurnal effect of the meteorology on downwind dispersion
- The time period(s) of concern as defined by the objective
- The variability in the impact from other non-site-related sources
- If defined, the degree of confidence needed for either the mean or maximum downwind concentrations observed
- The precision requirements for single measurements
- Cost and other logistical considerations

The duration of the removal action and the number of hours per day that site work is conducted determine the time, duration, and frequency of samples. Short-term sampling programs may require daily sampling, while long-term programs may require 24-hour sampling every sixth or twelfth day. If the site will be undergoing removal activities 24 hours a day, continuous air sampling may be warranted. However, if the site activities will be conducted for only eight hours a day, and there are no emissions likely to occur during the remaining 16 hours, then sampling would be appropriate prior to the start of daily activities, would continue during operations, and end at the conclusion of the daily activities. An off-peak sample collection can ensure that emissions are not persisting after the conclusion of daily cleanup activities. For some sites, emissions are still a factor several hours after daily site activities have been completed. Because of the typically decreased downwind dispersion in the evening, higher downwind concentrations than were present during daytime site activities may be detected. For sites where this is possible, the sampling duration needs to be lengthened accordingly.

Sampling duration and flow rate dictate the volume of air collected, and to a major degree, the detection limit. The analytical method selected will provide a reference to flow rate and volume. Flow rates are limited to the capacity of the pumps being employed and the contact time required by the collection media.

The duration or period of air sampling is commonly divided into two categories (1) samples collected over a brief time period are referred to as "instantaneous" or "grab" samples and are usually collected in less than five minutes and (2) average or integrated samples are collected over a significantly longer period of time. Integrated samples provide an average concentration over the entire sampling period. Integrated samples are not suited to determining cyclical releases of contaminants because periodic or cyclical events are averaged out by the proportionally long sampling duration.

Air quality dispersion models can predict the maximum air contaminant concentration expected from a source. The meteorological and site conditions expected to cause the highest concentration are known as worst-case conditions and can be identified by analyzing the modeling results. Depending upon the objective, one may sample when the model predicts worst-case conditions will exist.

7.2.5 Meteorological and Physical/Chemical Considerations

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data. Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

- Wind Speed

  When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

- Wind Direction

  Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source.

- Atmospheric Stability

  Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

- Temperature

  Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

- Humidity

  High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

- Atmospheric Pressure

  Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures.

  In many cases, the transport and dispersion of air pollutants is complicated by local meteorology. Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns.

  The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affects its behavior and can influence the method used to sample and analyze it.

8.0 CALCULATIONS

Volume is obtained by multiplying the sample time in minutes by the flow rate. Sample volume should be indicated on the chain of custody record. Adjustments for temperature and pressure differences may be required.

Results are usually provided in parts per million (ppm), parts per billion (ppb), milligrams per cubic meter (mg/m^3) or micrograms per cubic meter ($\mu g/m^3$).

Refer to the analytical method or regulatory guidelines for other applicable calculations.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

The manufacturer's instructions should be reviewed prior to instrument use. Instruments must be utilized in accordance with manufacturer's instructions. Equipment checkout and calibration activities must occur prior to and after monitoring and sampling and must be documented.

9.1 QA/QC Samples

QA/QC samples provide information on the variability and usability of environmental sample results. Various QA/QC samples may be collected to detect error. QA/QC samples are submitted with the field samples for analysis to aid in identifying the origin of analytical discrepancies; then a determination can be made as to how the analytical results should be used. Collocated samples, background samples, field blanks, and lot blanks are the most commonly collected QA/QC field samples. Performance evaluation (PE) samples and matrix spikes provide additional measures of data QA/QC control. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet site-specific QA or data quality objectives.

9.2 Sample Documentation

All sample and monitoring activities should be documented legibly, in ink. Any corrections or revisions should be made by lining through the incorrect entry and by initialing the error. All samples must be recorded on an Air Sampling Worksheet. A chain of custody record must be maintained from the time a sample is taken to the final deposition of the sample. Custody seals demonstrate that a sample container has not been opened or tampered with during transport or storage of samples.

10.0 DATA VALIDATION

Results for QA/QC samples should be evaluated for contamination. This information should be utilized to qualify the environmental sample results accordingly with data quality objectives.

11.0 HEALTH AND SAFETY

Personal protection equipment (PPE) requirements identified in federal and/or state regulations and 29 Code of Federal Regulations (CFR) 1910.120 for hazardous waste site work must be followed.

The majority of physical precautions involved in air sampling are related to the contaminant sampled. Attention should be given when sampling in potentially explosive, flammable or acidic atmospheres. On rare occasions, the collection media may be hazardous; for example, in the instance where an acidic or basic solution is utilized in an impinger.

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

12.0 REFERENCES

(1) U.S. EPA. *Air Superfund National Technical Guidance Series. Volume I. Application of Air Pathway Analyses for Superfund Activities*. EPA/450/1-89/001.

(2) U.S. EPA. *Air Superfund National Technical Guidance Series. Volume II. Estimation of Baseline Air Emissions at Superfund Sites*. EPA/450/1-89/002.

(3) U.S. EPA. *Air Superfund National Technical Guidance Series. Volume III. Estimations of Air Emissions from Cleanup Activities at Superfund Sites*. EPA/450/1-89/003.

(4) U.S. EPA. *Air Superfund National Technical Guidance Series. Volume IV. Procedures for Dispersion Air Modeling and Air Monitoring for Superfund Air Pathway Analysis*. EPA/450/1-89/004.

(5) *Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Wastes*, International Organization of Legal Metrology (OIML) U.S. National Working Group (NWG) for OIML, American Conference of Governmental Industrial Hygienists, Cincinnati, OH

(6) NIOSH. *Manual of Analytical Methods, Second Edition. Volumes 1-7.* U.S. Department of Health and Human Services Publication No. 84-100.

NIOSH. *Manual of Analytical Methods*, February 1984. U.S. Department of Health and Human Services Publication No. 84-100.

(7) ASTM. 1990. *Annual Book of Standards, Volume 11.03*.

(8) Riggin, R.M. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. EPA/600/4-84/041.

(9) Winberry, W.T. *Supplement to U.S. EPA/600/4-84/041: Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. EPA/600/4-87/006.

(10) OSHA. *Analytical Methods Manual, Second Edition. Part 1, Organic Substances*, January 1990. *Part 2, Inorganic Substances* August 1991.

(11) Patty, F.A., *Industrial Hygiene and Toxicology, Third Edition*, John Wiley and Sons, Inc., New York, NY.

(12) *Air Sampling Instruments for Evaluation of Atmospheric Contaminants, Seventh Edition*, 1989, American Conference of Governmental Industrial Hygienists, Cincinnati, OH

BIBLIOGRAPHY

Removal Program Representative Sampling Guidance, Volume 2: Air, Environmental Response Branch, Emergency Response Division, Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, April 1992, Interim Final.

APPENDIX A

Portable Screening Devices and Specialized Analytical Instruments

PORTABLE SCREENING DEVICES

Where possible, a datalogger should be used to minimize the length of time required for site personnel to be in a potentially contaminated area. Datalogger cable is available from manufacturers for linear output instruments and some nonlinear output instruments. U.S. EPA ERT/REAC has output cables for organic vapor analyzers (i.e., HNU and OVA), toxic gas analyzers (i.e., monitox) and real-time aerosol monitors (i.e., RAM and miniram).

C Total Hydrocarbon Analyzers

Total hydrocarbon analyzers used to detect a variety of volatile organic compounds (VOCs) at hazardous waste sites principally employ either a photoionization detector (PID) or a flame ionization detector (FID). Compounds are ionized by a flame or an ultraviolet lamp. PIDs depend on the ionization potential of the compounds. PIDs are sensitive to aromatic and olefinic (unsaturated) compounds such as benzene, toluene, styrene, xylenes, and acetylene. Greater selectivity is possible by using low-voltage lamps. The ionization potential of individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards. These instruments are not compound-specific and are typically used as screening instruments. FIDs are sensitive to volatile organic vapor compounds such as methane, propanol, benzene and toluene. They respond poorly to organic compounds lacking hydrocarbon characteristics.

C Oxygen and Combustible Gas Indicators

Combustible Gas Indicators (CGIs) provide efficient and reliable methods to test for potentially explosive atmospheres. CGI meters measure the concentration of a flammable vapor or gas in air and present these measurements as a percentage of the lower explosive limit (LEL).

The measurements are temperature-dependent. The property of the calibration gas determines sensitivity. LELs for individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards. If readings approach or exceed 10% of the LEL, extreme caution should be exercised in continuing the investigation. If readings approach or exceed 25% LEL, personnel should be withdrawn immediately.

CGIs typically house an electrochemical sensor to determine the oxygen concentration in ambient air. Normally, air contains approximately 20.9% oxygen by volume. Oxygen measurements are of particular importance for work in enclosed spaces, low-lying areas, or in the vicinity of accidents that have produced heavier-than-air vapors which could displace ambient air. The meters are calibrated for sea level and may indicate a false negative (i.e, O_2 content) at higher altitudes. Since the air has been displaced by other substances, these oxygen-deficient areas are also prime locations for taking additional organic vapor and combustible gas measurements. Oxygen-enriched atmospheres increase the potential for fires by their ability to contribute to combustion or to chemically react with flammable compounds and promote auto-ignition.

C Toxic Atmosphere Analyzers

The toxic atmosphere analyzer is a compound-specific instrument, designed and calibrated to identify and quantify a specific compound or class of compounds in either gaseous or vapor form. Cross-sensitivity to air pollutants not of interest may be lead to erroneous results.

U.S. EPA/ERT has the following toxic atmosphere analyzers: carbon monoxide, phosgene, nitrous oxide, hydrogen cyanide, sulfur dioxide, hydrogen sulfide, and chlorine gas.

C Aerosol/Particulate Monitors

A Real-Time Aerosol/Particulate Monitor (RAM) displays readings for total particulates. The instrument employs a pulse light emitting diode which generates a narrow band emission in conjunction with a photovoltaic cell to detect light scattered from particulates.

The U.S. EPA/ERT uses the RAM when the contaminant of concern is associated with particulates, and when responding to fires involving hazardous materials, to identify plume levels. The instrument is very useful in determining the presence of a plume when it is not visible. The U.S. EPA/ERT typically uses RAMs on tripods to obtain particulate concentrations at the breathing zone level. Personal dataloggers are used with the RAMs to document minimum, average and maximum concentrations. This provides real-time data without requiring those in personal protective equipment to be constantly present in the plume.

C Chemical Detector Tubes (Colorimetric Tubes)

A chemical detector tube is a hollow, tube-shaped, glass body containing one or more layers of chemically impregnated inert material. To use, the fused ends are broken off and a manufacturer-specified volume of air is drawn through the tube with a pump to achieve a given detection limit. The chemicals contained within the packing material undergo a chemical reaction with the airborne pollutant present, producing a color change during the intake of each pump stroke. The concentration of a pollutant is indicated by the length of discoloration on a calibrated scale printed on the detector tube.

C Radiation Meters

Radiation meters determine the presence and level of radiation. The meters use a gas or solid ion detection media which becomes ionized when radiation is present. The meters are normally calibrated to one probe. Meters that detect alpha, beta, and gamma radiation are available.

C Gold Film (Hydrogen Sulfide and Mercury Vapor) Monitors

Hydrogen sulfide (H_2S) and Mercury (Hg) monitors operate on the principle that electric resistivity increases across a gold film as a function of H_2S and Hg concentration. The monitors provide rapid and relatively low detection limits for H_2S and Hg in air. After extensive sampling periods or high concentrations of H_2S and Hg, the gold film must be heated to remove contamination and return the monitor to its original sensitivity.

C Infrared Detectors

Infrared detectors such as the Miniature Infrared Analyzer (MIRAN) use infrared (IR) absorption as a function of specific compounds. MIRAN instruments apply to situations where the contaminants are identified but concentrations are not. MIRAN instruments generally require AC power.

SPECIALIZED ANALYTICAL INSTRUMENTS

The continuous monitors described above provide qualitative measurement of air contaminants. Quantitative measurements in the field can be obtained using more sophisticated instruments, such as portable Gas Chromatographs, to analyze grab samples.

C Direct Air Sampling Portable Gas Chromatographs (GCs)

Portable GCs use gas chromatography to identify and quantify compounds. The time it takes for a compound to move through a chromatographic column is a function of that specific compound or group of compounds. A trained technician with knowledge of the range of expected concentrations of compounds can utilize a portable GC in the field to analyze grab samples. GCs generally require AC power and shelter to operate. This method is limited by its reliance on a short-term grab sample to be representative of the air quality at a site.

C Remote Optical Sensing

This technique, also referred to as long-path or open-path monitoring, involves transmitting either an infrared or ultraviolet light beam across a long open path and measuring the absorbance at specific wavelengths. The technique is capable of analyzing any preselected organic or inorganic volatile compound that can be resolved from compounds naturally occurring in ambient air. Current projected removal applications include perimeter monitoring during site cleanups and measurement of emission source strengths during site assessments.

C TAGA Direct Air Sampling Mass Spectrometer/Mass Spectrometer

The Trace Atmospheric Gas Analyzer (TAGA), which is operated by the U.S. EPA/ERT, is capable of real-time detection of preselected organic compounds at low parts-per-billion concentrations. The instrument has been successfully used by the U.S. EPA/ERT for isolating individual emission plumes and tracking those plumes back to their sources.

APPENDIX B

Air Sampling Equipment and Media/Devices

AIR SAMPLING EQUIPMENT

C High-Volume, Total Suspended Particulate (TSP) Samplers

High-volume TSP samplers collect all suspended particles by drawing air across an 8- by 10-inch glass-quartz filter. The sample rate is adjusted to 40 cubic feet per minute (CFM), or 1134 liters per minute (L/min), and it is held constant by a flow controller over the sample period. The mass of TSPs can be determined by weighing the filter before and after sampling. The composition of the filter varies according to the analytical method and the detection limit required.

C PM-10 Samplers

PM-10 samplers collect particulates with a diameter of 10 microns or less from ambient air. Particulates of this size represent the respirable fraction, and thus are of special significance. PM-10 samplers can be high-volume or low-volume. The high-volume sampler operates in the same manner as the TSP sampler at a constant flow rate of 40 CFM; it draws the sample through a special impactor head which collects particulates of 10 microns or less. The particulate is collected on an 8- by 10-inch filter. The low-volume sampler operates at a rate of approximately 17 L/min. The flow must remain constant through the impactor head to maintain the 10-micron cut-off point. The low-volume PM-10 collects the sample on 37-mm Teflon filters.

C High-Volume PS-1 Samplers

High-volume PS-1 samplers draw a sample through polyurethane foam (PUF) or a combination foam and XAD-2 resin plug, and a glass quartz filter at a rate of 5-10 CFM (144 to 282 L/min). This system is excellent for measuring low concentrations of semivolatiles, PCBs, pesticides, or chlorinated dioxins in ambient air.

C Area Sampling Pumps

These pumps provide flow-rate ranges of 2-20 L/min and have a telescopic sampling mast with the sampling train. Because of the higher volume, this pump is suitable for sampling low concentrations of airborne contaminants (i.e., asbestos sampling). These pumps are also used for metals, pesticides and PAH sampling which require large sample volumes.

C Personal Sampling Pumps

Personal sampling pumps are reliable portable sampling devices that draw air samples through a number of sampling media including resin tubes, impingers, and filters. Flow rates are usually adjustable from 0.1 to 4 L/min (or 0.01 to .75 L/min with a restrictive orifice) and can remain constant for up to 8 hours on one battery charge or continuously with an AC charger/converter.

C Canister Samplers

Evacuated canister sampling systems use the pressure differential between the evacuated canister and ambient pressure to bleed air into the canister. The sample is bled into the canister at a constant rate over the sampling period using a critical orifice, a mechanically compensated regulator, or a mass flow control
device until the canister is near atmospheric pressure.

Pressure canister sampling systems use a pump to push air into the canister. To maintain a higher, more controlled flow, the pump typically controls the pressure differential across a critical orifice at the inlet of the canister, resulting in a pressurized canister at the completion of sampling.

AIR SAMPLING MEDIA/DEVICES

If possible, before employing a specific sampling method, consult the laboratory that will conduct the analyses. Many of the methods can be modified to provide better results or a wider range of results.

C Summa^{R} Canisters

Summa canisters are highly polished passivated stainless steel cylinders. The Summa polishing process brings chrome and nickel to the surface of the canisters, which results in an inert surface. This surface restricts adsorption or reactions that occur on the canister's inner surface after collection. At the site, the canister is either placed in a sampler to control sample collection rate, or opened to collect a grab sample. Samples can be collected by allowing air to bleed into or be pumped into the canister. U.S. EPA/ERT uses 6-liter Summa canisters for VOC and permanent gas analysis.

C Passive Dosimeters

Passive dosimeters are clip-on vapor monitors (samplers) in which the diffused contaminants are absorbed on specially prepared active surfaces. Industrial hygienists commonly use dosimeters to obtain time-weighted averages or concentrations of chemical vapors, as they can trap over 130 organic compounds. Selective dosimeters have also been developed for a number of chemicals including formaldehyde, ethylene oxide, hydrogen sulfide, mercury vapor, nitrogen dioxide, sulfur dioxide, and ozone. Dosimeters must be sent to a laboratory for analysis.

C Polyurethane Foam (PUF)

PUF is a sorbent used with a glass filter for the collection of semivolatile organic compounds such as pesticides, PCBs, chlorinated dioxins and furans, and PAHs. Fewer artifacts (chemical changes that occur to collected compounds) are produced than with some other solid sorbents. PUF is used with the PS-1 sampler and U.S. EPA Method TO13. PUF can also be used with personal sampling pumps when sampling for PAHs using the Lewis/McCloud method. Breakthrough of the more volatile PCBs and PAHs may occur when using PUF.

C Sampling Bags (Tedlar^{R})

Sampling bags, like canisters, transport air samples to the laboratory for analysis. Samples are generally pumped into the bags, but sometimes a lung system is used, in which a pump creates a vacuum around the bag in a vacuum box. Then the sample flows from a source into the bag. This method is used for VOCs, fixed gases (CO_2, O_2, and N_2) and methane.

C Impingers

An impinger allows an air sample to be bubbled through a solution, which collects a specific contaminant by either chemical reaction or absorption. For long sampling periods, the impinger may need to be kept in an ice bath to prevent the solution from evaporating during sampling. The sample is drawn through the impinger by using a sampling pump or more elaborate sampling trains with multiple impingers.

C Sorbent Tubes/Cartridges

A variety of sampling media are available in sorbent tubes, which are used primarily for industrial hygiene. A few examples are carbon cartridges, carbon molecular sieves, Tenax tubes and tube containing the XAD-2 polymer. Depending upon the sorbent material, tubes can be analyzed using either a solvent extraction or thermal desorption. The former technique uses standard laboratory equipment and allows for multiple analyses of the same sample. The latter technique requires special, but readily available, laboratory equipment and allows only one analysis per sample. In addition, thermal desorption typically allows for lower detection limits by two or more orders of magnitude. Whenever sorbent tubes are being used for thermal desorption, they should be certified as "clean" by the laboratory doing the analysis.

Thermally Desorbed Media

During thermal desorption, high-temperature gas streams are used to remove the compounds collected on a sorbent medium. The gas stream is injected and often cryofocused into an analytical instrument, such as a GC, for compound analysis:

C Tenax Tubes

Tenax tubes are made from commercially available polymer (p-phenylene oxide) packed in glass or stainless steel tubes through which air samples are drawn or sometimes pumped. These tubes are used in U.S. EPA Method TO1 and VOST for volatile nonpolar organic, some polar organic, and some of the more volatile semivolatile organics. Tenax is not appropriate for many of the highly volatile organics (with vapor pressure greater than approximately 200 mm Hg).

C Carbonized Polymers

The carbonized molecular sieve (CMS), a carbonized polymer, is a commercially available, carbon sorbent packed in stainless-steel sampling tubes through which air samples are drawn or sometimes pumped. These are used in U.S. EPA Method TO2 for highly volatile nonpolar compounds which have low-breakthrough volumes on other sorbents. When high-thermal desorption temperatures are used with CMS, more variability in analysis may occur than with other sorbents.

C Mixed Sorbent Tubes

Sorbent tubes can contain two type of sorbents. Combining the advantages of each sorbent into one tube increases the possible types of compounds to be sampled. The combination of two sorbents can also reduce the chance that highly volatile compounds will break through the sorbent media. An example of a mixed sorbent tube is the combination of Tenax and charcoal with a carbonized molecular sieve. A potential problem with mixed sorbent tubes is the breakthrough of a compound from an earlier sorbent to a later sorbent from which it cannot be desorbed.

Solvent-Extracted Media

Solvent-extracted media use the principle of chemical extraction to remove compounds collected on a sorbent media. The chemical solvent is injected into an instrument, such as a GC, for analysis of compounds. Examples of solvent-extracted media follow:

C Chemically Treated Silica Gel

Silica gel is a sorbent which can be treated with various chemicals. The chemically treated silica gel can then be used to sample for specific compounds in air. Examples include the DNPH-coated silica gel cartridge used with U.S. EPA Method TO11.

C XAD-2 Polymers

XAD-2 polymers usually are placed in tubes, custom-packed sandwich-style with polyurethane foam, and prepared for use with U.S. EPA Method TO13 or the semi-VOST method. The polymers are used for the collection of semivolatile polar and nonpolar organic compounds. The compounds collected on the XAD-2 polymer are chemically extracted for analysis.

C Charcoal Cartridges

Charcoal cartridges, consisting of primary and backup sections, trap compounds by adsorption. Ambient air is drawn through them so that the backup section verifies that breakthrough of the analytes on the first section did not occur, and the sample collection was therefore quantitative. Quantitative sample collection is evident by the presence of target chemicals on the first charcoal section and the absence on the second section. Next, the adsorbed compounds must be eluted, usually with a solvent extraction, and analyzed by GC with a detector, such as a Mass Spectrometer (MS).

- Tenax Tubes

  Cartridges are used in OSHA and NIOSH methods in a manner similar to charcoal cartridges but typically for less volatile compounds.

Particulate Filters

Particulate filters are used by having a sampling pump pass air through them. The filter collects the particulates present in the air and is then analyzed for particulate mass or chemical or radiological composition. Particulate filters are made from different materials which are described below.

- Mixed Cellulose Ester (MCE)

  MCE is manufactured from mixed esters of cellulose which are a blend of nitro-cellulose and cellulose acetate. MCE filters are used often for particulate sampling.

- Glass Fiber

  Glass fiber is manufactured from glass fibers without a binder. Particulate filters with glass fiber provide high flow rates, wet strength, and high, solid holding capacity. Generally, the filters are used for gravimetric analysis of particulates.

- Polyvinyl Chloride

  Particulate filters with polyvinyl chloride are resistant to concentrated acids and alkalis. Their low moisture pickup and light tare weight make them ideal for gravimetric analysis.

- Teflon

  Teflon is manufactured from polytetrafluorethylene (PTFE). Particulate filters with Teflon are easy to handle and exceptionally durable. Teflon filters are used for metal collection.

- Silver

  Particulate filters manufactured from pure silver have high collection efficiency and uniform pore size. These filters are used for mercury collection and analysis.

- Cellulose

  Particulate filters with cellulose contain less than 0.01% ash. These filters are used to collect particulates.

DRUM SAMPLING

SOP#: 2009
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1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide technical guidance on implementing safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents. Container contents are sampled and characterized for disposal, bulking, recycling, segregation, and classification purposes.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, drums must be excavated, (if necessary), inspected, staged, and opened. Drum excavation must be performed by qualified personnel. Inspection involves the observation and recording of visual qualities of each drum and any characteristics pertinent to the classification of the drum's contents. Staging involves the physical grouping of drums according to classifications established during the physical inspection. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination. The contents of a drum can be further characterized by performing various field tests.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples collected from drums are considered waste samples and as such, adding preservatives is not required due to the potential reaction of the sample with the preservative. Samples should, however, be cooled to 4ºC and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Waste sample handling procedures should be as follows:

1. Label the sample container with the appropriate sample label and complete the appropriate field data sheet(s). Place sample container into two resealable plastic bags.

2. Place each bagged sample container into a shipping container which has been lined with plastic. Pack the container with enough non-combustible, absorbent, cushioning material to minimize the possibility of containers breaking, and to absorb any material which may leak.

   Note: Depending on the nature and quantity of the material to be shipped, different packaging may be required. The transportation company or a shipping/receiving expert should be consulted prior to packing the samples.

3. Complete a chain of custody record for each shipping container, place into a resealable

plastic bag, and affix to the inside lid of the shipping container.

4. Secure and custody seal the lid of the shipping container. Label the shipping container appropriately and arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

If buried drums are suspected, geophysical investigation techniques such as magnetometry or ground penetrating radar may be employed in an attempt to determine the location and depth of drums. During excavation, the soil must be removed with great caution to minimize the potential for drum rupture.

Until the contents are characterized, sampling personnel should assume that unlabelled drums contain hazardous materials. Labelled drums are frequently mislabelled, especially drums that are reused. Because a drum's label may not accurately describe its contents, extreme caution must be exercised when working with or around drums.

If a drum which contains a liquid cannot be moved without rupture, its contents may be immediately transferred to a sound drum using an appropriate method of transfer based on the type of waste. In any case, preparations should be made to contain the spill (i.e., spill pads, dike, etc.) should one occur.

If a drum is leaking, open, or deteriorated, then it must be placed immediately in overpack containers.

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually overpressurized or if shock-sensitive materials are suspected. A laser thermometer may be effective in order to determine the level of the drum contents via surface temperature differences.

Drums that have been overpressurized to the extent that the head is swollen several inches above the level of the chime should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube, goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. Venting should be done from behind a wall or barricade. Once the pressure has been relieved, the bung can be removed and the drum sampled.

Because there is potential for accidents to occur during handling, particularly initial handling, drums should only be handled if necessary. All personnel should be warned of the hazards prior to handling drums. Overpack drums and an adequate volume of absorbent material should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm adequate to contain the entire volume of liquid in the drums should be constructed before any handling takes place. If drum contents spill, personnel trained in spill response should be used to isolate and contain the spill.

5.0 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for sampling:

- Personal protection equipment
- Wide-mouth amber glass jars with Teflon cap liner, approximately 500 mL volume
- Other appropriate sample jars
- Uniquely numbered sample identification labels with corresponding data sheets
- Drum/Tank Sampling Data Sheets and Field Test Data Sheets for Drum/Tank Sampling
- Chain of Custody records
- Decontamination materials
- Glass thieving tubes or COLIWASA
- Coring device
- Stainless steel spatula or spoons
- Laser thermometer
- Drum overpacks
- Absorbent material for spills
- Drum opening devices

Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of a non-sparking metal alloy (i.e., brass, bronze/manganese, aluminum, etc.) formulated to reduce the likelihood of sparks. The use of a "NON-SPARKING" wrench does not completely eliminate the possibility of a spark being produced.

Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads must be opened by other means.

Hand Pick, Pickaxe, and Hand Spike

These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available; whereas, the spikes are generally uniquely fabricated four foot long poles with a pointed end.

Backhoe Spike

Another means used to open drums remotely for sampling is a metal spike attached or welded to a backhoe bucket. This method is very efficient and is often used in large-scale operations.

Hydraulic Drum Opener

Recently, remotely operated hydraulic devices have been fabricated to open drums. This device uses hydraulic pressure to force a non-sparking spike through the wall of a drum. It consists of a manually operated pump which pressurizes fluid through a length of hydraulic line.

Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a two-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn bung fitting selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

6.0 REAGENTS

Reagents are not typically required for preserving drum samples. However, reagents will be utilized for decontamination of sampling equipment.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Drum Excavation

If it is presumed that buried drums are on-site and prior to beginning excavation activities, geophysical investigation techniques should be utilized to approximate the location and depth of the drums. In addition, it is important to ensure that all locations where excavation will occur are clear of utility lines, pipes and poles (subsurface as well as above surface).

Excavating, removing, and handling drums are generally accomplished with conventional heavy construction equipment. These activities should be performed by an equipment operator who has experience in drum excavation. During excavation activities, drums must be approached in a manner that will avoid digging directly into them.

The soil around the drum should be excavated with non-sparking hand tools or other appropriate means and as the drums are exposed, a visual inspection should be made to determine the condition of the drums. Ambient air monitoring should be done to determine the presence of unsafe levels of volatile organics, explosives, or radioactive materials. Based on this preliminary visual inspection, the appropriate mode of drum excavation and handling may be determined.

Drum identification and inventory should begin before excavation. Information such as location, date of removal, drum identification number, overpack status, and any other identification marks should be recorded on the Drum/Tank Sampling Data Sheet (Attachment 1, Appendix A).

7.3 Drum Inspection

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. The drums should be inspected for the following:

1. Drum condition, corrosion, rust, punctures, bungs, and leaking contents.
2. Symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable), or further identifying the drums.
3. Signs that the drum is under pressure.
4. Shock sensitivity.

Monitoring should be conducted around the drums using instruments such as radiation meters, organic vapor analyzers (OVA) and combustible gas indicators (CGI).

Survey results can be used to classify the drums into categories, for instance:

- Radioactive
- Leaking/deteriorating
- Bulging
- Lab packs
- Explosive/shock sensitive
- Empty

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized. Once a drum has been visually inspected and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, the drum is affixed with a numbered tag and transferred to a staging area. Color-coded tags, labels or bands should be used to identify the drum's category based on visual inspection. A description of each drum, its condition, any unusual markings, the location where it was buried or stored, and field monitoring information are recorded on a Drum/Tank Sampling Data Sheet (Attachment 1, Appendix A). This data sheet becomes the principal record keeping tool for tracking the drum on-site.

7.4 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

During staging, the drums should be physically separated into the following categories: those containing liquids, those containing solids, those containing lab packs, and those which are empty.

This is done because the strategy for sampling and handling drums/containers in each of these categories will be different. This may be achieved by visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.

Where there is good reason to suspect that drums contain radioactive, explosive, or shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effects of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor. Drums may be restaged as necessary after opening and sampling.

7.5 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches
- Drum deheading
- Remote drum puncturing or bung removal

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under OSHA 1910.120, manual drum opening with bung wrenches or deheaders should be performed ONLY with structurally sound drums and waste contents that are known to be non-shock sensitive, non-reactive, non-explosive, and non-flammable.

7.5.1 Manual Drum Opening with a Bung Wrench

Manual drum opening with bung wrenches (Figure 1, Appendix B) should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-shock sensitive, non-reactive, non-explosive or non-flammable. If opening the drum with bung wrenches is deemed safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear.
- Drums should be positioned upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up.
- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, a "cheater bar" can be attached to the handle to improve leverage.

7.5.2 Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader (Figure 2, Appendix B) by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader.

Self-propelled drum openers which are either electrically or pneumatically driven are available and can be used for quicker and more efficient deheading.

The drum deheader should be decontaminated, as necessary, after each drum is opened to avoid cross contamination and/or adverse chemical reactions from incompatible materials.

7.5.3 Manual Drum Opening with a Hand Pick, Pickaxe, or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike (Figure 3, Appendix B). Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore, this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, spray from drums is common and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

7.5.4 Remote Drum Opening with a Backhoe Spike

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but provides a high degree of safety compared to manual methods of opening.

In the opening area, drums should be placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike (Figure 4, Appendix B) should be decontaminated after each drum is opened to prevent cross contamination and/or adverse reaction from incompatible material. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This combined with the normal personal protection gear should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system.

7.5.5 Remote Drum Opening with Hydraulic Devices

A piercing device with a non-sparking, metal point is attached to the end of a hydraulic line and is pushed into the drum by the hydraulic pressure (Figure 5, Appendix B). The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

7.5.6 Remote Drum Opening with Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely (Figure 6, Appendix B). Prior to opening the drum, a bung fitting must be selected to fit the bung to be removed. The adjustable bracketing system is then attached to the drum and the pneumatic drill is aligned over the bung. This must be done before the drill can be operated. The operator then moves away from the drum to operate the equipment. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

7.6 Drum Sampling

After the drum has been opened, preliminary monitoring of headspace gases should be performed first with an explosimeter/oxygen meter. Afterwards, an OVA or other instruments should be used. If possible, these instruments should be intrinsically safe. In most cases it is impossible to observe the contents of these sealed or partially sealed drums. Since some layering or stratification is likely in any solution left undisturbed, a sample that represents the entire depth of the drum must be taken.

When sampling a previously sealed drum, a check should be made for the presence of a bottom sludge. This is easily accomplished by measuring the depth to apparent bottom then comparing it to the known interior depth.

7.6.1 Glass Thief Sampler

The most widely used implement for sampling drum liquids is a glass tube commonly referred to as a glass thief (Figure 7, Appendix B). This tool is cost effective, quick, and disposable. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

Procedures for Use:

1. Remove the cover from the sample container.
2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.
5. Carefully remove the capped tube from the drum and insert the uncapped end into the appropriate sample container.
6. Release stopper and allow the glass thief to drain until the container is approximately two-thirds full.
7. Remove tube from the sample container, break it into pieces and place the pieces in the drum.
8. Cap the sample container tightly and label it. Place the sample container into a carrier.
9. Replace the bung or place plastic over the drum.
10. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.
11. Perform hazard categorization analyses if included in the project scope.
12. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube into this layer; then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. The use of this technique should be cleared with the project officer or other glass thief disposal techniques should be evaluated.

7.6.2 COLIWASA Sampler

The Composite Liquid Waste Sampler (COLIWASA) and modifications thereof are equipment that collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. The COLIWASA (Figure 8, Appendix B) is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. One model of the COLIWASA is shown in Appendix B; however, the design can be modified and/or adapted somewhat to meet the needs of the sampler.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.
5. Carefully discharge the sample into the appropriate sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container tightly and label it. Place the sample container in a carrier.

7. Replace the bung or place plastic over the drum.

8. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.

9. Perform hazard categorization analyses if included in the project scope.

10. Transport the sample to the decontamination zone and package for transport to the analytical laboratory, as necessary. Complete the Chain of Custody records.

7.6.3 Coring Device

A coring device may be used to sample drum solids. Samples should be taken from different areas within the drum. This sampler consists of a series of extensions, a T- handle, and the coring device.

Procedures for use:

1. Assemble the sampling equipment.

2. Remove the cover from the sample container.

3. Insert the sampling device to the bottom of the drum. The extensions and the "T" handle should extend above the drum.

4. Rotate the sampling device to cut a core of material.

5. Slowly withdraw the sampling device so that as much sample material as possible is retained within it.

6. Transfer the sample to the appropriate sample container, and label it. A stainless steel spoon or scoop may be used as necessary.

7. Cap the sample container tightly and place it in a carrier.

8. Replace the bung or place plastic over the drum.

9. Log all samples in the site log book and on Drum/Tank Sampling Data Sheets.

10. Perform hazard categorization analyses if included in the project scope.

11. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

7.7 Hazard Categorization

The goal of characterizing or categorizing the contents of drums is to obtain a quick, preliminary assessment of the types and levels of pollutants contained in the drums. These activities generally involve rapid, non-rigorous methods of analysis. The data obtained from these methods can be used to make decisions regarding drum staging or restaging, bulking or compositing of the drum contents.

As a first step in obtaining these data, standard tests should be used to classify the drum contents into general categories such as auto-reactives, water reactives, inorganic acids, organic acids, heavy metals, pesticides, cyanides, inorganic oxidizers, and organic oxidizers. In some cases, further analyses should be conducted to more precisely identify the drum contents.

There are several methods available to perform these tests:

- the HazCat^{R} chemical identification system
- the Chlor-N-Oil Test Kit
- Spill-fyter Chemical Classifier Strips
- Setaflash (for ignitability)

These methods must be performed according to the manufacturers' instructions and the results must be documented on the Field Test Data Sheet for Drum/Tank Sampling (Attachment 2, Appendix A).

Other tests which may be performed include:

- Water Reactivity
- Specific Gravity Test (compared to water)
- Water Solubility Test
- pH of Aqueous Solution

The tests must be performed in accordance with the instructions on the Field Test Data Sheet for Drum/Tank Sampling and results of the tests must be documented on these data sheets.

The specific methods that will be used for hazard categorization must be documented in the Quality Assurance Work Plan.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on Chain of Custody records, Drum/Tank Sampling Data Sheets, Field Test Data Sheet for Drum/Tank Sampling, or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

More specifically, the opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

12.0 REFERENCES

Guidance Document for Cleanup of Surface Tank and Drum Sites, OSWER Directive 9380.0-3.

Drum Handling Practices at Hazardous Waste Sites, EPA-600/2-86-013.

APPENDIX A

Attachments

ATTACHMENT 1. Drum/Tank Sampling Data Sheet

Samplers: ______________________________ Date: ______________________________

Site Name: ______________________________ Work Order Number: 3347-040-001-__________

Container Number/Sample Number: ______ REAC Task Leader: __________________________

SITE INFORMATION:

1. Terrain, drainage description:____

2. Weather conditions (from observation):____

MET station on site: No Yes

CONTAINER INFORMATION:

1. Container type: Drum Tank Other:____

2. Container dimensions: Shape:____

Approximate size:____

3. Label present: No
Yes:____

Other Markings: ____
____
____
____

4. Spill or leak present: No Yes Dimensions:______________________________________

5. Container location: (Circle one) N/A See Map Other: ______________________
____
____
____
____
____

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 1. Drum/Tank Sampling Data Sheet (cont'd)

SAMPLE INFORMATION:

1. Description: _____ liquid _____ solid (_____ powder or _____ crystals) _____ sludge

2. Color: __________________________ Vapors:______________________
   Other:____

3. Local effects present: (damage - environmental, material)____

FIELD MONITORING:

1. PID: _____________________ Background (clean zone)

_____________________ Probe used/Model used

_____________________ Reading from container opening

2. FID: _____________________ Background (clean zone)

_____________________ Reading from container opening

3. Radiation Meter:

_____________________ Model used

_____________________ Background (clean zone)

_____________________ Reading from container opening

4. Explosimeter/Oxygen Meter:

_____________________ Oxygen level from container opening

_____________________ LEL level from container opening

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling

Samplers: ______________________________ Date: ______________________

Site Name: _____________________________ Work Order Number: 3347-040-001-__________

Container Number/Sample Number: ______________ REAC Task Leader: ________________________

SAMPLE MONITORING INFORMATION:

1. PID: ____________________ Background (clean zone)

____________________ Probe used/Model used

____________________ Reading from sample

2. FID: ____________________ Background (clean zone)

____________________ Reading from sample

3. Radiation Meter: ________________ Model used

________________ Background (clean zone)

________________ Reading from sample

4. Explosimeter/Oxygen Meter: ____________ Oxygen level (sample)

____________ LEL level (sample)

SAMPLE DESCRIPTION:

________ Liquid ________ Solid ________ Sludge ________ Color ________ Vapors

WATER REACTIVITY:

1. Add small amount of sample to water: _____ bubbles _____ color change to _______________

_____ vapor formation _____ heat _____ No Change

SPECIFIC GRAVITY TEST (compared to water):

1. Add small amount of sample to water: _____ sinks _____ floats

2. If liquid sample sinks, screen for chlorinated compounds. If liquid sample floats and appears to be oily, screen for PCBs (Chlor-N-Oil kit).

APPENDIX A (Cont'd)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

CHLOR N OIL TEST KIT INFORMATION:

1. Test kit used for this sample: Yes No

2. Results: _____ PCB not present _____ PCB present, less than 50 ppm

_____ PCB present, greater than 50 ppm _____ 100% PCB present

WATER SOLUBILITY TEST:

1. Add approximately one part sample to five parts water. You may need to stir and heat gently. **[DO NOT HEAT IF WATER REACTIVE!]** Results: ________ total ________ partial ________ no solubility

pH OF AQUEOUS SOLUTION:

1. Using 0-14 pH paper, check pH of water/sample solution: ___________________.

SPILL-FYTER CHEMICAL CLASSIFIER STRIPS:

1. Acid/Base Risk: (Circle one)	Color Change
Strong acid (0)	RED
Moderately acidic (1-3)	ORANGE
Weak acid (5)	YELLOW
Neutral (7)	GREEN
Moderately basic (9-11)	Dark GREEN
Strong Base (13-14)	Dark BLUE
2. Oxidizer Risk: (Circle one)	
Not Present	WHITE
Present	BLUE, RED, OR ANY DIVERGENCE FROM WHITE
3. Fluoride Risk: (Circle one)	
Not Present	PINK
Present	YELLOW

APPENDIX A (Cont’d)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

4. Petroleum Product, Organic Solvent Risk: (Circle one)

Not Present	LIGHT BLUE
Present	DARK BLUE

5. Iodine, Bromine, Chlorine Risk: (Circle one)

Not Present	PEACH
Present	WHITE OR YELLOW

SETAFLASH IGNITABILITY TEST:

140ºF	Ignitable: ________	Non-Ignitable ________
160ºF	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________
______	Ignitable: ________	Non-Ignitable ________

Comments:
____
____
____
____
____
____

HAZCAT KIT TESTS:

1. Test: ____________________________________ Outcome:__________________________________

Comments:____

____

2. Test: ____________________________________ Outcome:__________________________________

Comments:____

____

APPENDIX A (Cont’d)

Attachments

ATTACHMENT 2. Field Test Data Sheet for Drum/Tank Sampling (cont'd)

3. Test: ______________________________________ Outcome:____________________________________

Comments:____

____

4. Test: ______________________________________ Outcome:____________________________________

Comments:____

____

5. Test: ______________________________________ Outcome:____________________________________

Comments:____

____

<u>HAZCAT PESTICIDES KIT</u>:

Present: __________________________________ Not Present: ____

Comments: ____

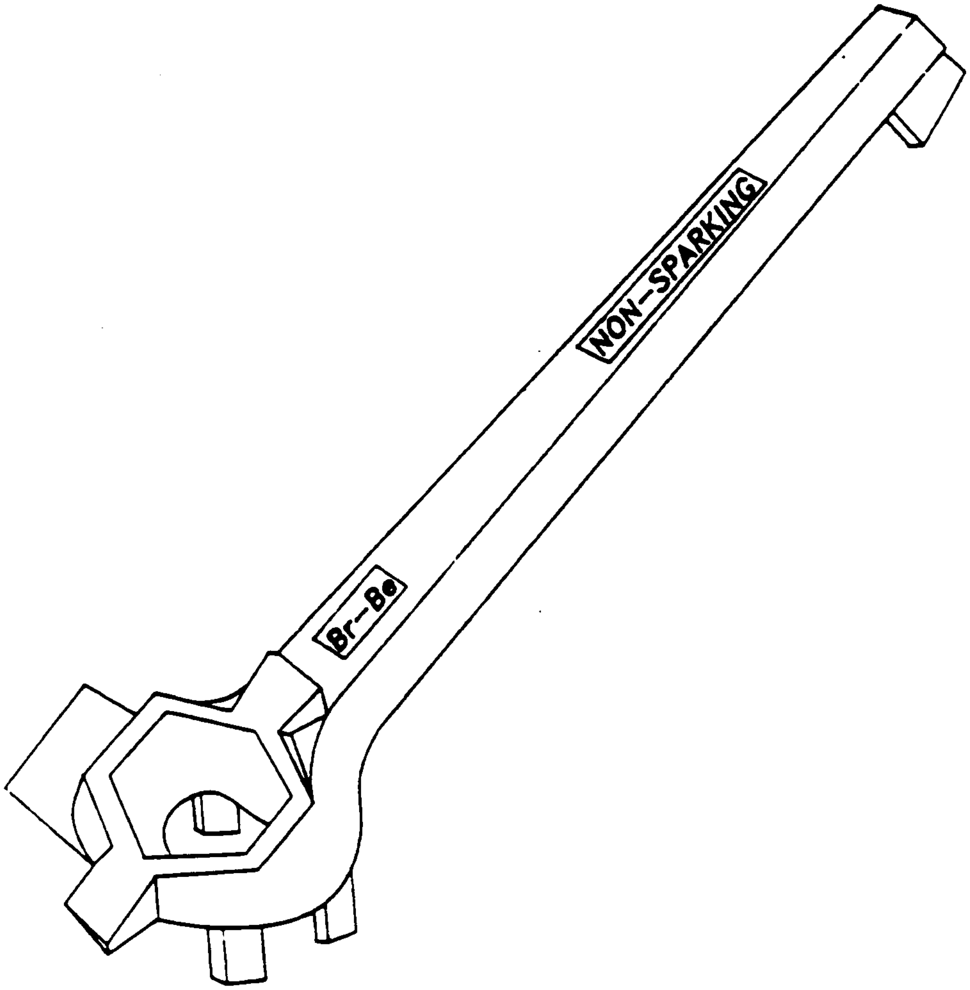
____

____

APPENDIX B

Figures

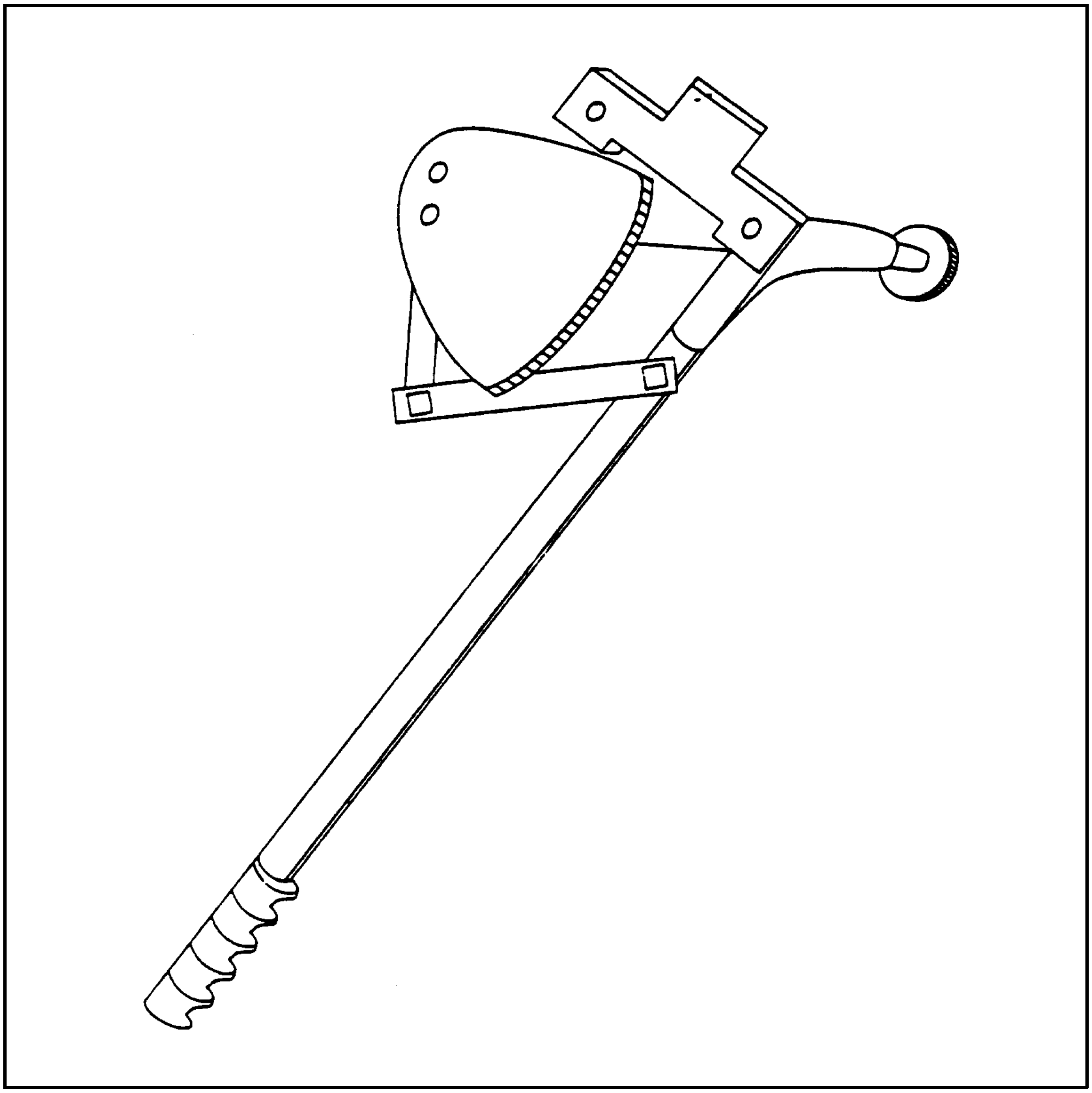
Figure 1. Universal Bung Wrench



APPENDIX B (Cont'd)

Figures

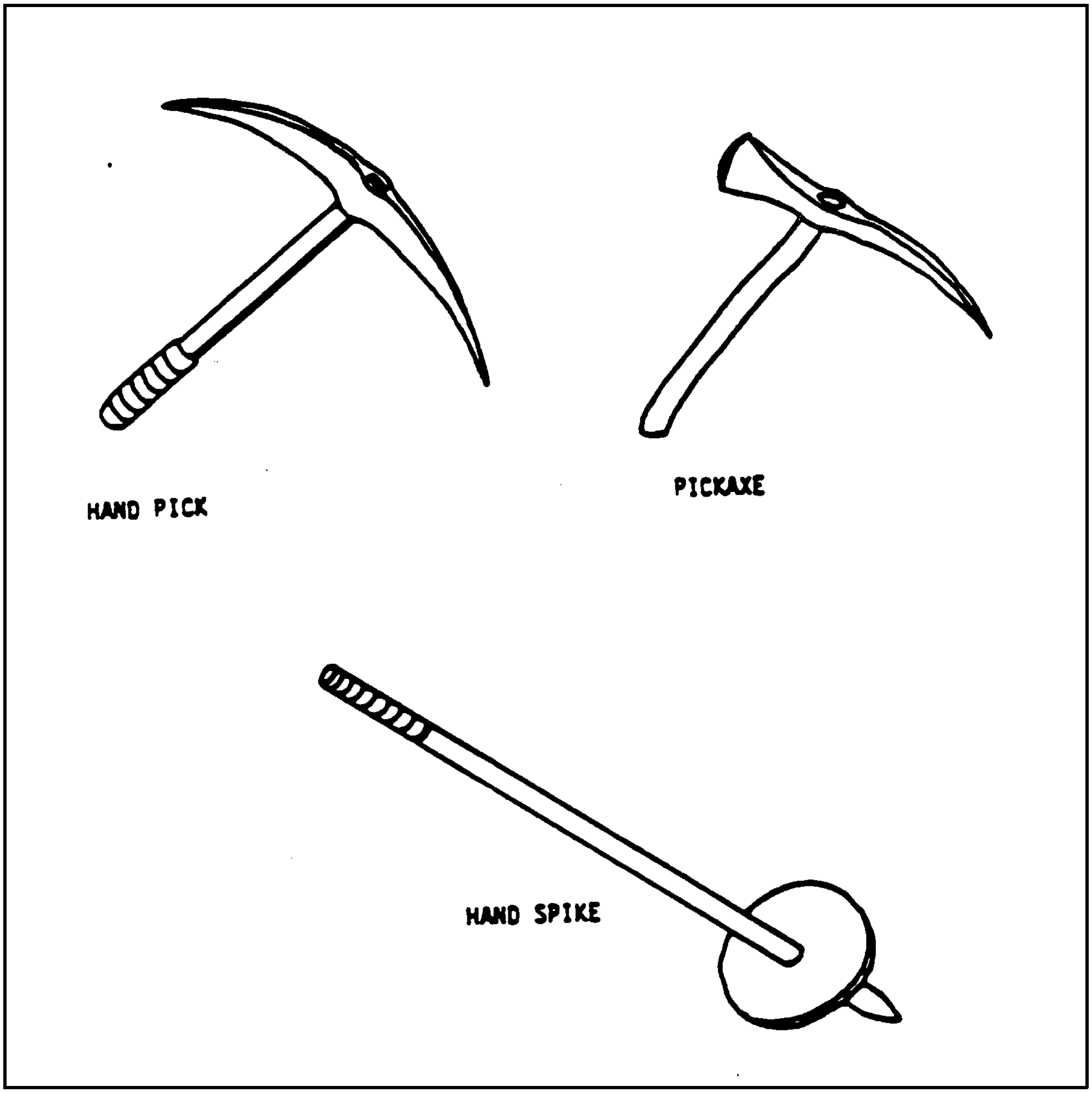
Figure 2. Drum Deheader



APPENDIX B (Cont'd)

Figures

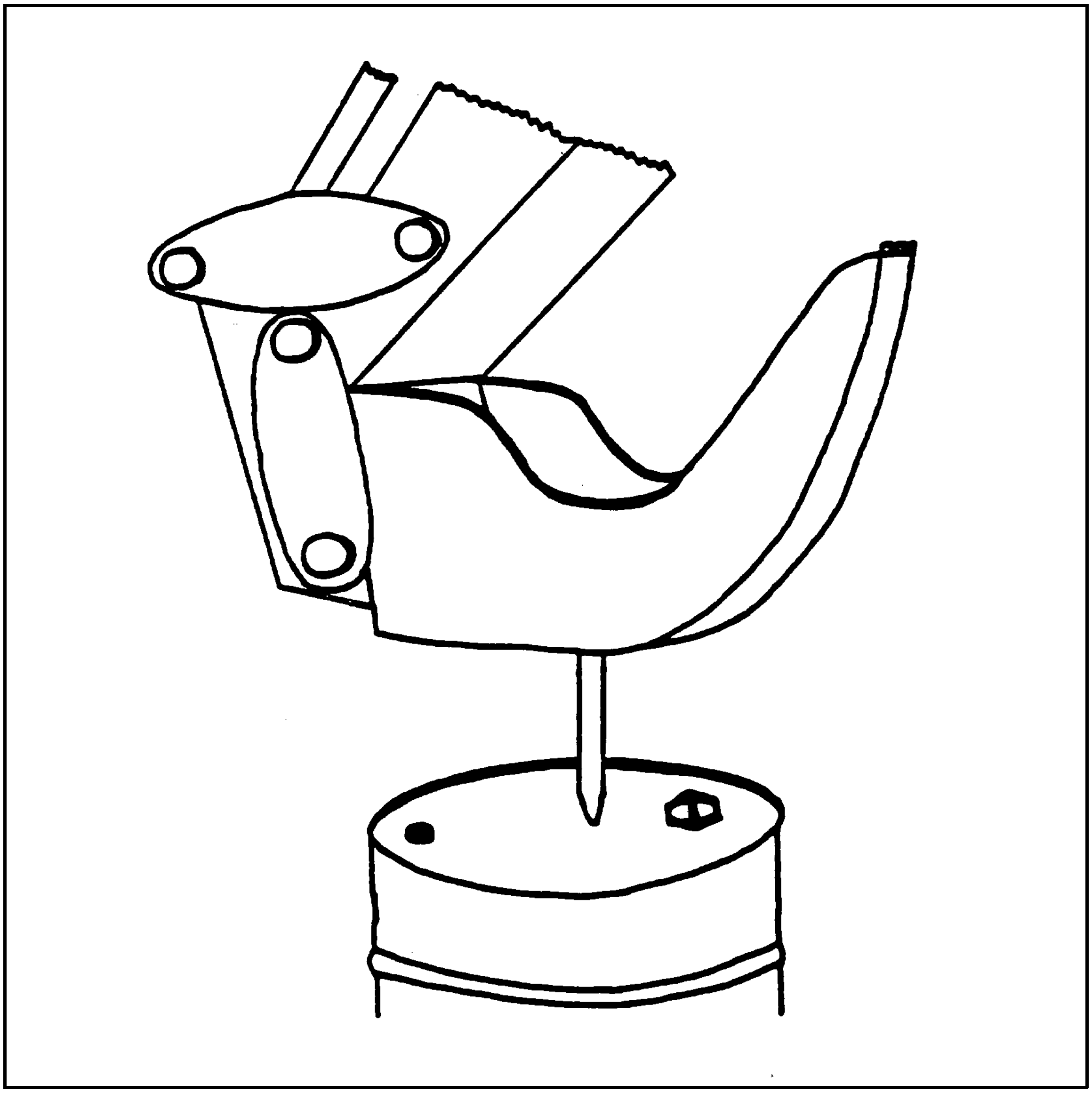
Figure 3. Hand Pick, Pickaxe, and Hand Spike



APPENDIX B (Cont’d)

Figures

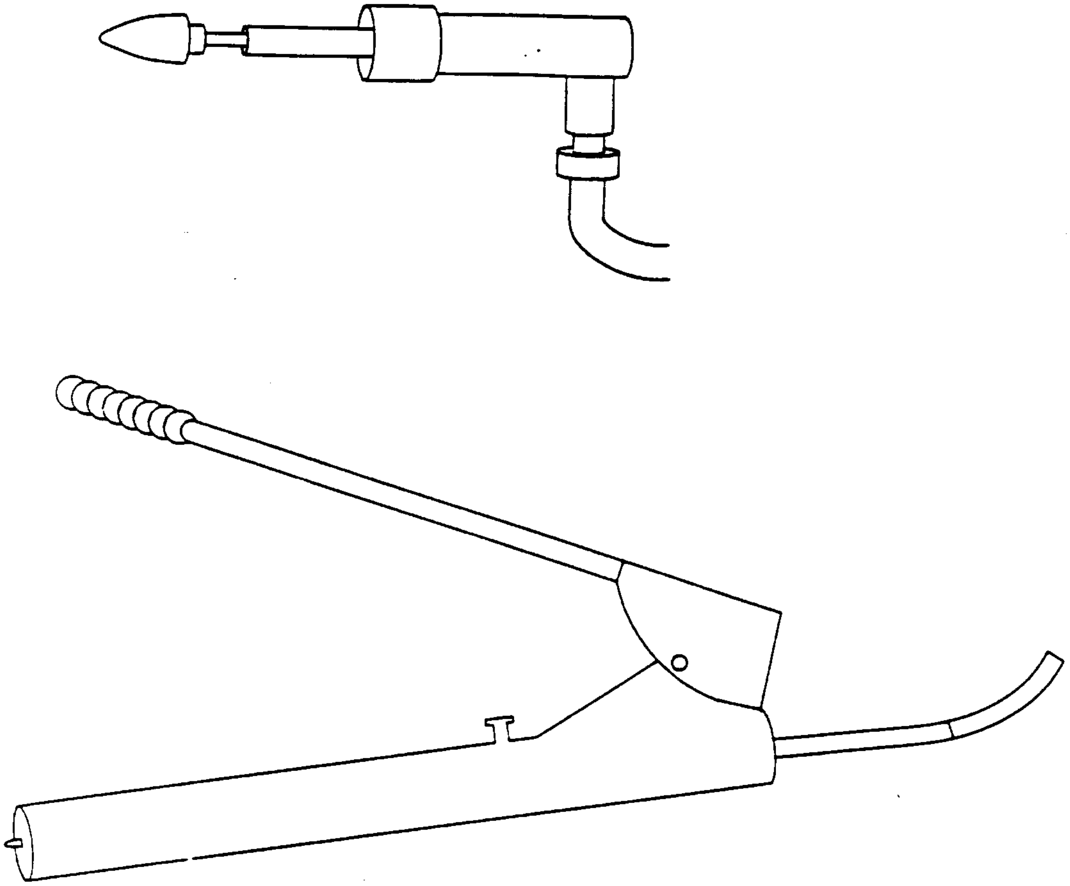
Figure 4. Backhoe Spike



APPENDIX B (Cont’d)

Figures

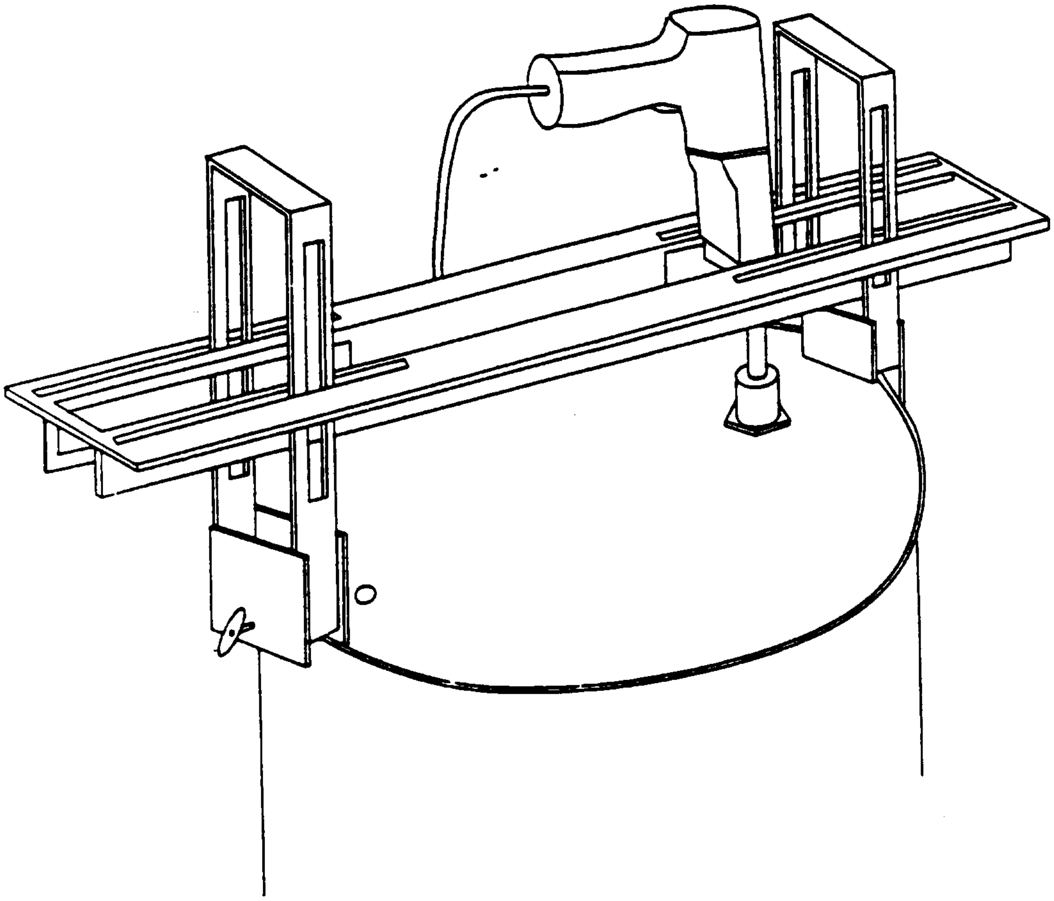
Figure 5. Hydraulic Drum Opener



APPENDIX B (Cont'd)

Figures

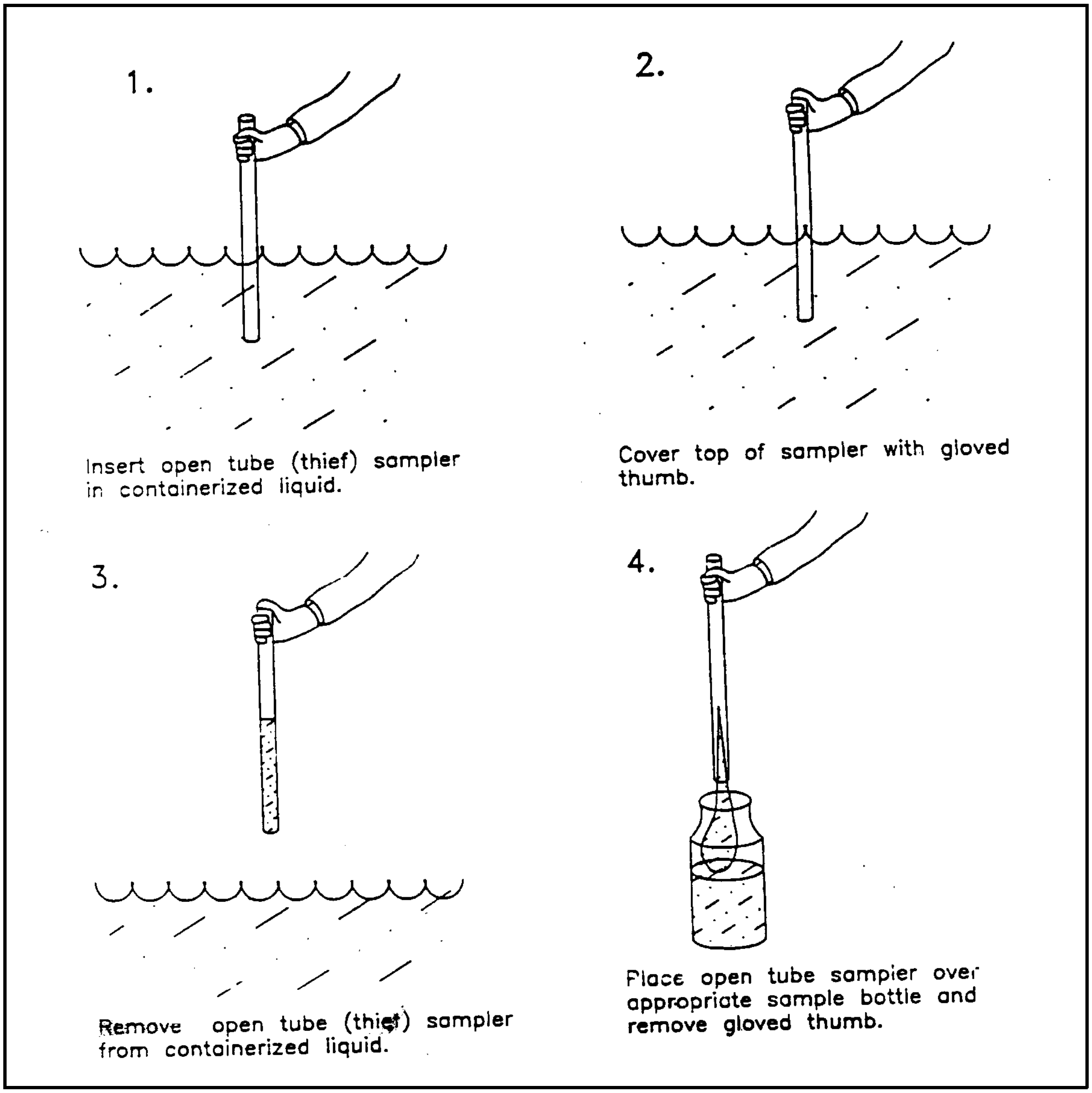
Figure 6. Pneumatic Bung Remover



APPENDIX B (Cont'd)

Figures

Figure 7. Glass Thief



1\. Insert open tube (thief) sampler in containerized liquid.

2\. Cover top of sampler with gloved thumb.

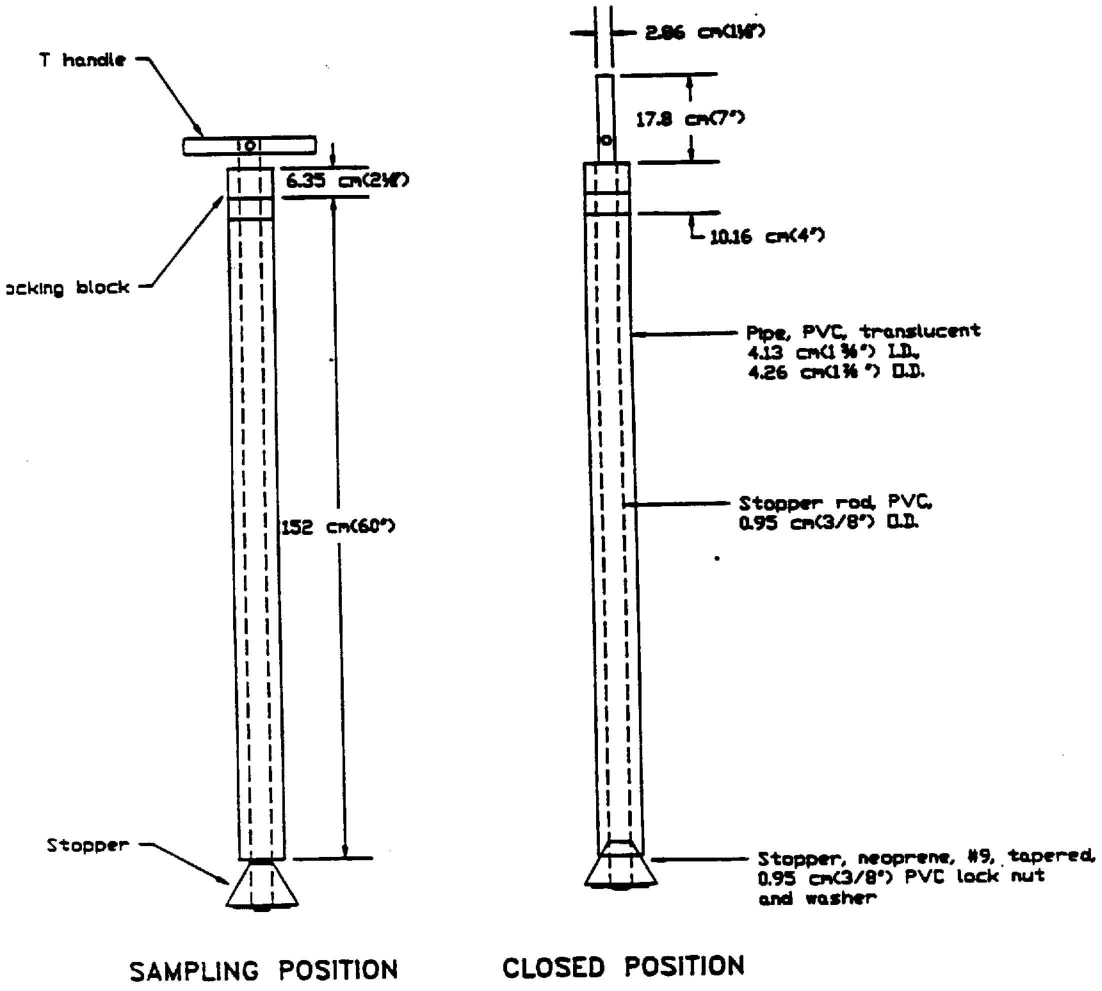
3\. Remove open tube (thief) sampler from containerized liquid.

4\. Place open tube sampler over appropriate sample bottle and remove gloved thumb.

APPENDIX B (Cont'd)

Figures

Figure 8. COLIWASA



TANK SAMPLING

SOP#: 2010
DATE: 11/16/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide technical guidance for the implementation of sampling protocols for tanks and other confined spaces from outside the vessel.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

The safe collection of a representative sample should be the criteria for selecting sample locations. A representative sample can be collected using techniques or equipment that are designed for obtaining liquids or sludges from various depths. The structure and characteristics of storage tanks present problems with collection of samples from more than one location; therefore, the selection of sampling devices is an important consideration.

Depending on the type of vessel and characteristics of the material to be sampled, one can choose a bacon bomb sampler, sludge judge, subsurface grab sampler, glass thief, bailer or Composite Liquid Waste Sampler (COLIWASA) to collect the sample. A sludge judge, bacon bomb or COLIWASA can be used to determine if the tank contents are stratified. Various other custom-made samplers may be used depending on the specific application.

All sample locations should be surveyed for air quality prior to sampling. At no time should sampling continue with an LEL reading greater than 25%.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples collected from tanks are considered waste samples and as such, addition of preservatives is not required due to the potential reaction of the sample with the preservative. Samples should however, be cooled to 4EC with ice and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Waste sample handling procedures should be as follows:

1. Place sample container in two ziplock plastic bags.
2. Place each bagged container in a 1-gallon covered can containing absorbent packing material. Place the lid on the can.
3. Mark the sample identification number on the outside of the can.
4. Place the marked cans in a cooler, and fill remaining space with absorbent packing material.
5. Fill out chain of custody record for each cooler, place in plastic, and affix to inside lid of cooler.
6. Secure and custody seal the lid of cooler.

7. Arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Sampling a storage tank requires a great deal of manual dexterity, often requiring climbing to the top of the tank upon a narrow vertical or spiral stairway or ladder while wearing protective clothing and carrying sampling equipment.

Before climbing onto the vessel, a structural survey should be performed. This will ensure appropriate consideration of safety and accessibility prior to initiation of any field activities.

As in all opening of containers, extreme caution should be taken to avoid ignition or combustion of volatile contents. All tools used must be constructed of a non-sparking material and electronic instruments must be intrinsically safe.

All sample locations should be surveyed for air quality prior to sampling. At no time should sampling continue with a lower explosive limit (LEL) reading greater than 25%.

5.0 EQUIPMENT/APPARATUS

Storage tank materials include liquids, sludges, still bottoms, and solids of various types. The type of sampler chosen should be compatible with the waste. Samplers commonly used for tanks include: a bacon bomb sampler, sludge judge, glass thief, bailer, COLIWASA, and subsurface grab sampler.

<u>Tank Sampling Equipment Checklist:</u>

- Sampling plan
- Safety equipment
- Tape measure
- Weighted tape line, measuring stick or equivalent
- Camera/film
- Stainless steel bucket or bowl
- Sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Field data sheets
- Chain of Custody records
- Flashlight (explosion proof)
- Coolers
- Ice
- Decontamination supplies
- Bacon bomb sampler
- Sludge judge
- Glass thieves
- Bailers
- COLIWASA
- Subsurface grab sampler
- Water/oil level indicator
- OVA (organic vapor analyzer or equivalent)
- Explosimeter/oxygen meter
- High volume blower

6.0 REAGENTS

Reagents are not typically required for the preservation of waste samples. However, reagents will be utilized for decontamination of equipment. Decontamination solutions required are specified in the Sampling Equipment Decontamination SOP.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Identify and mark all sampling locations.

7.2 Preliminary Inspection

1. Inspect the external structural characteristics of each tank and record in the site logbook.

Potential sampling points should be evaluated for safety, accessibility and sample quality.

2. Prior to opening a tank for internal inspection, the tank sampling team shall:

    - Review safety procedures and emergency contingency plans with the Health and Safety Officer.
    - Ensure that the tank is properly grounded.
    - Remove all sources of ignition from the immediate area.

3. Each tank should be mounted using appropriate means. Remove manway covers using non-sparking tools.

4. Collect air quality measurements for each potential sample location using an explosimeter/oxygen meter for a lower explosive limit (LEL/O_2) reading and an OVA/HNU for an organic vapor concentration. Both readings should be taken from the tank headspace, above the sampling port, and in the breathing zone.

5. Prior to commencing sampling, the tank headspace should be cleared of any toxic or explosive vapor concentration using a high volume explosion proof blower. No work shall start if LEL readings exceed 25%. At 10% LEL, work can continue but with extreme caution.

7.3 Sampling Procedure

1. Determine the depth of any and all liquid, solid, and liquid/solid interface, and depth of sludge using a weighted tape measure, probe line, sludge judge, or equivalent.

2. Collect liquid samples from one (1) foot below the surface, from mid-depth of liquid, and from one (1) foot above the bottom sludge layer. This can be accomplished with a subsurface grab sampler or bacon bomb. For liquids less than five (5) feet in depth, use a glass thief or COLIWASA to collect the sample.

    If sampling storage tanks, vacuum trucks, or process vessels, collect at least one sample from each compartment in the tank. Samples should always be collected through an opened hatch at the top of the tank. Valves near the bottom should not be used, because of their questionable or unknown integrity. If such a valve cannot be closed once opened, the entire tank contents may be lost to the ground surface. Also, individual strata cannot be sampled separately through a valve near the bottom.

3. Compare the three samples for visual phase differences. If phase differences appear, systematic iterative sampling should be performed. By halving the distance between two discrete sampling points, one can determine the depth of the phase change.

4. If another sampling port is available, sample as above to verify the phase information.

5. Measure the inside diameter of the tank and determine the volume of wastes using the depth measurements (Appendix A). Measuring the external diameter may be misleading as some tanks are insulated or have external supports that are covered.

6. Sludges can be collected using a bacon bomb sampler, glass thief, or sludge judge.

7. Record all information on the sample data sheet or site logbook. Label the container with the appropriate sample tag.

8. Decontaminate sampling equipment as per the steps listed in the Sampling Equipment Decontamination SOP.

7.4 Sampling Devices

7.4.1 Bacon Bomb Sampler

The bacon bomb sampler (Figure 1, Appendix B) is designed for the collection of material from various levels within a storage tank. It consists of a cylindrical body, usually made of chrome-plated brass and bronze with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger opens and closes the valve. A line is attached to the removable top cover which has a locking mechanism to keep the plunger closed after sampling.

Procedures for Use:

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desire level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line being careful not to pull up on the plunger line and thereby prevent accidental opening of the bottom valve.
6. Rinse or wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the flange or manway or place plastic over the tank.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Sludge Judge

A sludge judge (Figure 2, Appendix B) is used for obtaining an accurate reading of settleable solids in any liquid. The sampling depth is dependent upon the length of the sludge judge. The sampler consists of 3/4" plastic pipe in 5-ft. sections, marked at 1-ft. increments, with screw-type fittings.

Procedures for Use:

1. Lower the sludge judge to the bottom of the tank.
2. When the bottom has been reached, the pipe is allowed to fill to the surface level. This will seat the check valve, trapping the column of material.
3. When the unit has been raised clear of the tank liquid, the amount of sludge in the sample can be read using the one foot increments marked on the pipe sections.
4. By touching the pin extending from the bottom section against a hard surface, the material is released from the unit.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
6. Replace the flange or manway or place plastic over the tank.
7. Log all samples in the site logbook and on field data sheets and label all samples.
8. Package samples and complete necessary paperwork.
9. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.3 Subsurface Grab Sampler

Subsurface grab samplers (Figure 3, Appendix B) are designed to collect samples of liquids at various depths. The sampler is usually constructed of aluminum or stainless steel tubing with a polypropylene or teflon head that attaches to a 1-liter sample container.

Procedures for Use:

1. Screw the sample bottle onto the sampling head.

2. Lower the sampler to the desired depth.

3. Pull the ring at the top which opens the spring-loaded plunger in the head assembly.

4. When the bottle is full, release the ring, lift sampler, and remove sample bottle.

5. Cap the sample container tightly and place prelabeled sample container in a carrier.

6. Replace the flange or manway or place plastic over the tank.

7. Log all samples in the site logbook and on field data sheets and label all samples.

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.4 Glass Thief

The most widely used implement for sampling is a glass tube commonly referred to as a glass thief (Figure 4, Appendix B). This tool is simple, cost effective, quick, and collects a sample without having to decontaminate. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

Procedures for Use:

1. Remove cover from sample container.

2. Insert glass tubing almost to the bottom of the tank or until a solid layer is encountered. About one foot of tubing should extend above the drum.

3. Allow the waste in the tank to reach its natural level in the tube.

4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.

5. Carefully remove the capped tube from the tank and insert the uncapped end in the sample container. Do not spill liquid on the outside of the sample container.

6. Release stopper and allow the glass thief to drain until the container is approximately 2/3 full.

7. Remove tube from the sample container, break it into pieces and place the pieces in the tank.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.

9. Replace the bung or place plastic over the tank.

10. Log all samples in the site logbook and on field data sheets and label all samples.

11. Package samples and complete necessary paperwork.

12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

In many instances a tank containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube down into this layer and then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

7.4.5 Bailer

The positive-displacement volatile sampling bailer (Figure 5, Appendix B) (by GPI) is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions. Generally, bailers can provide an acceptable sample, providing that the sampling personnel use extra care in the collection process.

Operation

1. Make sure clean plastic sheeting surrounds the tank.

2. Attach a line to the bailer.

3. Lower the bailer slowly and gently into the tank so as not to splash the bailer into the tank contents.

4. Allow the bailer to fill completely and retrieve the bailer from the tank.

5. Begin slowly pouring from the bailer.

6. Cap the sample container tightly and place prelabeled sample container in a carrier.

7. Replace the flange or manway or place plastic over the tank.

8. Log all samples in the site logbook and on field data sheets and label all samples.

9. Package samples and complete necessary paperwork.

10. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.6 COLIWASA

Sampling devices are available that allow collection of a sample from the full depth of a tank and maintain its integrity in the transfer tube until delivery to the sample bottle. The sampling device is known as a Composite Liquid Waste Sampler (COLIWASA) (Figure 6, Appendix B). The COLIWASA is a much cited sampler designed to permit representative sampling of multiphase wastes from tanks and other containerized wastes.

One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. Disposable COLIWASA's are a viable alternative. However, the COLIWASA is still the sampling device of choice for specific applications, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use:

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.

5. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container tightly and place prelabeled sample container in a carrier.

7. Replace the bung or place plastic over the tank.

8. Log all samples in the site logbook and on field data sheets and label all samples.

9. Package samples and complete necessary paperwork.

10. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

8.0 CALCULATIONS

There are no specific calculations for these procedures. Refer to Appendix A regarding calculations utilized in determining tank volumes.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures. More specifically, the hazards associated with tank sampling may cause bodily injury, illness, or death to the worker. Failure to recognize potential hazards of waste containers is the cause of most accidents. It should be assumed that the most unfavorable conditions exist, and that the danger of explosion and poisoning will be present. Hazards specific to tank sampling are:

1. Hazardous atmospheres which are either flammable, toxic, asphyxiating, or corrosive.

2. If activation of electrical or mechanical equipment would cause injury, each piece of equipment should be manually isolated to prevent inadvertent activation while workers are occupied.

3. Communication is of utmost importance between the sampling worker and the standby person to prevent distress or injury going unnoticed.

4. Proper procedures to evacuate a tank with forced air and grounding of equipment and tanks should be reviewed.

12.0 REFERENCES

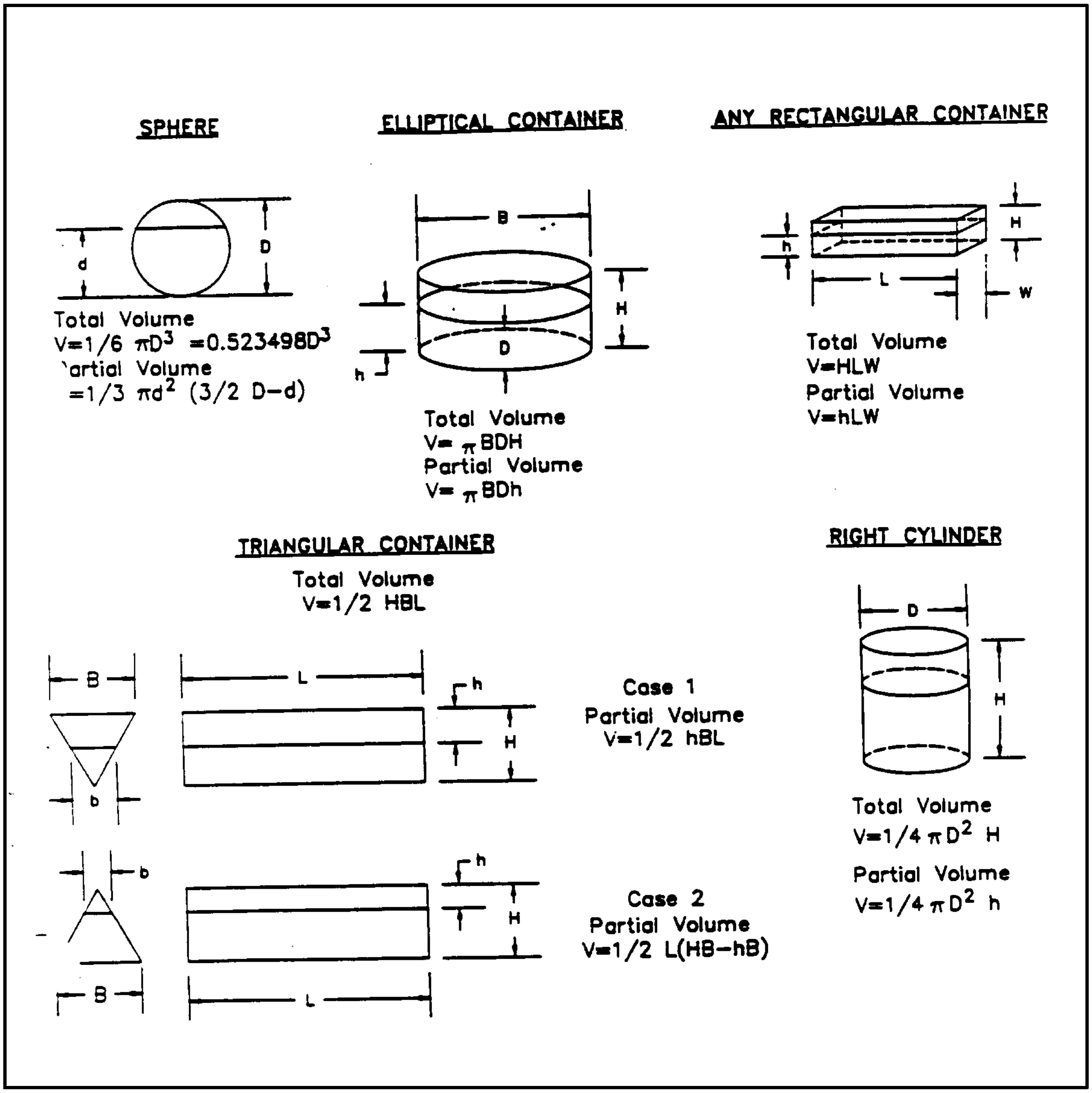
Guidance Document for Cleanup of Surface Tank and Drum Sites, OSWER Directive 9380.0-3.

Drum Handling Practices at Hazardous Waste Sites, EPA-600/2-86-013.

APPENDIX A

Calculations

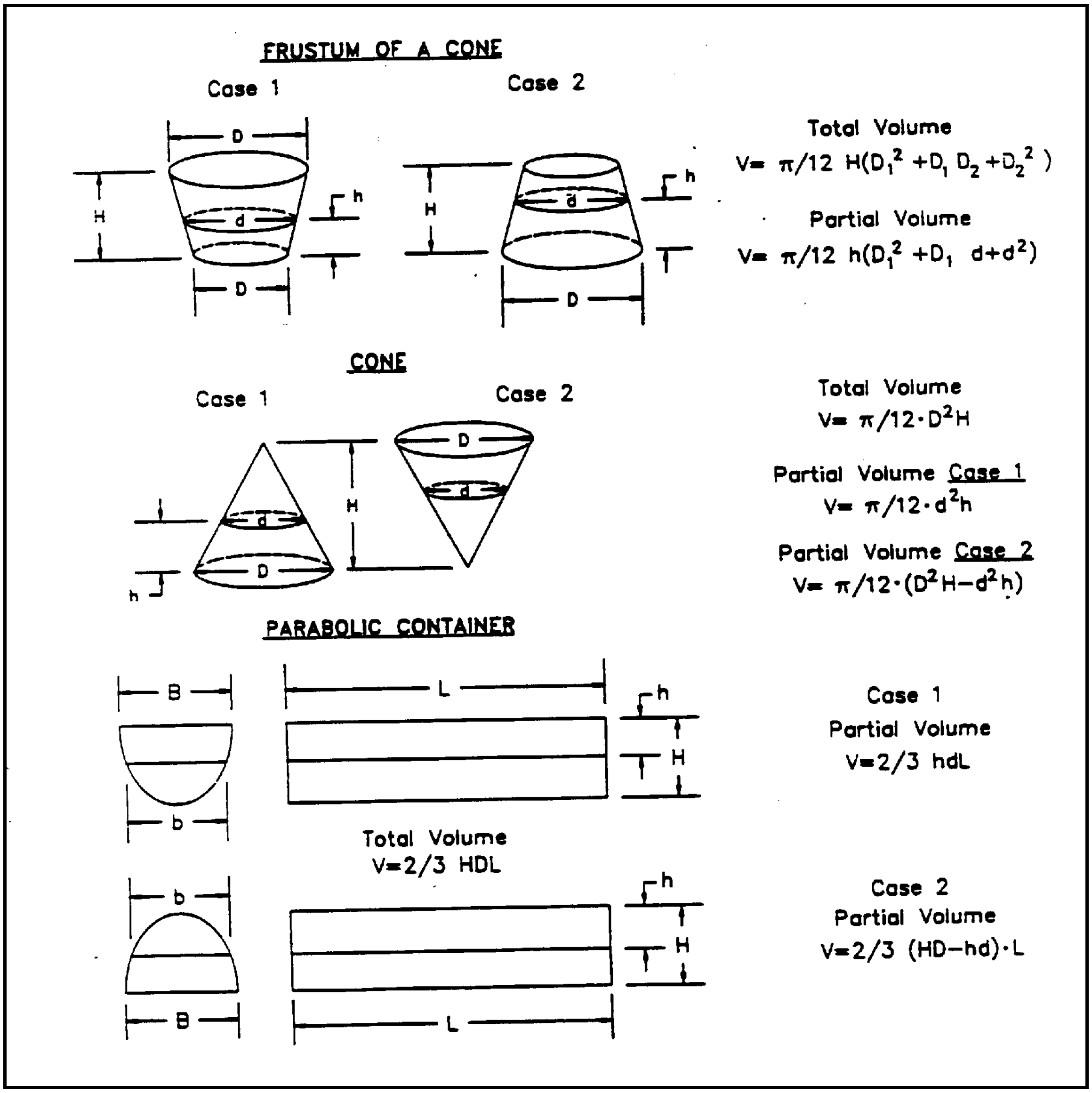
Various Volume Calculations



APPENDIX A (Cont’d)

Calculations

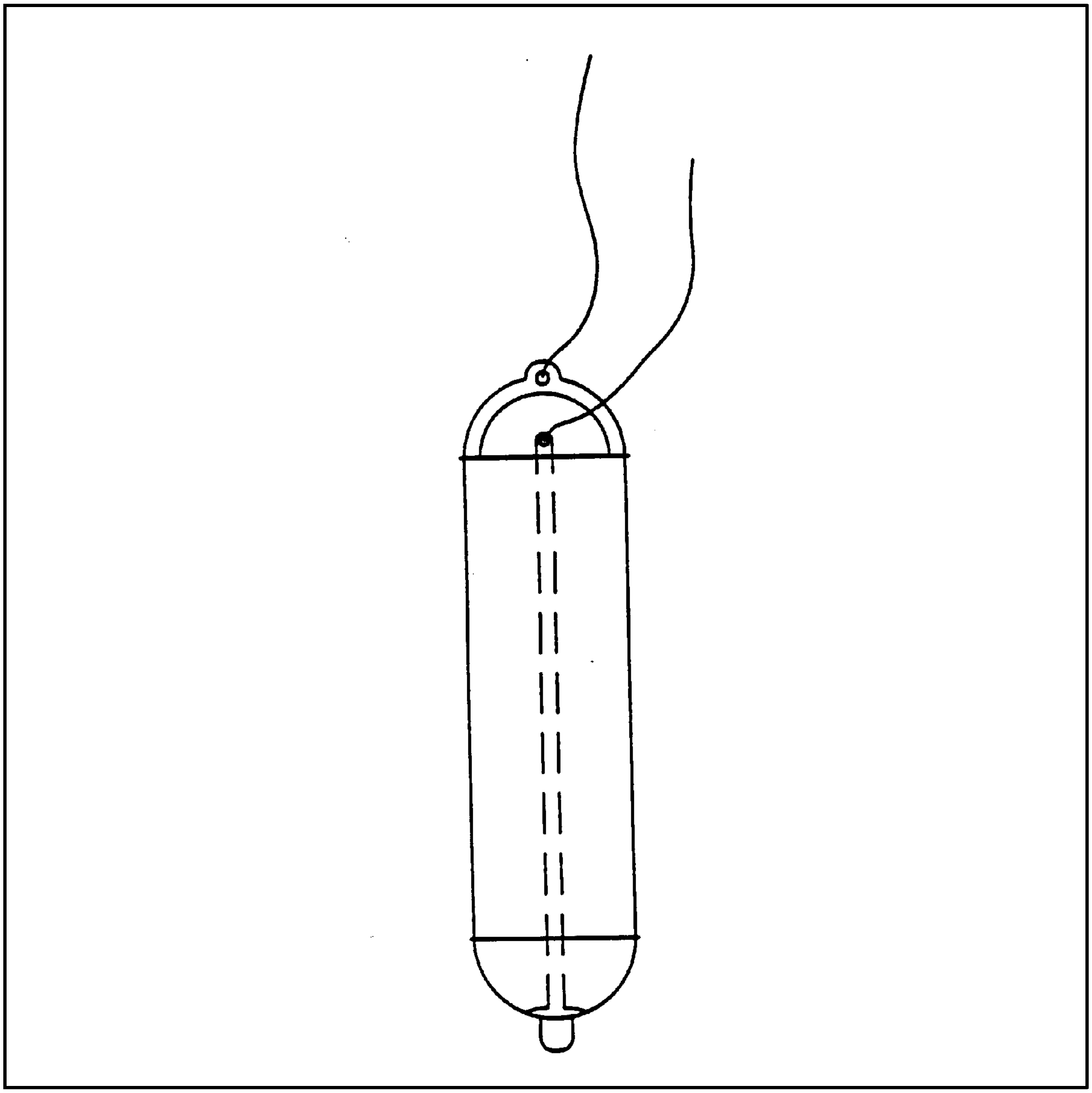
Various Volume Calculations (Cont'd)



APPENDIX B

Figures

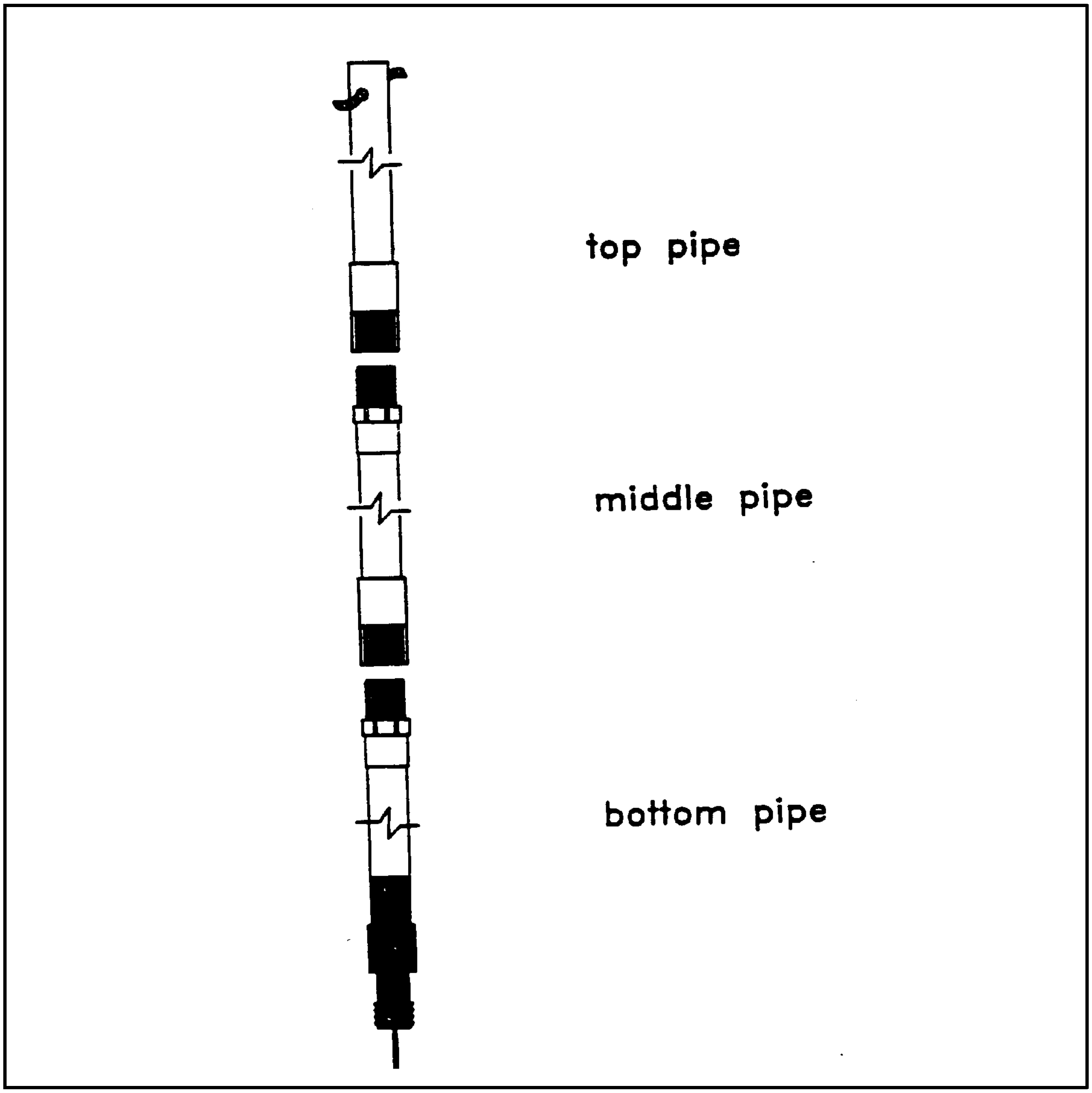
FIGURE 1. Bacon Bomb Sampler



APPENDIX B (Cont'd)

Figures

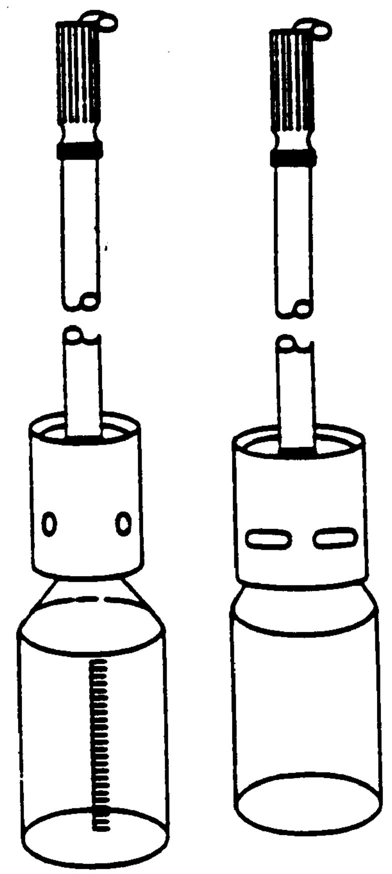
FIGURE 2. Sludge Judge



APPENDIX B (Cont'd)

Figures

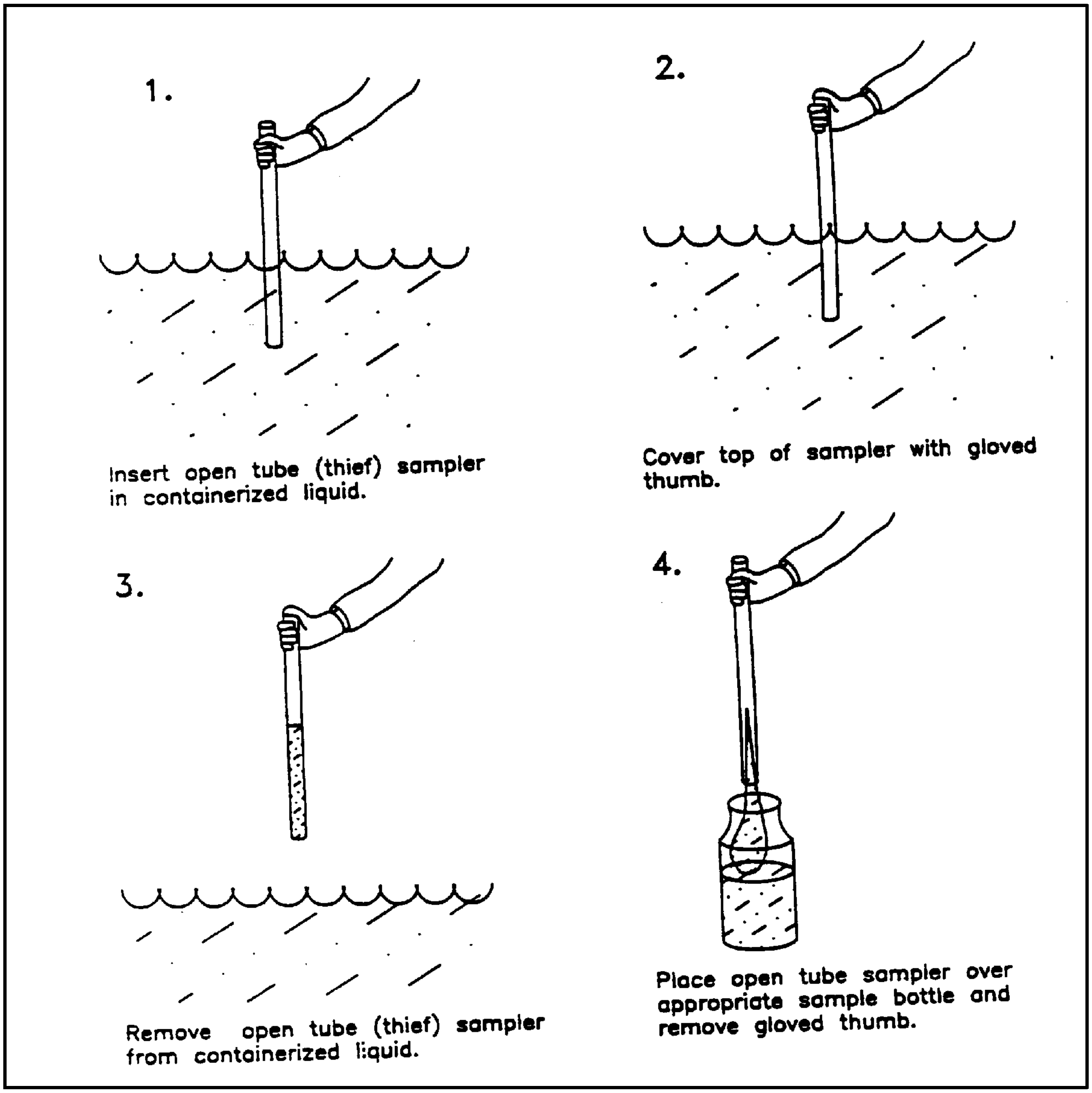
FIGURE 3. Subsurface Grab Sampler



APPENDIX B (Cont'd)

Figures

FIGURE 4. Glass Thief



1. Insert open tube (thief) sampler in containerized liquid.

2. Cover top of sampler with gloved thumb.

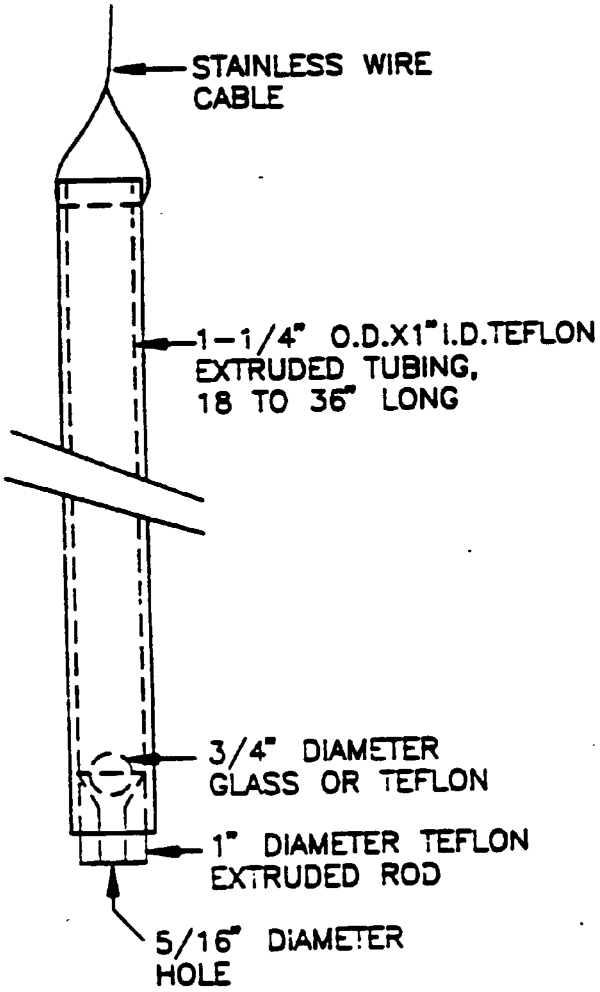
3. Remove open tube (thief) sampler from containerized liquid.

4. Place open tube sampler over appropriate sample bottle and remove gloved thumb.

APPENDIX B (Cont'd)

Figures

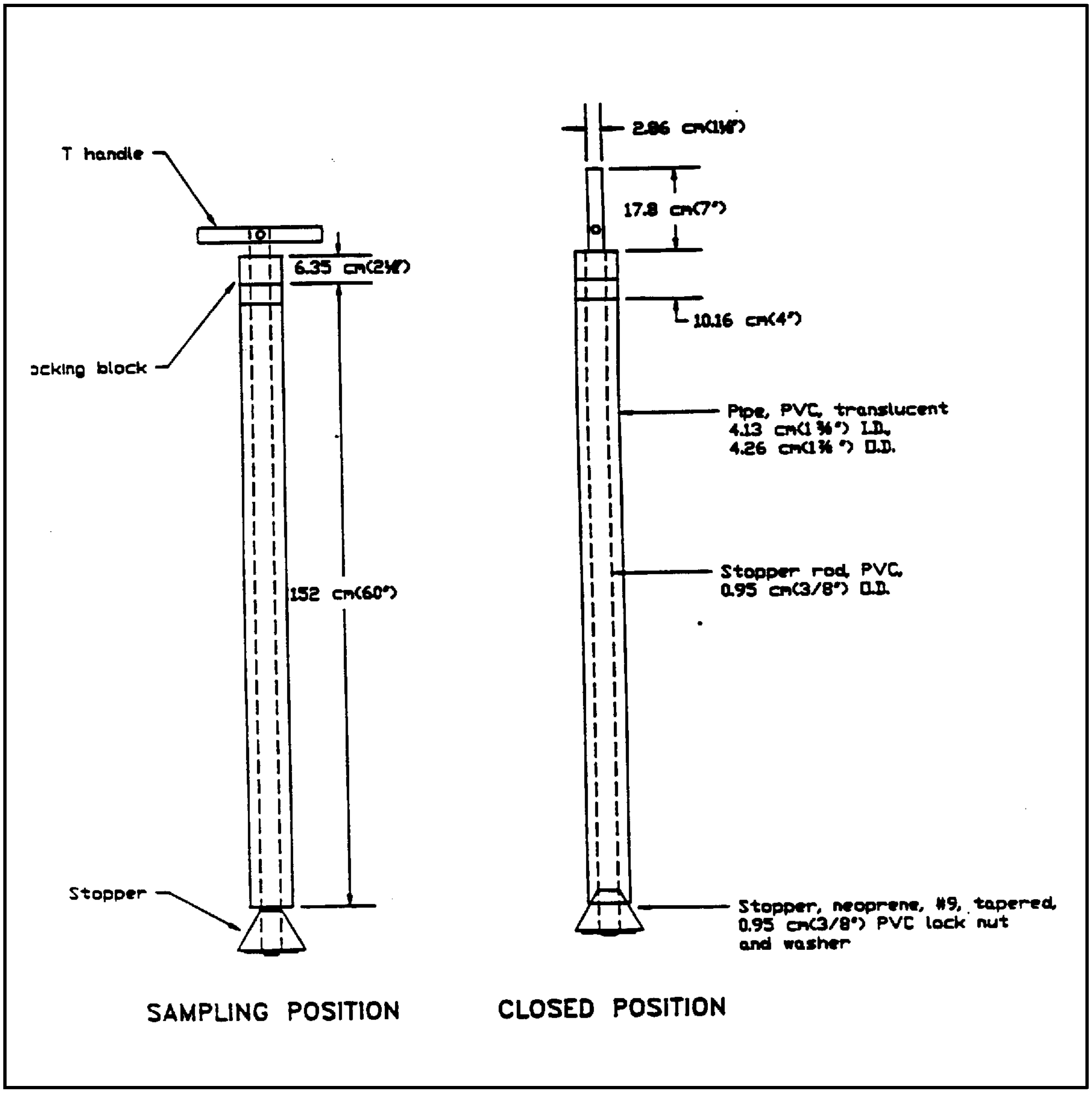
FIGURE 5. Bailer



APPENDIX B (Cont'd)

Figures

FIGURE 6. COLIWASA



CHIP, WIPE, AND SWEEP SAMPLING

SOP#: 2011
DATE: 11/16/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) outlines the recommended protocol and equipment for collection of representative chip, wipe, and sweep samples to monitor potential surficial contamination.

This method of sampling is appropriate for surfaces contaminated with non-volatile species of analytes (i.e., PCB, PCDD, PCDF, metals, cyanide, etc.) Detection limits are analyte specific. Sample size should be determined based upon the detection limit desired and the amount of sample requested by the analytical laboratory. Typical sample area is one square foot. However, based upon sampling location, the sample size may need modification due to area configuration.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Since surface situations vary widely, no universal sampling method can be recommended. Rather, the method and implements used must be tailored to suit a specific sampling site. The sampling location should be selected based upon the potential for contamination as a result of manufacturing processes or personnel practices.

Chip sampling is appropriate for porous surfaces and is generally accomplished with either a hammer and chisel, or an electric hammer. The sampling device should be laboratory cleaned and wrapped in clean, autoclaved aluminum foil until ready for use. To collect the sample, a measured and marked off area is chipped both horizontally and vertically to an even depth of 1/8 inch. The sample is then transferred to the proper sample container.

Wipe samples are collected from smooth surfaces to indicate surficial contamination; a sample location is measured and marked off. While wearing a new pair of surgical gloves, a sterile gauze pad is opened, and soaked with solvent. The solvent used is dependent on the surface being sampled. This pad is then stroked firmly over the sample surface, first vertically, then horizontally, to ensure complete coverage. The pad is then transferred to the sample container.

Sweep sampling is an effective method for the collection of dust or residue on porous or non-porous surfaces. To collect such a sample, an appropriate area is measured off. Then, while wearing a new pair of disposable surgical gloves, a dedicated brush is used to sweep material into a dedicated dust pan. The sample is then transferred to the proper sample container.

Samples collected by all three methods are then sent to the laboratory for analysis.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples should be stored out of direct sunlight to reduce photodegredation, cooled to 4^{o}C and shipped to the laboratory performing the analysis. Appropriately sized laboratory cleaned, glass sample jars should be used for sample collection. The amount of sample required will be determined in concert with the analytical laboratory.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

This method has few significant interferences or problems. Typical problems result from rough porous surfaces which may be difficult to wipe, chip, or sweep.

5.0 EQUIPMENT

Equipment required for performing chip, wipe, or sweep sampling is as follows:

C Lab clean sample containers of proper size and composition
C Site logbook
C Sample analysis request forms
C Chain of Custody records
C Custody seals
C Field data sheets
C Sample labels
C Disposable surgical gloves
C Sterile wrapped gauze pad (3 in. x 3 in.)
C Appropriate pesticide (HPLC) grade solvent
C Medium sized laboratory cleaned paint brush
C Medium sized laboratory cleaned chisel
C Autoclaved aluminum foil
C Camera
C Hexane (pesticide/HPLC grade)
C Iso-octane
C Distilled/deionized water

6.0 REAGENTS

Reagents are not required for preservation of chip, wipe or sweep samples. However, reagents will be utilized for decontamination of sampling equipment.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Chip Sample Collection

Sampling of porous surfaces is generally accomplished by using a chisel and hammer or electric hammer. The sampling device should be laboratory cleaned or field decontaminated as per the Sampling Equipment Decontamination SOP. It is then wrapped in cleaned, autoclaved aluminum foil. The sampler should remain in this wrapping until it is needed. Each sampling device should be used for only one sample.

1. Choose appropriate sampling points; measure off the designated area. Photo documentation is optional.

2. Record surface area to be chipped.

3. Don a new pair of disposable surgical gloves.

4. Open a laboratory-cleaned chisel or equivalent sampling device.

5. Chip the sample area horizontally, then vertically to an even depth of approximately 1/8 inch.

6. Place the sample in an appropriately prepared sample container with a Teflon lined cap.

7. Cap the sample container, attach the label and custody seal, and place in a plastic bag. Record all pertinent data in the site logbook and on field data sheets. Complete the sampling analysis request form and chain of custody record before taking the next sample.

8. Store samples out of direct sunlight and cool to 4EC.

9. Follow proper decontamination procedures then deliver sample(s) to the laboratory for analysis.

7.3 Wipe Sample Collection

Wipe sampling is accomplished by using a sterile gauze pad, adding a solvent in which the contaminant is most soluble, then wiping a pre-determined, pre-measured area. The sample is packaged in an amber jar to prevent photodegradation and packed in coolers for shipment to the lab. Each gauze pad is used for only one wipe sample.

1. Choose appropriate sampling points; measure off the designated area. Photo documentation is optional.

2. Record surface area to be wiped.

3. Don a new pair of disposable surgical gloves.

4. Open new sterile package of gauze pad.

5. Soak the pad with solvent of choice.

6. Wipe the marked surface area using firm strokes. Wipe vertically, then horizontally to insure complete surface coverage.

7. Place the gauze pad in an appropriately prepared sample container with a Teflon-lined cap.

8. Cap the sample container, attach the label and custody seal, and place in a plastic bag. Record all pertinent data in the site logbook and on field data sheets. Complete the sampling analysis request form and chain of custody record before taking the next sample.

9. Store samples out of direct sunlight and cool to 4ºC.

10. Follow proper decontamination procedures, then deliver sample(s) to the laboratory for analysis.

7.4 Sweep Sample Collection

Sweep sampling is appropriate for bulk contamination. This procedure utilizes a dedicated, hand held sweeper brush to acquire a sample from a pre-measured area.

1. Choose appropriate sampling points; measure off the designated area. Photo documentation is optional.

2. Record the surface area to be swept.

3. Don new pair of disposable surgical gloves.

4. Sweep the measured area using a dedicated brush; collect the sample in a dedicated dust pan.

5. Transfer sample from dust pan to sample container.

6. Cap the sample container, attach the label and custody seal, and place in a plastic bag. Record all pertinent data in the site log book and on field data sheets. Complete the sampling analysis request form and chain of custody record before taking the next sample.

7. Store samples out of direct sunlight and cool to 4EC.

8. Leave contaminated sampling device in the sample material, unless decontamination is practical.

9. Follow proper decontamination procedures, then deliver sample(s) to the laboratory for analysis.

8.0 CALCULATIONS

Results are usually provided in mg/g, µg/g, mass per unit area, or other appropriate measurement. Calculations are typically done by the laboratory.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain of custody forms, field data sheets or within the site logbook.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

The following specific quality assurance activities apply to wipe samples:

For wipe samples, a blank should be collected for each sampling event. This consists of a sterile gauze pad, wet with the appropriate solvent, and placed in a prepared sample container. The blank will help identify potential introduction of contaminants via the sampling methods, the pad, solvent or sample container. Spiked wipe samples can also be collected to better assess the data being generated. These are prepared by spiking a piece of foil of known area with a standard of the analyte of choice. The solvent containing the standard is allowed to evaporate, and the foil is wiped in a manner identical to the other wipe samples.

Specific quality assurance activities for chip and sweep samples should be determined on a site specific basis.

10.0 DATA VALIDATION

A review of the quality control samples will be conducted and the data utilized to qualify the environmental results.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow EPA, OSHA and corporate health and safety procedures.

12.0 REFERENCES

U.S. EPA, A Compendium of Superfund Field Operation Methods. EPA/540/5-87/001.

NJDEP Field Sampling Procedures Manual, February, 1988.

U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOIL SAMPLING

CONTENTS

SUPERCEDES: SOP #2012; Revision 0.0; 11/16/94; U.S. EPA Contract 68-C4-0022.

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Sampling depths are assumed to be those that can be reached without the use of a drill rig, direct-push, or other mechanized equipment (except for a back-hoe). Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriate site report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction. The amount of sample to be collected and proper sample container type are discussed in ERT/REAC SOP #2003 Rev. 0.0 08/11/94, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary potential problems associated with soil sampling - cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT

Soil sampling equipment includes the following:

- Maps/plot plan
- Safety equipment, as specified in the site-specific Health and Safety Plan
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and custody seals
- Field data sheets and sample labels
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Vehimeyer soil sampler outfit
    - Tubes
    - Points
    - Drive head
    - Drop hammer
    - Puller jack and grip
- Backhoe

6.0 REAGENTS

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in ERT/REAC SOP #2006 Rev. 0.0 08/11/94, *Sampling Equipment Decontamination*, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared by the property owner or the On-Scene-Coordinator (OSC) prior to soil sampling; and utility clearance should always be confirmed before beginning work.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material is removed to the required depth and a stainless steel or plastic scoop is then used to collect the sample.

This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required. Tools plated with chrome or other materials should not be used. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.

3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of approximately three feet.

The following procedure is used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole and proceed to Step 10.

5. Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler, and unscrew the drill rods.

8. Remove the cutting tip and the core from the device.

9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

    When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.

12. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure is used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes the spillage of sample.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

Split spoon sampling is generally used to collect undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D1586-98, "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils".

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.

2. Place the sampler in a perpendicular position on the sample material.

3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.

4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.

5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 1/2 inch diameters. A larger barrel may be necessary to obtain the required sample volume.

6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Test Pit/Trench Excavation

A backhoe can be used to remove sections of soil, when detailed examination of soil characteristics are required. This is probably the most expensive sampling method because of the relatively high cost of backhoe operation.

The following procedures are used for collecting soil samples from test pits or trenches:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of overhead and buried utilities.

2. Review the site specific Health & Safety plan and ensure that all safety precautions including appropriate monitoring equipment are installed as required.

3. Using the backhoe, excavate a trench approximately three feet wide and approximately one foot deep below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.

4. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.

5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.

6. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration

activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OHSA and corporate health and safety procedures, in addition to the procedures specified in the site specific Health & Safety Plan..

12.0 REFERENCES

Mason, B.J. 1983. Preparation of Soil Sampling Protocol: Technique and Strategies. EPA-600/4-83-020.

Barth, D.S. and B.J. Mason. 1984. Soil Sampling Quality Assurance User's Guide. EPA-600/4-84-043.

U.S. Environmental Protection Agency. 1984 Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. 1980. Samplers and Sampling Procedures for Hazardous Waste Streams. EPA-600/2-80-018.

ASTM D 1586-98, ASTM Committee on Standards, Philadelphia, PA.

APPENDIX A
Figures
SOP #2012
February 2000

FIGURE 1. Sampling Augers

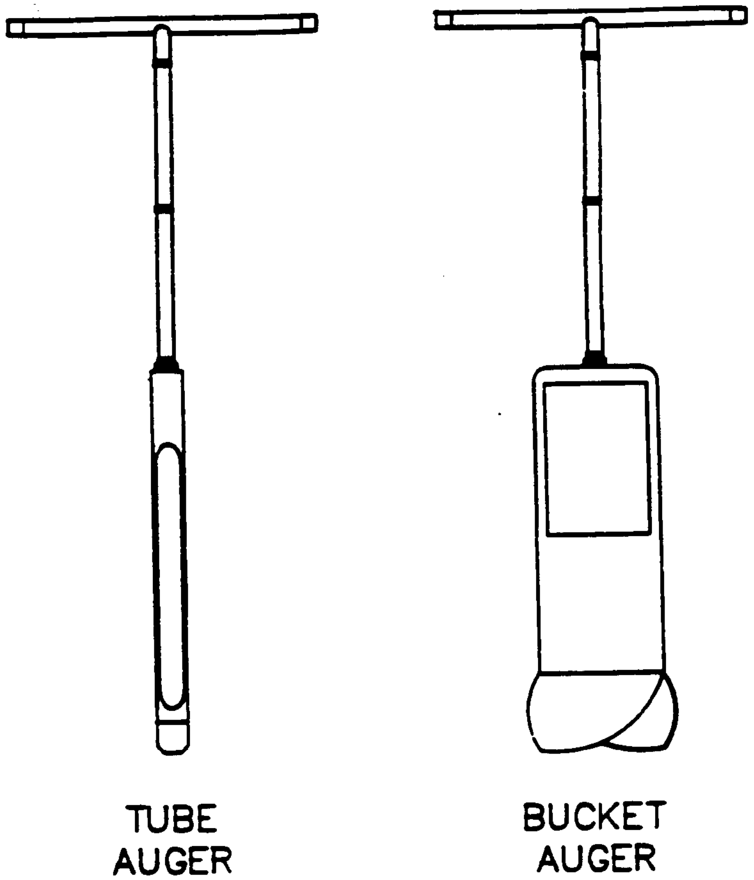
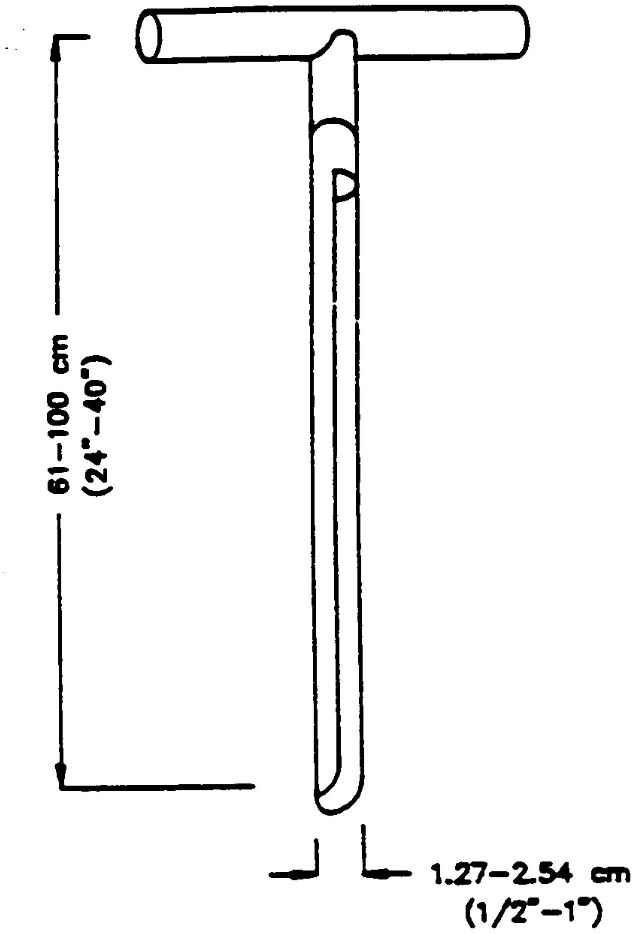


FIGURE 2. Sampling Trier



SOP#: 2013
DATE: 11/17/94
REV. #: 0.0

SURFACE WATER SAMPLING

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- Bacon bomb sampler
- Dip sampler
- Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers.

2. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.

3. Cap the container, place in a ziploc plastic bag and cool to 4^{o}C.

4. Record all pertinent data in the site logbook and on field data sheets.

5. Complete the Chain of Custody record.

6. Attach custody seals to cooler prior to shipment.

7. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP.

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Sample bottles/preservatives
- Ziploc bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Sample bottle labels

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain the necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

7.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

7.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

7.3 Sample Collection

7.3.1 Kemmerer Bottle

A Kemmerer bottle (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.
3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.
4. Retrieve the sampler and discharge from the bottom drain the first 10-20 mL to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container.

7.3.2 Bacon Bomb Sampler

A bacon bomb sampler (Figure 2, Appendix A) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.
2. Release the trigger line and retrieve the sampler.
3. Transfer the sample to the appropriate sample container by pulling up on the trigger.

7.3.3 Dip Sampler

A dip sampler (Figure 3, Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.
3. Retrieve the sampler and transfer the sample to the appropriate sample container.

7.3.4 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants is a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him/her to lose his/her balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

12.0 REFERENCES

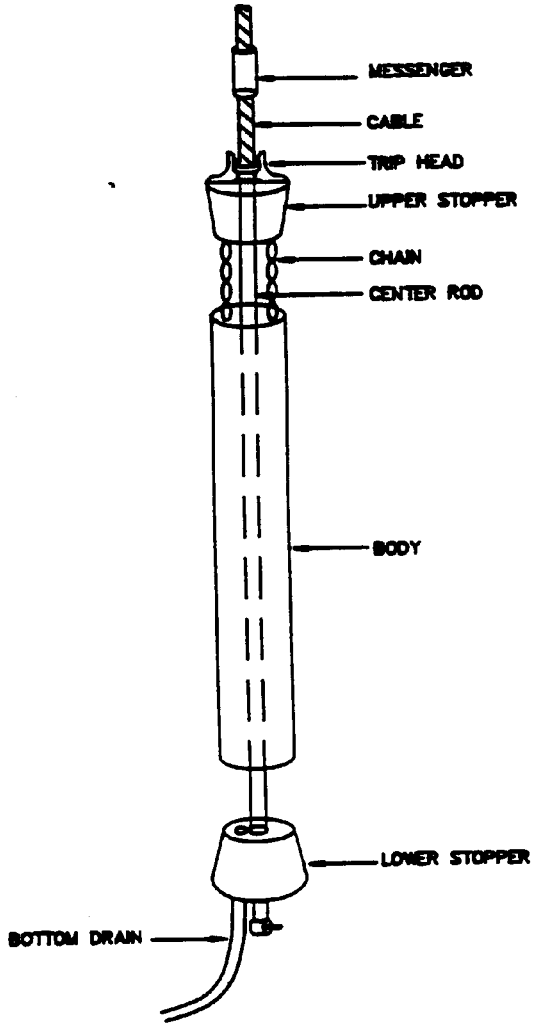
U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination Reston, Virginia. (Chapter Updates available).

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

APPENDIX A

Figures

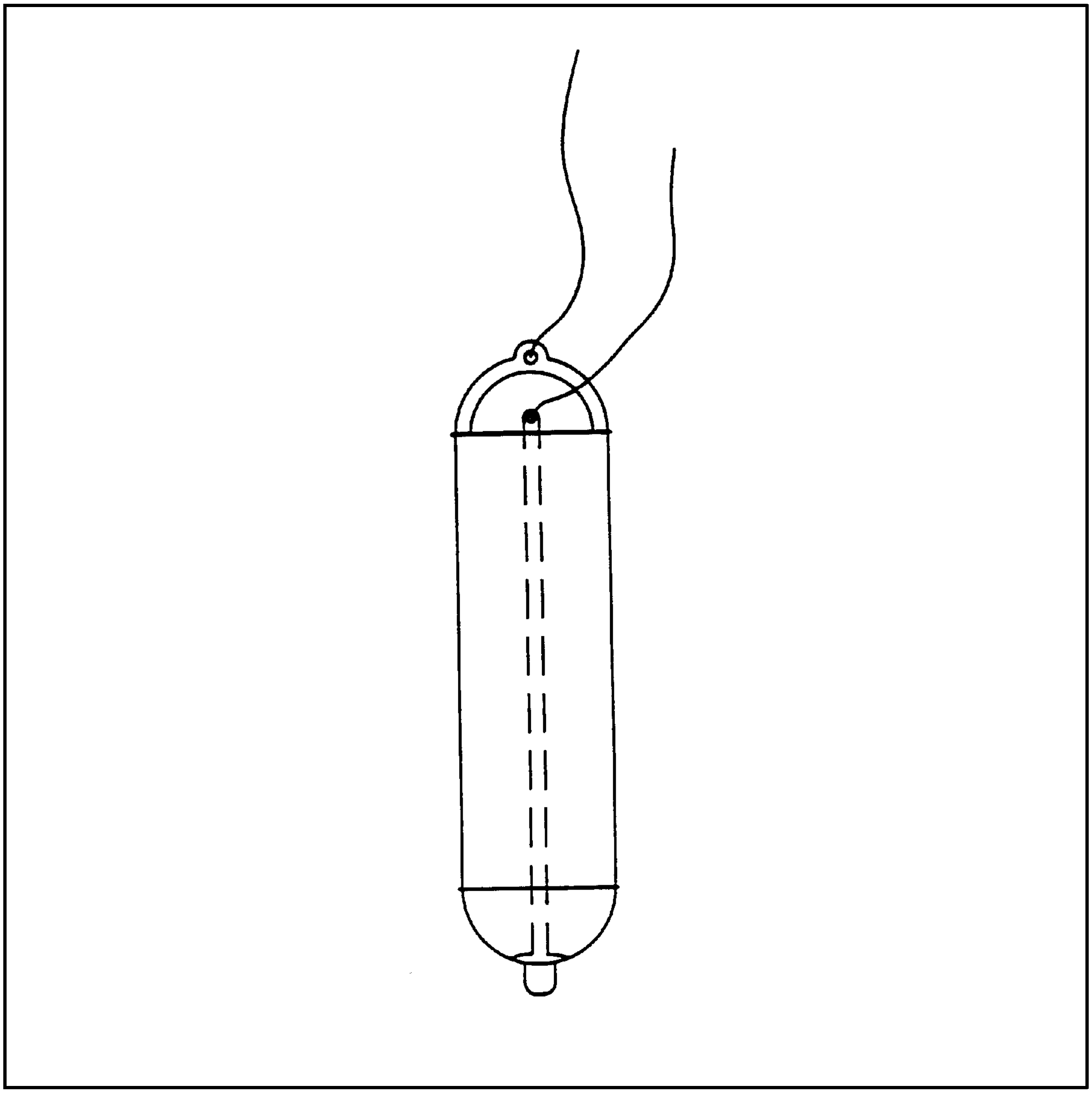
FIGURE 1. Kemmerer Bottle



APPENDIX A (Cont'd)

Figures

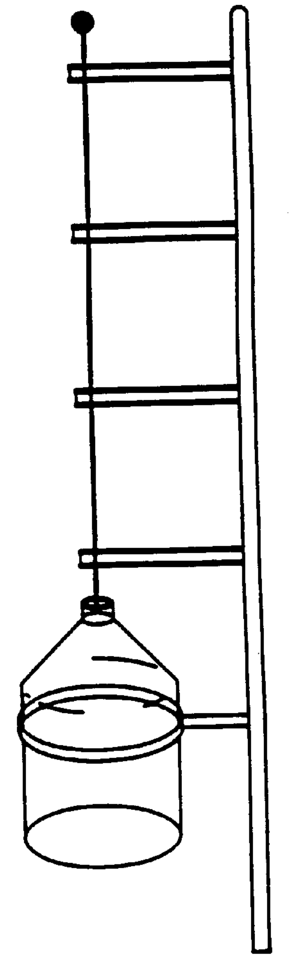
FIGURE 2. Bacon Bomb Sampler



APPENDIX A (Cont'd)

Figures

FIGURE 3. Dip Sampler



ASBESTOS SAMPLING

SOP#: 2015
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

Asbestos has been used in many commercial products including building materials such as flooring tiles and sheet goods, paints and coatings, insulation, and roofing asphalts. These products and others may be found at hazardous waste sites hanging on overhead pipes, contained in drums, abandoned in piles, or as part of a structure. Asbestos tailing piles from mining operations can also be a source of ambient asbestos fibers. Asbestos is a known carcinogen and requires air sampling to assess airborne exposure to human health. This Standard Operating Procedure (SOP) provides procedures for asbestos air sampling by drawing a known volume of air through a mixed cellulose ester (MCE) filter. The filter is then sent to a laboratory for analysis. The U.S. Environmental Protection Agency/Environmental Response Team (U.S. EPA/ERT) uses one of four analytical methods for determining asbestos in air. These include: U.S. EPA's Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air for Transmission Electron Microscopy (TEM)(1); U.S. EPA's Modified Yamate Method for TEM(2); National Institute for Occupational Safety and Health (NIOSH) Method 7402 (direct method only) for TEM; and NIOSH Method 7400 for Phase Contrast Microscopy (PCM)(3). Each method has specific sampling and analytical requirements (i.e., sample volume and flow rate) for determining asbestos in air.

The U.S. EPA/ERT typically follows procedures outlined in the TEM methods for determining mineralogical types of asbestos in air and for distinguishing asbestos from non-asbestos minerals. The Phase Contrast Microscopy (PCM) method is used by U.S. EPA/ERT as a screening tool since it is less costly than TEM. PCM cannot distinguish asbestos from non-asbestos fibers, therefore the TEM method may be necessary to confirm analytical results. For example, if an action level for the presence of fibers has been set and PCM analysis indicates that the action level has been exceeded, then TEM analysis can be used to quantify and identify asbestos structures through examination of their morphology crystal structures (through electron diffraction), and elemental composition (through energy dispersive X-ray analysis). In this instance samples should be collected for both analyses in side by side sampling trains (some laboratories are able to perform PCM and TEM analysis from the same filter). The Superfund method is designed specifically to provide results suitable for supporting risk assessments at Superfund sites, it is applicable to a wide range of ambient air situations at hazardous waste sites. U.S. EPA's Modified Yamate Method for TEM is also used for ambient air sampling due to high volume requirements. The PCM and TEM NIOSH analytical methods require lower sample volumes and are typically used indoors; however, ERT will increase the volume requirement for outdoor application.

Other Regulations pertaining to asbestos have been promulgated by U.S. EPA and OSHA. U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations (40 CFR Part 61, Subparts A and M). U.S. EPA's 40 CFR 763 (July 1, 1987)(4) and its addendum 40 CFR 763 (October 30, 1987)(4) provide comprehensive rules for the asbestos abatement industry. State and local regulations on these issues vary and may be more stringent than federal requirements. The OSHA regulations in 29 CFR 1910.1001 and 29 CFR 1926.58 specify work practices and safety equipment such as respiratory protection and protective clothing when handling asbestos. The OSHA standard for an 8-hour, time-weighted average (TWA) is 0.2 fibers/cubic centimeters of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length >5 µm(5,6). An action level of 0.1 fiber/cc (one-half the OSHA standard) is the level U.S. EPA has established in which employers must initiate such activities as air monitoring, employee training, and medical surveillance(5,6).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, the site should be characterized by identifying on-site as well as off-site sources of airborne asbestos. The array of sampling locations and the schedule for sample collection, is critical to the success of an investigation. Generally, sampling strategies to characterize a single point source are fairly straightforward, while multiple point sources and area sources increase the complexity of the sampling strategy. It is not within the scope of this SOP to provide a generic asbestos air sampling plan. Experience, objectives, and site characteristics will dictate the sampling strategy.

During a site investigation, sampling stations should be arranged to distinguish spatial trends in airborne asbestos concentrations. Sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case) or area of concern (downwind), crosswind, as well as background (upwind) contributions be quantified. See Table 1 (Appendix A) for U.S. EPA/ERT recommended sampling set up for ambient air. Indoor asbestos sampling requires a different type of strategy which is identified in Table 2 (Appendix A). It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

Much information can be derived from each analytical method previously mentioned. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. The site sampling objectives should be carefully identified so as to select the most appropriate analytical method. Additionally, some preparation (i.e., lot blanks results) prior to site sampling may be required, these requirements are specified in the analytical methods.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container and Storage Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers. The original cassette box is used to hold the samples.

2. Wrap the cassette individually in a plastic sample bag. Each bag should be marked indicating sample identification number, total volume, and date.

3. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand carry to lab.

4. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates exceeding 16 liters/minute (L/min) which could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

4.1 U.S. EPA's Superfund Method

4.1.1 Direct-transfer TEM Specimen Preparation Methods

Direct-Transfer TEM specimen preparation methods have the following significant interferences:

- C The achievable detection limit is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- C The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- C Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high a particulate loading occurs on the filter, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. If too high a fiber loading occurs on the filter, even if satisfactory TEM specimens can be prepared, accurate fiber counting will not be possible.

4.1.2 Indirect TEM Specimen Preparation Methods

Indirect TEM specimen preparation methods have the following interferences:

- C The size distribution of asbestos structures is modified.

- C There is increased opportunity for fiber loss or introduction of extraneous contamination.

- C When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 U.S. EPA's Modified Yamate Method for TEM

High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

5.0 EQUIPMENT/MATERIALS

5.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow-rate and pumping time sufficient to achieve the desired volume of air sampled.

The lower flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters/minute (cc/min) to 4 L/min. These pumps are usually battery powered. High flow pumps are utilized when flow rates between 2 L/min to 20 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. High flow pumps usually run on AC power and can be plugged into a nearby outlet. If an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several electrical extension cords may be required if sampling locations are remote.

The recommended volume for the Superfund method (Phase I) requires approximately 20 hours to collect. Such pumps typically draw 6 amps at full power so that 2 lead/acid batteries should provide sufficient power to collect a full sample. The use of line voltage, where available, eliminates the difficulties associated with transporting stored electrical energy.

A stand should be used to hold the filter cassette at the desired height for sampling and the filter cassette shall be isolated from the vibrations of the pump.

5.2 Filter Cassette

The cassettes are purchased with the required filters in position, or can be assembled in a laminar flow hood or clean area. When the filters are in position, a shrink cellulose band or adhesive tape should be applied to cassette joints to prevent air leakage.

5.2.1 TEM Cassette Requirements

Commercially available field monitors, comprising 25 mm diameter three-piece cassettes, with conductive extension cowls shall be used for sample collection. The cassette must be new and not previously used. The cassette shall be loaded with an MCE filter of pore size 0.45 µm, and supplied from a lot number which has been qualified as low background for asbestos determination. The cowls should be constructed of electrically conducting material to minimize electrostatic effects. The filter shall be backed by a 5 µm pore size MCE filter (Figure 1, Appendix B).

5.2.2 PCM Cassette Requirements

NIOSH Method 7400, PCM involves using a 0.8 to 1.2 µm mixed cellulose ester membrane, 25 mm diameter, 50 mm conductive cowl on cassette (Figure 2, Appendix B). Some labs are able to perform PCM and TEM analysis on the same filter; however, this should be discussed with the laboratory prior to sampling.

5.3 Other Equipment

C Inert tubing with glass cyclone and hose barb
C Whirlbags (plastic bags) for cassettes
C Tools - small screw drivers
C Container - to keep samples upright
C Generator or electrical outlet (may not be required)
C Extension cords (may not be required)
C Multiple plug outlet
C Sample labels
C Air data sheets
C Chain of Custody records

6.0 REAGENTS

Reagents are not required for the preservation of asbestos samples.

7.0 PROCEDURES

7.1 Air Volumes and Flow Rates

Sampling volumes are determined on the basis of how many fibers need to be collected for reliable measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location.

Since the concentration of airborne aerosol contaminants will have some effect on the sample, the following is a suggested criteria to assist in selecting a flow rate based on real-time aerosol monitor (RAM) readings in milligrams/cubic meter (mg/m^3).

	Concentration	Flow Rate
C Low RAM readings:	<6.0 mg/m^3	11-15. L/min
C Medium RAM readings:	>6.0 mg/m$_3$	7.5 L/min
C High RAM readings:	>10. mg/m^3	2.5 L/min

In practice, pumps that are available for environmental sampling at remote locations operate under a maximum load of approximately 12 L/min.

7.1.1 U.S. EPA's Superfund Method

The Superfund Method incorporates an indirect preparation procedure to provide flexibility in the amount of deposit that be can be tolerated on the sample filter and to allow for the selective concentration of asbestos prior to analysis. To minimize contributions to background contamination from asbestos present in the plastic matrices of membrane filters while allowing for sufficient quantities of asbestos to be collected, this method also requires the collection of a larger volume of air per unit area of filter than has traditionally been collected for asbestos analysis. Due to the need to collect large volumes of air, higher sampling flow rates are recommended in this method than have generally been employed for asbestos sampling in the past. As an alternative, samples may be collected over longer time intervals. However, this restricts the flexibility required to allow samples to be collected while uniform meteorological conditions prevail.

The sampling rate and the period of sampling should be selected to yield as high a sampled volume as possible, which will minimize the influence of filter contamination. Wherever possible, a volume of 15 cubic meters (15,000 L) shall be sampled for those samples intended for analysis only by the indirect TEM preparation method (Phase 1 samples). For those samples to be prepared by both the indirect and the direct specimen preparation methods (Phase 2 samples), the volumes must be adjusted so as to provide a suitably-loaded filter for the direct TEM preparation method. One option is to collect filters at several loadings to bracket the estimated optimum loading for a particular site. Such filters can be screened in the laboratory so that only those filters closest to optimal loading are analyzed. It has been found that the volume cannot normally exceed 5 cubic meters (5000 L) in an urban or agricultural area, and 10 cubic meters (10,000 L) in a rural area for samples collected on a 25 mm filter and prepared by a direct-transfer technique.

An upper limit to the range of acceptable flow rates for this method is 15 L/min. At many locations, wind patterns exhibit strong diurnal variations. Therefore, intermittent sampling (sampling over a fixed time interval repeated over several days) may be necessary to accumulate 20 hours of sampling time over constant wind conditions. Other sampling objectives also may necessitate intermittent sampling. The objective is to design a sampling schedule so that samples are collected under uniform conditions throughout the sampling interval. This method provides for such options. Air volumes collected on Phase I samples are maximized (<16 L/min). Air volumes collected on Phase 2 samples are limited to provide optimum loading for filters to be prepared by a direct-transfer procedure.

7.1.2 U.S. EPA's Modified Yamate Method for TEM

U.S. EPA's TEM method requires a minimum volume of 560 L and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1200 L to 1800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area of a 25 mm (385 sq mm) and 37 mm (855 sq m) differ.

7.1.3 NIOSH Method for TEM and PCM

The minimum recommended volume for TEM and PCM is 400 L at 0.1 fiber/cc. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (700 to 2800 L) is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres i.e., areas with high levels of asbestos, require smaller sample volumes (<400 L) to obtain countable samples.

In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If > 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration. Do not exceed 0.5 mg total dust loading on the filter.

7.2 Calibration Procedures

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, (e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator) with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

A rotameter can be used provided it has been recently precalibrated with a primary calibrator. Three separate constant flow calibration readings should be obtained both before sampling and after sampling. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used shall provide a non-fluctuating air-flow through the filter, and shall maintain the initial volume flow-rate to within ± 10% throughout the sampling period. The mean value of these flow-rate measurements shall be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling shall be terminated. Flexible tubing is used to connect the filter cassette to the sampling pump.Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

7.2.1 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. See Manufacturer's manual for operational instructions.
2. Set up the calibration train as shown in (Figure 3, Appendix B) using a sampling pump, electronic calibrator, and a representative filter cassette. The same lot sampling cassette used for sampling should also be used for calibrating.
3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.
4. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.
5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.
6. Perform the calibration three times until the desired flow rate of ± 5% is attained.

7.2.2 Calibrating a Rotameter with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.
2. Set up the calibration train as shown in (Figure 4, Appendix B) using a sampling pump, rotameter, and electronic calibrator.
3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° vertical.
4. Turn the electronic calibrator and sampling pump on.
5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.
6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.
7. Record the electronic calibrator flow rate reading and the corresponding rotameter reading. Indicate these values on the rotameter (sticker). The rotameter should be able to work within the desired flow range. Readings can also be calibrated for 10 cm^3 increments for Low Flow rotameters, 500 cm^3 increments for medium flow rotameters and 1 liter increments for high flow rotameters.
8. Perform the calibration three times until the desired flow rate of ± 5% is attained. Once on site, a secondary calibrator, i.e., rotameter may be used to calibrate sampling pumps.

7.2.3 Calibrating a Personal Sampling Pump with a Rotameter

1. See manufacturer's manual for Rotameter's Operational Instructions.

2. Set up the calibration train as shown in (Figure 5, Appendix B) using a rotameter, sampling pump, and a representative sampling cassette.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the rotameter.

4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6° vertical.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the precalibrated flow rate value. A sticker on the rotameter should indicate this value.

7. A verification of calibration is generally performed on-site in the clean zone immediately prior to the sampling.

7.3. Meteorology

It is recommended that a meteorological station be established. If possible, sample after two to three days of dry weather and when the wind conditions are at 10 mph or greater. Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly important when monitoring for asbestos downwind from a fixed source.

7.4 Ambient Sampling Procedures

7.4.1 Pre-site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).

3. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety plan.

4. Once on-site the calibration is performed in the clean zone. The calibration procedures are listed in Section 7.2.

5. After calibrating the sampling pump, mobilize to the sampling location.

7.4.2 Site Sampling

1. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap (Figure 6 and 7, Appendix B). The cassette should be positioned downward, perpendicular to the wind

2. If AC or DC electricity is required then turn it on. If used, the generator should be placed 10 ft. downwind from the sampling pump.

3. Record the following in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

4. Turn the pump on. Should intermittent sampling be required, sampling filters must be covered between active periods of sampling. To cover the sample filter: turn the cassette to face upward, place the cassette cap on the cassette, remove the inlet plug from the cassette cap, attach a rotameter to the inlet opening of the cassette cap to measure the flow rate, turn off the sampling pump, place the inlet plug into the inlet opening on the cassette cap. To resume sampling: remove the inlet plug, turn on the sampling pump, attach a rotameter to measure the flow rate, remove the cassette cap, replace the inlet plug in the cassette cap and invert the cassette, face downward and perpendicular to the wind.

5. Check the pump at sampling midpoint if sampling is longer than 4 hours. The generators may need to be regased depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

6. At the end of the sampling period, orient the cassette up, turn the pump off.

7. Check the flow rate as shown in Section 7.2.3. When sampling open-faced, the sampling cap should be replaced before post calibrating. Use the same cassette used for sampling for post calibration (increase dust/fiber loading may have altered the flow rate.

8. Record the post flow rate.

9. Record the cumulative time or run.

10. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.

7.4.3. Post Site Sampling

1. Follow handling procedures in Section 3.2, steps 1-4.

2. Obtain an electronic or hard copy of meteorological data which occurred during the sampling event. Record weather: wind speed, ambient temperature, wind direction, and precipitation. Obtaining weather data several days prior to the sampling event can also be useful.

7.5 Indoor Sampling Procedures

PCM analysis is used for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM (U.S. EPA's Modified Yamate Method) is used to identify asbestos from non-asbestos fibers.

Sampling pumps should be placed four to five feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. Refer to Table 2 (Appendix A) for a summary of indoor sampling locations and rationale for selection.

Indoor sampling utilizes high flow rates to increased sample volumes (2000 L for PCM and 2800 to 4200 L for TEM) in order to obtain lower detection limits below the standard, (i.e., 0.01 f/cc or lower [PCM] and 0.005 structures/cc or lower [TEM]).

7.5.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past, an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The results from this sampling option typifies worst case condition. This is referred to as aggressive air sampling for asbestos. Refer to Table 2 for sample station locations.

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1000 sq. ft. of floor.

2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.

3. Follow procedures in Section 7.4.1 and 7.4.2 (Turn off the pump and then the fan(s) when sampling is complete.).

4. Follow handling procedures in Section 3.2, steps 1-4.

8.0 CALCULATIONS

The sample volume is calculated from the average flow rate of the pump multiplied by the number of minutes the pump was running (volume = flow rate X time in minutes). The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample (zero for lot, field and trip blanks).

The concentration result is calculated using the sample volume and the numbers of asbestos structures reported after the application of the cluster and matrix counting criteria.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Follow all QA/QC requirements from the laboratories as well as the analytical methods.

9.1 TEM Requirements

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine whether there is contamination by extraneous asbestos structures during specimen preparation.

3. Examine of laboratory blanks to determine if contamination is being introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters shall be examined. Reference filters should be maintained as part of the laboratory's Quality Assurance program.

5. To minimize subjective effects, some specimens should be recounted by a different microscopist.

6. Asbestos laboratories shall be accredited by the National Voluntary Laboratory Accreditation Program.

7. At this time, performance evaluation samples for asbestos in air are not available for Removal Program Activities.

9.2 PCM Requirements

1. Examine reference slides of known concentration to determine the analyst's ability to satisfactorily count fibers. Reference slides should be maintained as part of the laboratory's quality assurance program.

2. Examine field blanks to determine if there is contamination by extraneous structures during sample handling.

3. Some samples should be relabeled then submitted for counting by the same analyst to determine possible bias by the analyst.

4. Participation in a proficiency testing program such as the AIHA-NIOSH proficiency analytical testing (PAT) program.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures. More specifically, when entering an unknown situation involving asbestos, a powered air purifying respirator (PAPR) (full face-piece) is necessary in conjunction with HEPA filter cartridges. See applicable regulations for action level, PEL, TLV, etc. If previous sampling indicates asbestos concentrations are below personal health and safety levels, then Level D personal protection is adequate.

12.0 REFERENCES

(1) Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air, Part 1: Method, EPA/540/2-90/005a, May 1990, and Part 2: Technical Background Document, EPA/540/2-90/005b, May 1990.

(2) Methodology for the Measurement of Airborne Asbestos by Electron Microscopy, EPA's Report No. 68-02-3266, 1984, G. Yamate, S.C. Agarwal, and R. D. Gibbons.

(3) National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method. Third Edition. 1987.

(4) U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 763. July 1, 1987. Code of Federal Regulations 40 CFR 763 Addendum. October 30, 1987.

(5) U.S. Environmental Protection Agency. Asbestos-Containing Materials in Schools; Final Rule and Notice. 52 FR 41826.

(6) Occupational Safety and Health Administration. Code of Federal Regulations 29 CFR 1910.1001. Washington, D.C. 1987.

APPENDIX A

Tables

TABLE 1.

SAMPLE STATIONS FOR OUTDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Upwind/Background(1)	Collect a minimum of two simultaneous upwind/background samples 30° apart from the prevailing windlines.	Establishes background fiber levels.
Downwind	Deploy a minimum of 3 sampling stations in a 180 degree arc downwind from the source.	Indicates if asbestos is leaving the site.
Site Representative and/or Worst Case	Obtain one site representative sample which shows average condition on-site or obtain worst case sample (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

(1) More than one background station may be required if the asbestos originates from different sources.

APPENDIX A (Cont'd)

Tables

TABLE 2

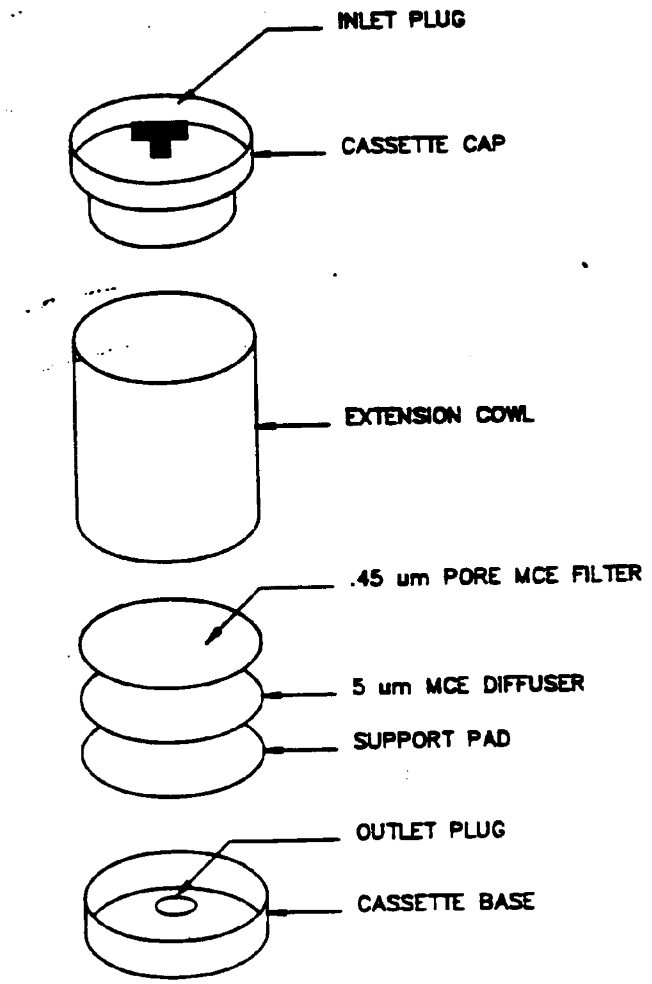
SAMPLE STATIONS FOR INDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Indoor Sampling	If a work site is a single room, disperse 5 samplers throughout the room. If the work site contains up to 5 rooms, place at least one sampler in each room. If the work site contains more than 5 rooms, select a representative sample of the rooms.	Establishes representative samples from a homogeneous area.
Upwind/Background	If outside sources are suspected, deploy a minimum of two simultaneous upwind/background samples 30° apart from the prevailing windlines.	Establish whether indoor asbestos concentrations are coming from an outside source.
Worst Case	Obtain one worst case sample, i.e., aggressive sampling (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

APPENDIX B

Figures

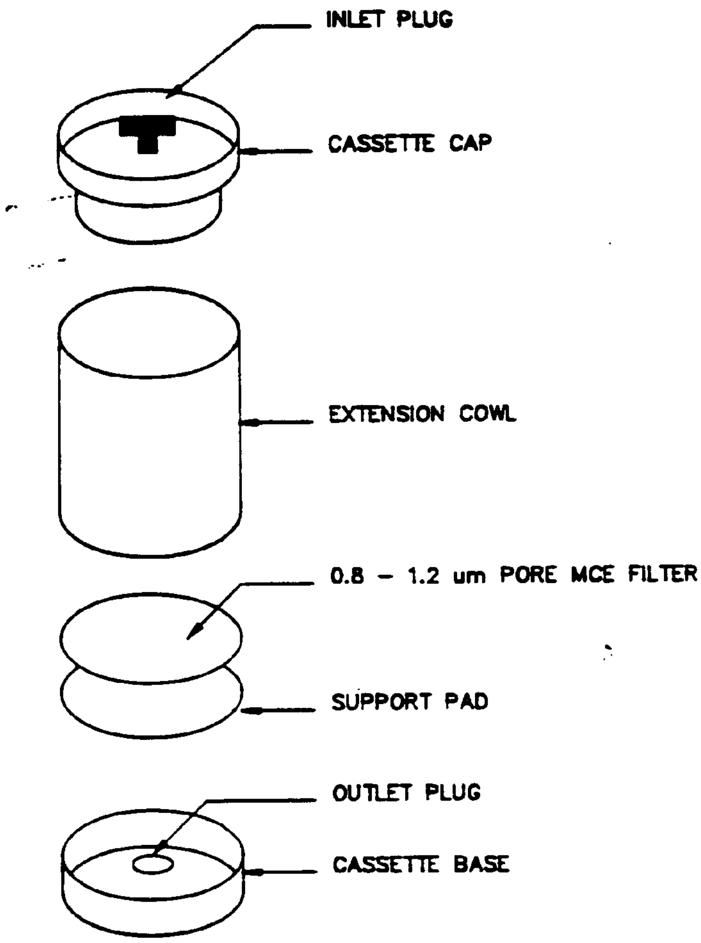
FIGURE 1. Transmission Electron Microscopy Filter Cassette



APPENDIX B (Cont'd)

Figures

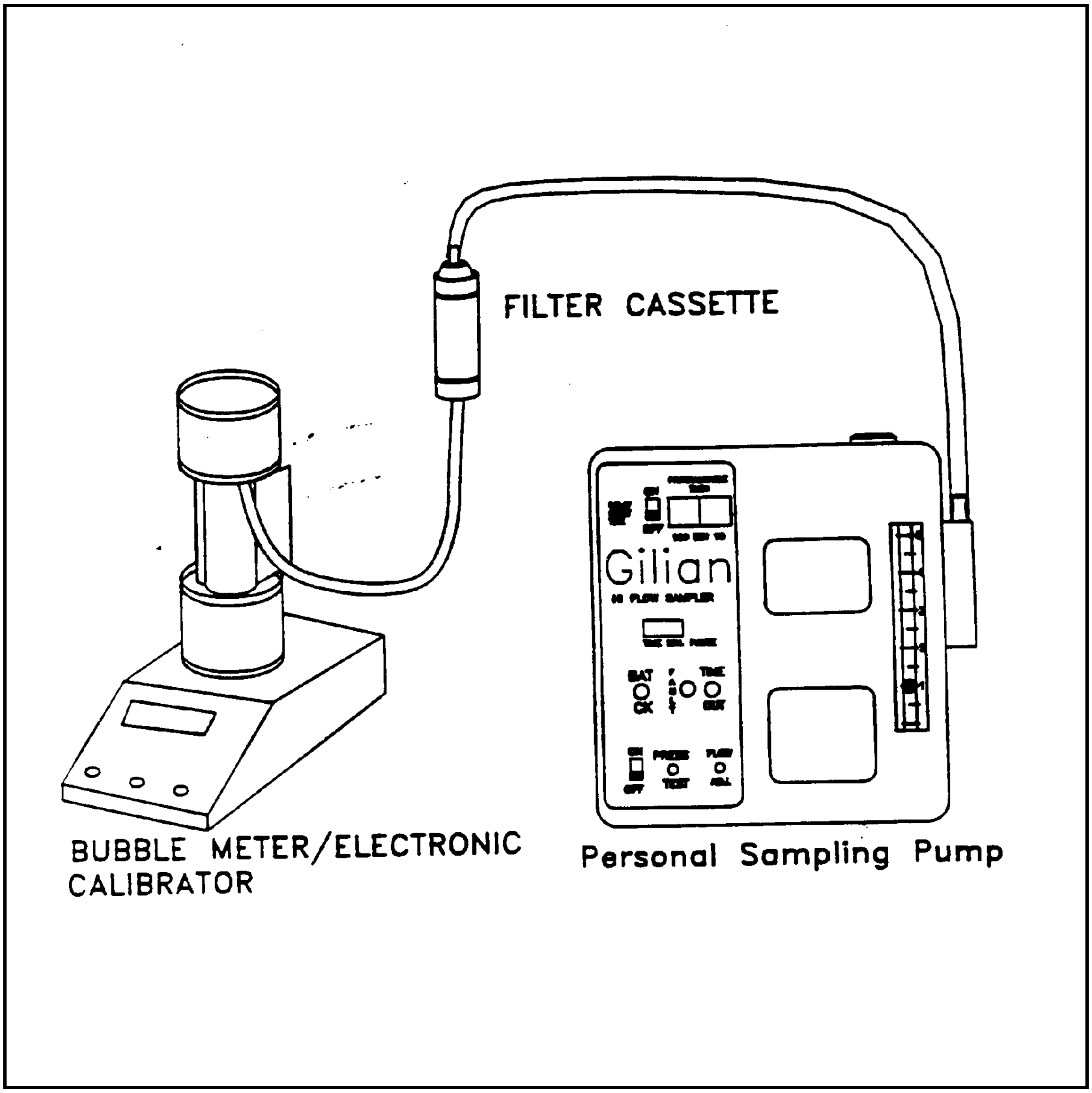
FIGURE 2. Phase Contrast Microscopy Filter Cassette



APPENDIX B (Cont'd)

Figures

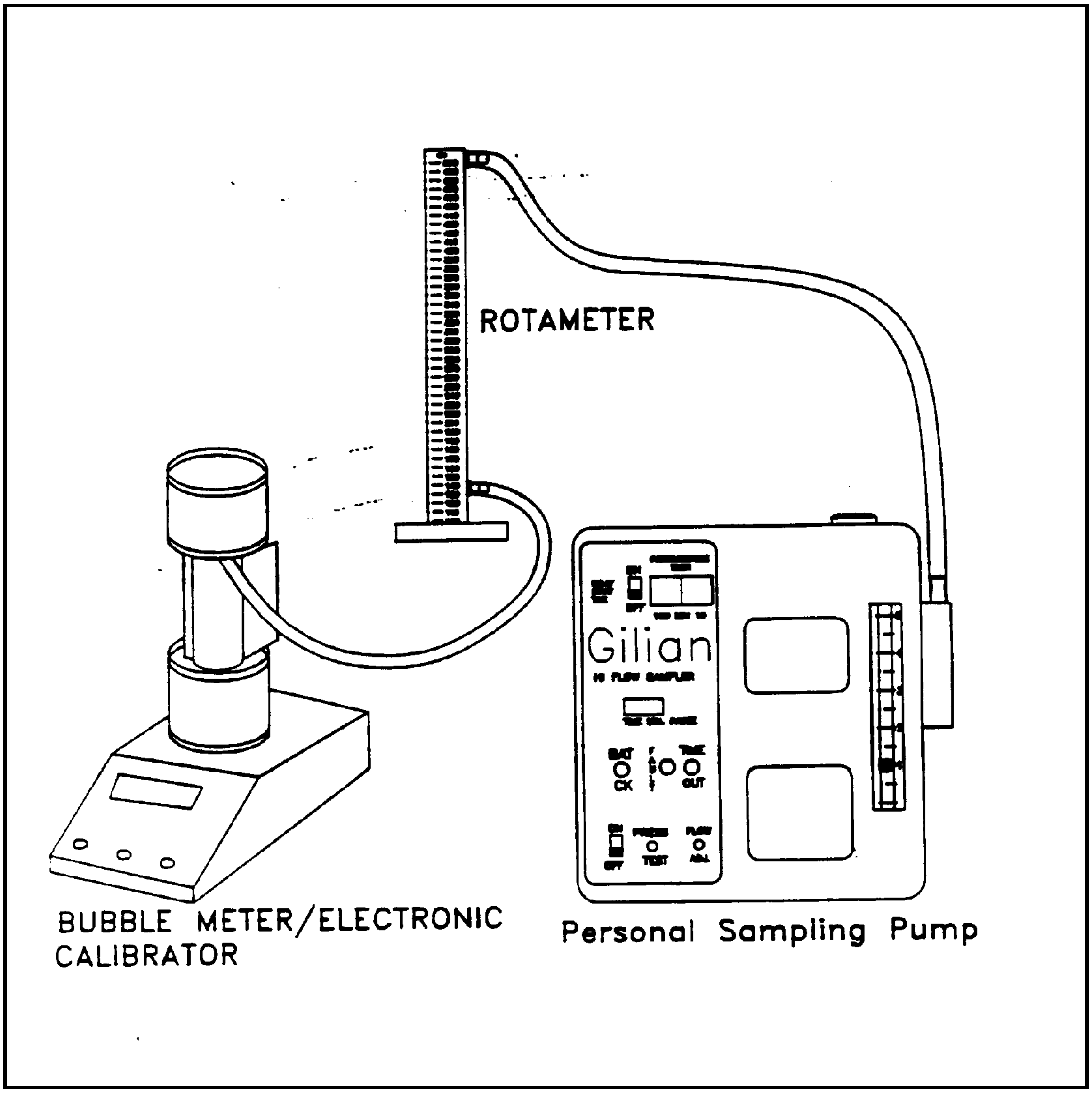
FIGURE 3. Calibrating a Personal Sampling Pump with a Bubble Meter



APPENDIX B (Cont'd)

Figures

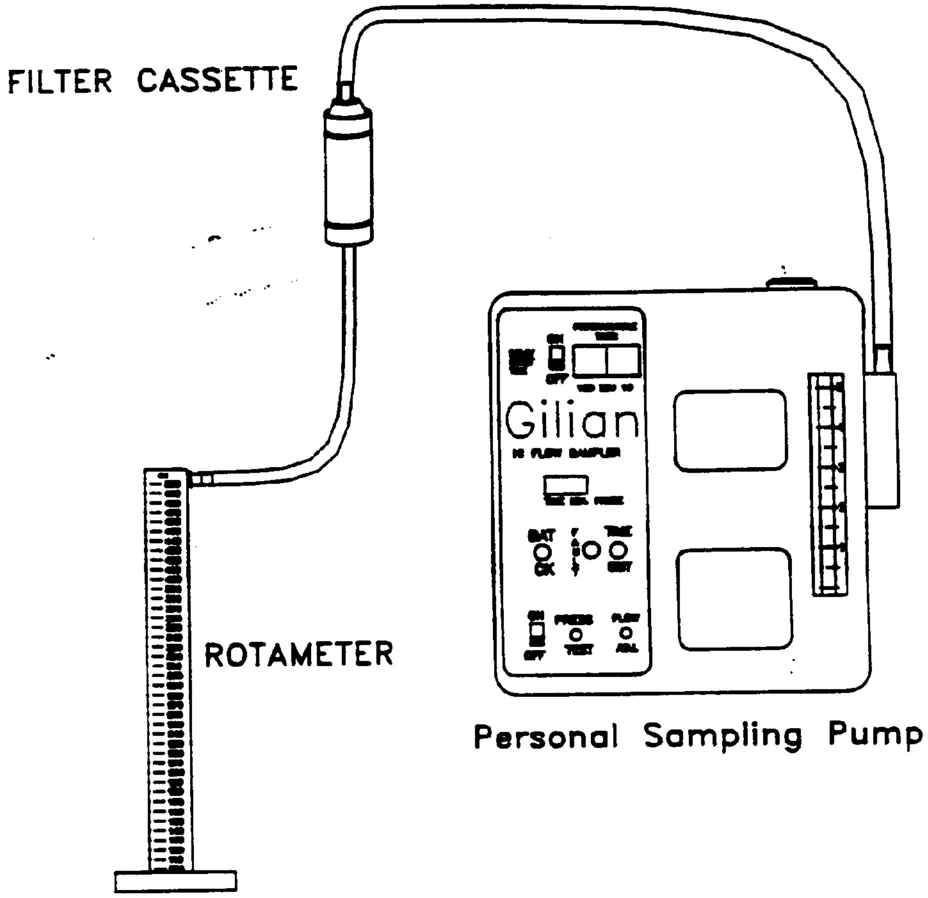
FIGURE 4. Calibrating a Rotameter with a Bubble Meter



APPENDIX B (Cont'd)

Figures

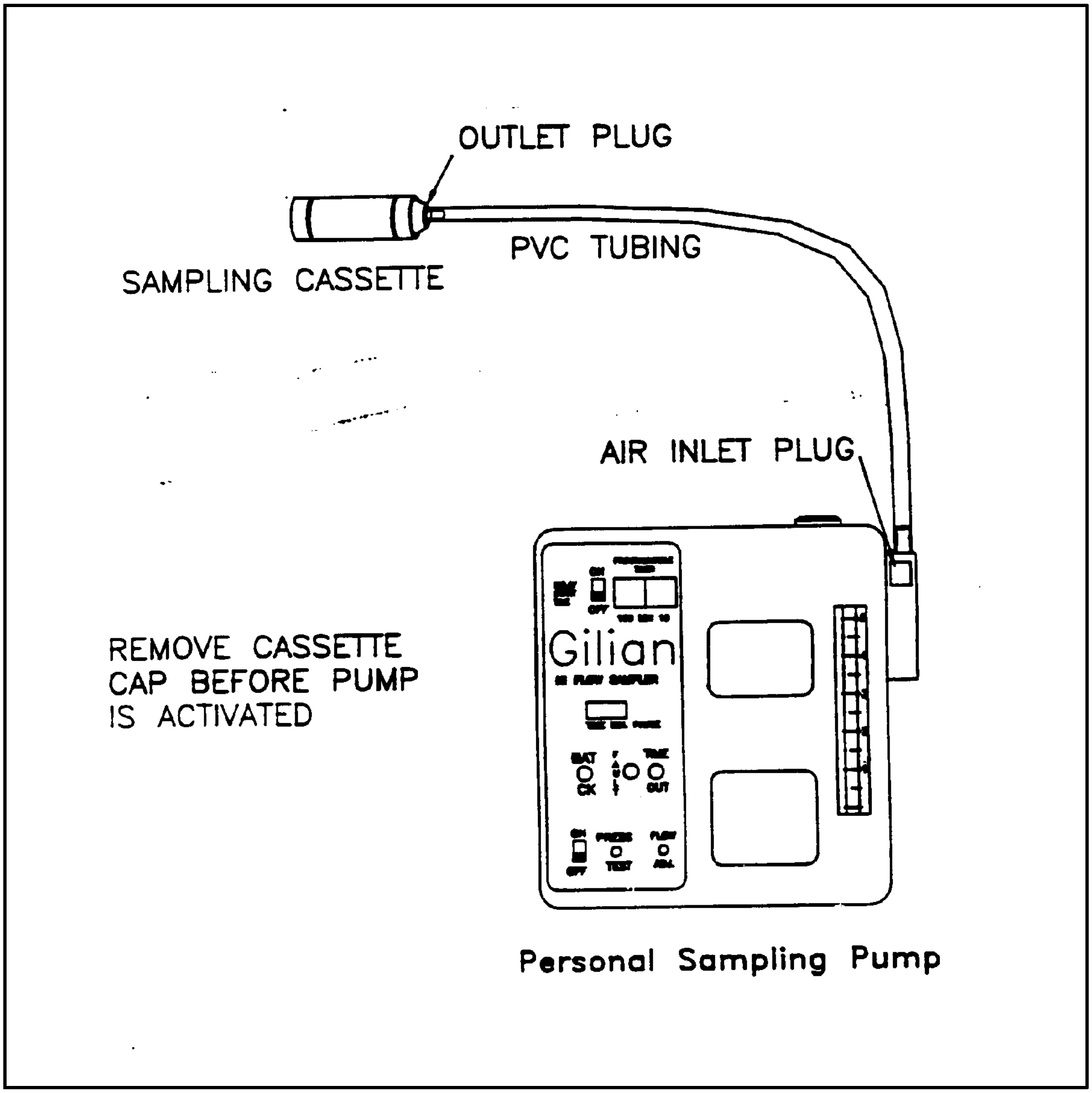
FIGURE 5. Calibrating a Sampling Pump with a Rotameter



APPENDIX B (Cont'd)

Figures

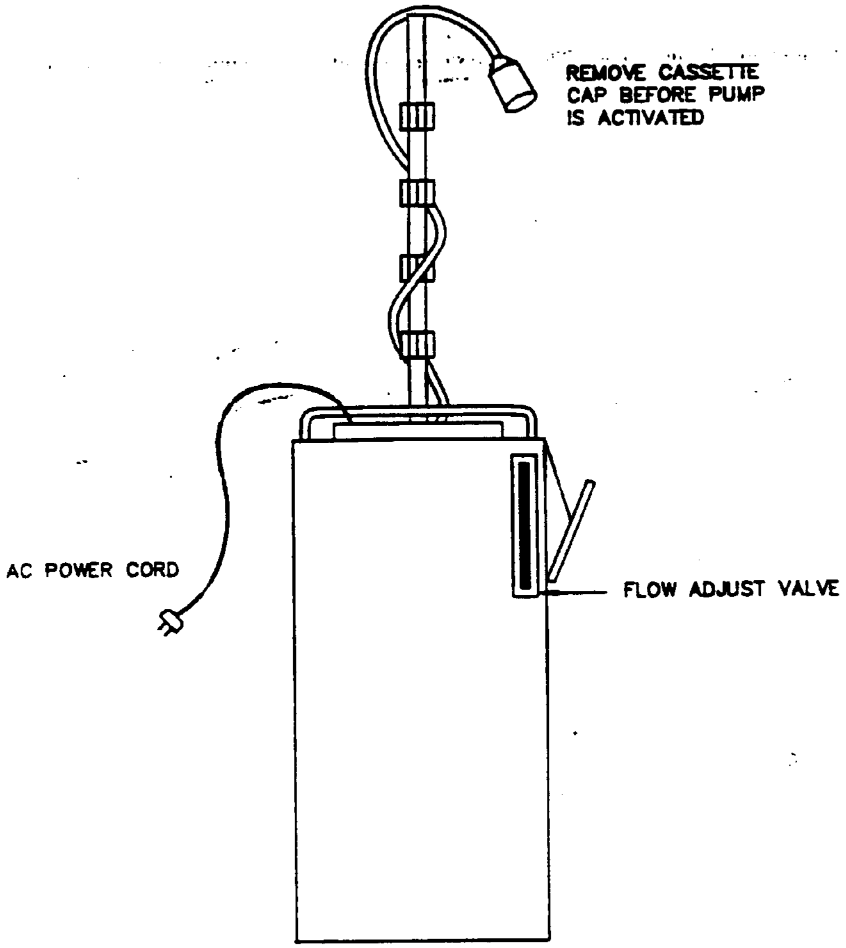
FIGURE 6. Personal Sampling Train for Asbestos



APPENDIX B (Cont'd)

Figures

FIGURE 7. High Flow Sampling Train for Asbestos



SEDIMENT SAMPLING

SOP#: 2016
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- toxicity;
- biological availability and effects of contaminants;
- benthic biota;
- extent and magnitude of contamination;
- contaminant migration pathways and source;
- fate of contaminants;
- grain size distribution.

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type.

Sediment is collected from beneath an aqueous layer either directly, using a hand held device such as a shovel, trowel, or auger; or indirectly, using a remotely activated device such as an Ekman or Ponar dredge. Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analyses requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested. The homogenization procedure should not be used if sample analysis includes volatile organics; in this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

1. Chemical preservation of solids is generally not recommended. Cooling to 4°C is usually the best approach, supplemented by the appropriate holding time for the analyses requested.

2. Wide mouth glass containers with Teflon lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the Work Plan.

3. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses

requested. Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.

4. If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition (e.g., Teflon) containers. The sediment is homogenized thoroughly to obtain a composite representative of the area sampled. The composite sediment sample is transferred to a labeled container(s) of appropriate size and construction for the analyses requested. Transfer of sediment is accomplished with a stainless steel or plastic lab spoon or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection device or pooled from multiple areas in the homogenization container prior to mixing. This is done to minimize loss of contaminant due to volatilization during homogenization.

5. All sampling devices should be decontaminated, then wrapped in aluminum foil. The sampling device should remain in this wrapping until it is needed. Each sampling device should be used for only one sample. Disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a waterbody. Contaminants are more likely to be concentrated in sediments typified by fine particle size and a high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results and should be justified and specified in the Work Plan.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of sediment samples may include:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels
- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spade or shovel
- Spatula
- Scoop
- Trowel
- Bucket auger
- Tube auger
- Extension rods
- "T" handle
- Sediment coring device (tube, drive head, eggshell check value, nosecone, acetate tube, extension rods, "T" handle)
- Ponar dredge
- Ekman dredge
- Nylon rope or steel cable
- Messenger device

6.0 REAGENTS

Reagents are not used for preservation of sediment samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP.

7.0 PROCEDURES

7.1 Preparation

1. Determine the objective(s) and extent of the sampling effort. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives of the study.

2. Obtain the necessary sampling and monitoring equipment.

3. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.

4. Decontaminate or preclean equipment, and ensure that it is in working order.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

Selection of a sampling device is most often contingent upon: (1) the depth of water at the sampling location, and (2) the physical characteristics of the sediment to be sampled. The following procedures may be utilized:

7.2.1 Sampling Surface Sediment with a Trowel or Scoop from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 12 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water render this method less accurate than others discussed below. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team member. A stainless steel or plastic sampling implement will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials; plating is particularly common with garden trowels.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, remove the desired thickness and volume of sediment from the sampling area.

2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

7.2.2 Sampling Surface Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of bucket auger or tube auger, a series of extensions, and a "T" handle (Figure 1, Appendix A). The use of additional extensions in conjunction with a bucket auger can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. However, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger or tube auger is driven into the sediment and used to extract a core. The various depths represented by the core are homogenized or a subsample of the core is taken from the appropriate depth.

The following procedure will be used to collect sediment samples with a bucket auger or tube auger:

1. An acetate core may be inserted into the bucket auger or tube auger prior to sampling if characteristics of the sediments or waterbody warrant. By using this technique, an intact core can be extracted.

2. Attach the auger head to the required length of extensions, then attach the "T" handle to the upper extension.

3. Clear the area to be sampled of any surface debris.

4. Insert the bucket auger or tube auger into the sediment at a 0° to 20° angle from vertical. This orientation minimizes spillage of the sample from the sampler upon extraction from the sediment and water.

5. Rotate the auger to cut a core of sediment.

6. Slowly withdraw the auger; if using a tube auger, make sure that the slot is facing upward.

7. Transfer the sample or a specified aliquot of sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.3 Sampling Deep Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, deep sediment is considered to range from six to greater than 18 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches. Collection of deep sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a bucket auger, a tube auger, a series of extensions and a "T" handle. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to five feet or more. However, water clarity must be high enough to permit the sampler to directly observe the sampling operation. In addition, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger is used to bore a hole to the upper range of the desired sampling depth and then withdrawn. The tube auger is then lowered down the borehole, and driven into the sediment to the lower range of the desired sampling depth. The tube is then withdrawn and the sample recovered from the tube. This method can be used to collect firmly consolidated sediments, but is somewhat limited by the depth of the aqueous layer, and the integrity of the initial borehole.

The following procedure will be used to collect deep sediment samples with a bucket auger and a tube auger:

1. Attach the bucket auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.

2. Clear the area to be sampled of any surface debris.

3. Begin augering, periodically removing any accumulated sediment (i.e., cuttings) from the auger bucket. Cuttings should be disposed of far enough from the sampling area to minimize cross contamination of various depths.

4. After reaching the upper range of the desired depth, slowly and carefully remove bucket auger from the boring.

5. Attach the tube auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.

6. Carefully lower tube auger down borehole using care to avoid making contact with the borehole sides and, thus, cross contaminating the sample. Gradually force tube auger into sediment to the lower range of the desired sampling depth. Hammering of the tube auger to facilitate coring should be avoided as the vibrations may cause the boring walls

to collapse.

7. Remove tube auger from the borehole, again taking care to avoid making contact with the borehole sides and, thus, cross contaminating the sample.

8. Discard the top of core (approximately 1 inch); as this represents material collected by the tube auger before penetration to the layer of concern.

9. Transfer sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.4 Sampling Surface Sediment with an Ekman or Ponar Dredge from Beneath a Shallow or Deep Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth. Collection of surface sediment can be accomplished with a system consisting of a remotely activated device (dredge) and a deployment system. This technique consists of lowering a sampling device (dredge) to the surface of the sediment by use of a rope, cable, or extended handle. The mechanism is activated, and the device entraps sediment in spring loaded or lever operated jaws.

An Ekman dredge is a lightweight sediment sampling device with spring activated jaws. It is used to collect moderately consolidated, fine textured sediment. The following procedure will be used for collecting sediment with an Ekman dredge (Figure 2, Appendix A):

1. Attach a sturdy nylon rope or stainless steel cable through the hole on the top of the bracket, or secure the extension handle to the bracket with machine bolts.

2. Attach springs to both sides of the jaws. Fix the jaws so that they are in open position by placing trip cables over the release studs. Ensure that the hinged doors on the dredge top are free to open.

3. Lower the sampler to a point 4 to 6 inches above the sediment surface.

4. Drop the sampler to the sediment.

5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the button on the upper end of the extension handle.

6. Raise the sampler and slowly decant any free liquid through the top of the sampler. Care should be taken to retain the fine sediment fraction during this procedure.

7. Open the dredge jaws and transfer the sample into a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment grabs until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

A Ponar dredge is a heavyweight sediment sampling device with weighted jaws that are lever or spring activated. It is used to collect consolidated fine to coarse textured sediment. The following procedure will be used for collecting sediment with a Ponar dredge (Figure 3, Appendix A):

1. Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge.

2. Arrange the Ponar dredge with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.

3. Slowly lower the sampler to a point approximately two inches above the sediment.

4. Drop the sampler to the sediment. Slack on

the line will release the trip bar or spring loaded pin; pull up sharply on the line closing the dredge.

5. Raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.

6. Open the dredge and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenized and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

7.2.5 Sampling Subsurface Sediment with a Coring Device from Beneath a Shallow Aqueous Layer

For purposes of this method, subsurface sediment is considered to range from 6 to 24 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of subsurface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a tube sampler, acetate tube, eggshell check valve, nosecone, extensions, and "T" handle, or drivehead. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. This sampler may be used with either a drive hammer for firm sediment, or a "T" handle for soft sediment. However, sample handling and manipulation increases in difficulty with increasing depth of water.

The following procedure describes the use of a sample coring device (Figure 4, Appendix A) used to collect subsurface sediments.

1. Assemble the coring device by inserting the acetate core into the sampling tube.

2. Insert the "egg shell" check valve into the lower end of the sampling tube with the convex surface positioned inside the acetate core.

3. Screw the nosecone onto the lower end of the sampling tube, securing the acetate tube and eggshell check valve.

4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.

5. Place the sampler in a perpendicular position on the sediment to be sampled.

6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, rotate the sampler to shear off the core at the bottom. Slowly withdraw the sampler from the sediment and proceed to Step 15.

7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.

8. Drive the sampler into the sediment to the desired depth.

9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.

10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.

11. Rotate the sampler to shear off the core at the bottom.

12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90°.

13. Slowly withdraw the sampler from the sediment. If the drivehead was used, pull the hammer upwards and dislodge the sampler from the sediment.

14. Carefully remove the coring device from the water.

15. Unscrew the nosecone and remove the eggshell check valve.

16. Slide the acetate core out of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. If head space is present in the upper end, a hacksaw may be used to shear the acetate tube off at the sediment surface. The acetate core may then be capped at both ends. Indicate on the acetate tube the appropriate orientation of the sediment core using a waterproof marker. The sample may be used in this fashion, or the contents transferred to a sample or homogenization container.

17. Open the acetate tube and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA/OSHA and Corporate health and safety procedures.

More specifically, when sampling sediment from waterbodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the waterbody, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel is determined to be necessary, appropriate protective measures must be implemented.

12.0 REFERENCES

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

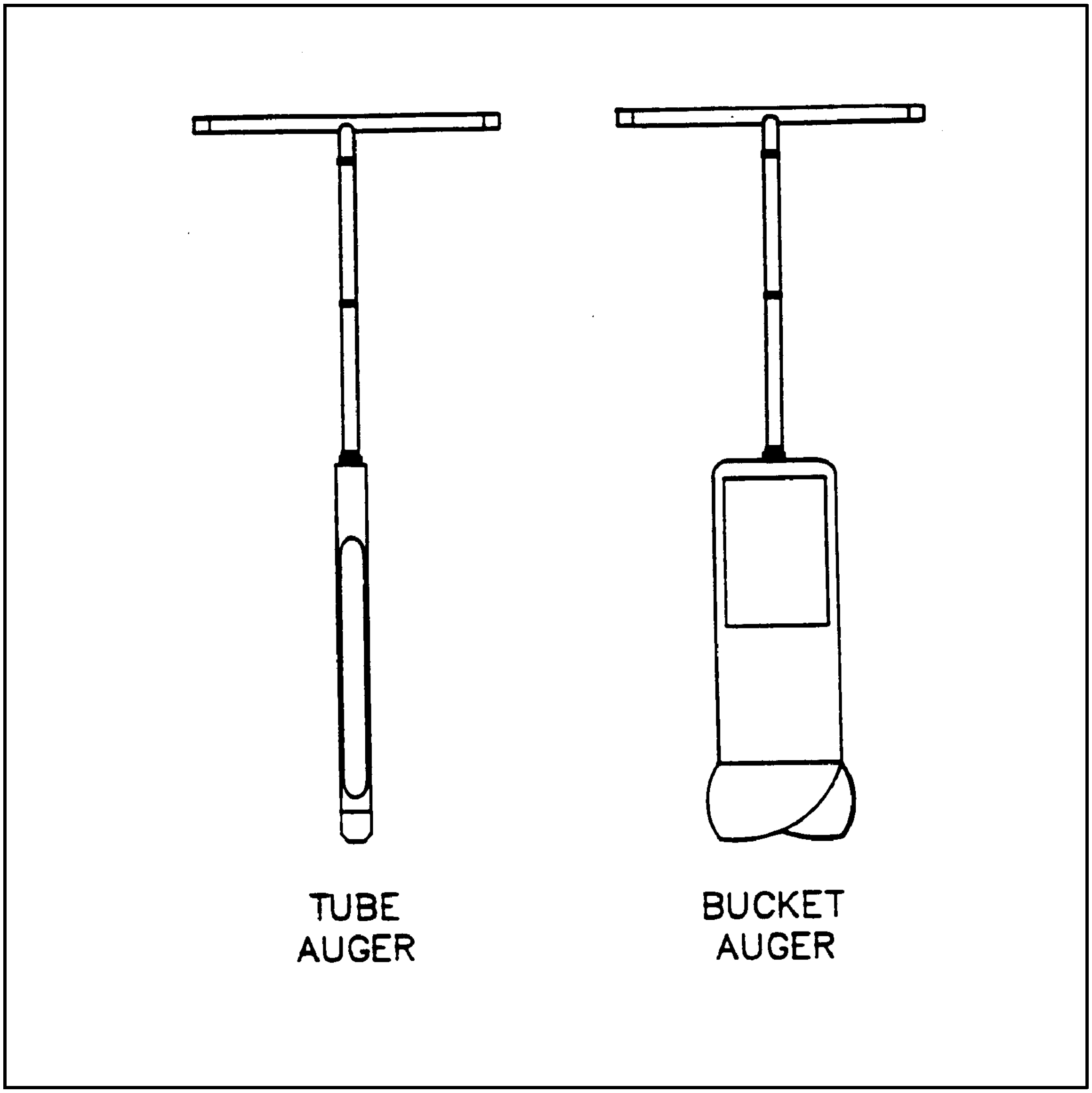
U.S. EPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

APPENDIX A

Figures

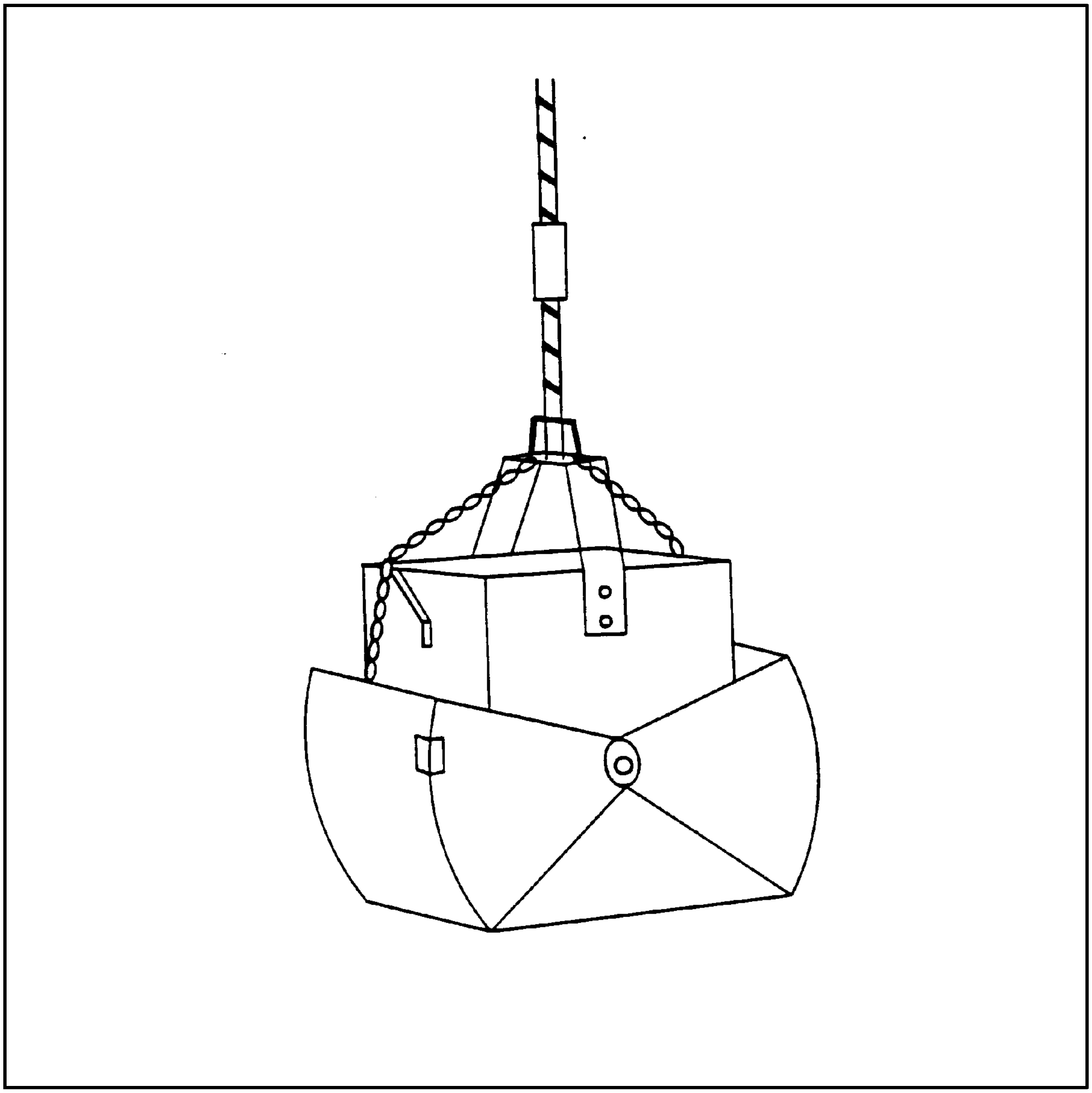
FIGURE 1. Sampling Auger



APPENDIX A (Cont'd)

Figures

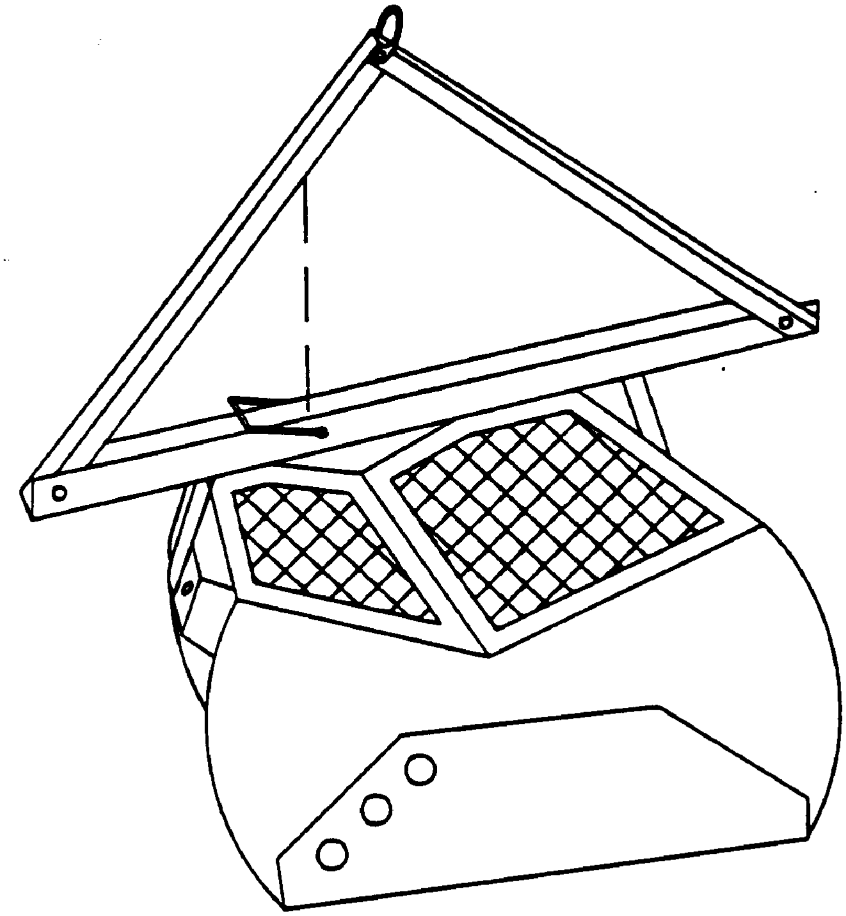
FIGURE 2. Ekman Dredge



APPENDIX A (Cont'd)

Figures

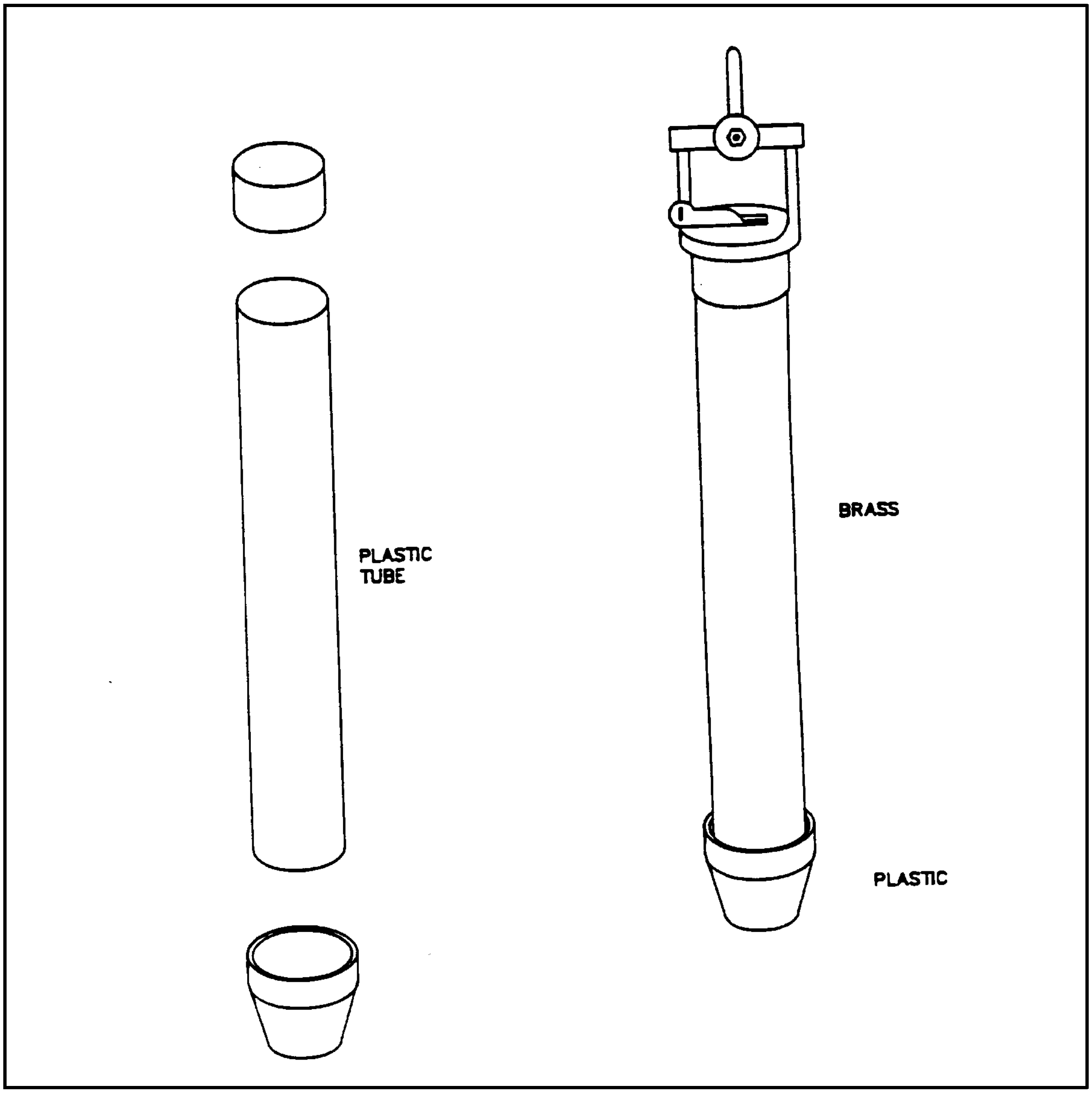
FIGURE 3. Ponar Dredge



APPENDIX A (Cont'd)

Figures

FIGURE 4. Sample Coring Device



WASTE PILE SAMPLING

SOP#: 2017
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to outline the equipment and methods used in collecting representative samples from waste piles, sludges or other solid or liquid waste mixed with soil.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Stainless steel shovels, trowels, or scoops should be used to clear away surface material before samples are collected. For depth samples, a decontaminated auger may be required to advance the hole, then another decontaminated auger used for sample collection. For a sample core, thin-wall tube samplers or grain samplers may be used. Near surfaces, samples can be collected with a clean stainless steel spoon or trowel.

All samples collected, except those for volatile organic analysis, should be placed into a Teflon lined or stainless steel pail and mixed thoroughly before transfer to appropriate sample container.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is generally not recommended. Refrigeration to 4°C is usually the best approach, supplemented by a minimal holding time, depending on contaminants of concern.

Wide mouth glass containers with Teflon lined caps are typically used for waste pile samples. Sample volume required is a function of the analytical requirements and should be specified in the work plan.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are several variables involved in waste sampling, including shape and size of piles, compactness, and structure of the waste material. Shape and size of waste material or waste piles vary greatly in areal extent and height. Since state and federal regulations often require a specified number of samples per volume of waste, the size and shape must be used to calculate volume and to plan for the correct number of samples. Shape must also be accounted for when planning physical access to the sampling point and the equipment necessary to successfully collect the sample at that location.

Material to be sampled may be homogeneous or heterogeneous. Homogeneous material resulting from known situations may not require an extensive sampling protocol. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components (i.e. layers, strata) are being represented.

The term "representative sample" is commonly used to denote a sample that has the properties and composition of the population from which it was collected and in the same proportions as found in the population. This can be misleading unless one is dealing with a homogenous waste from which one sample can represent the whole population.

The usual options for obtaining the most "representative sample" from waste piles are simple random sampling or stratified random sampling. Simple random sampling is the method of choice unless: (1) there are known distinct strata; (2) one wants to prove or disprove that there are distinct strata; or (3) one is limited in the number of samples and desires to statistically minimize the size of a "hot spot" that could go unsampled. If any of these conditions exist, stratified random sampling would be the better strategy.

Stratified random sampling can be employed only if all points within the pile can be accessed. In such cases, the pile should be divided into a three-dimensional grid system with, the grid cubes should be numbered, and the grid cubes to be sampled should be chosen by random number tables or generators. The only exceptions to this are situations in which representative samples cannot be collected safely or where the investigative team is trying to determine worst case conditions.

If sampling is limited to certain portions of the pile, a statistically based sample will be representative only of that portion, unless the waste is homogenous.

5.0 EQUIPMENT/APPARATUS

Waste pile solids include powdered, granular, or block materials of various sizes, shapes, structure, and compactness. The type of sampler chosen should be compatible with the waste. Samplers commonly used for waste piles include: stainless steel scoops, shovels, trowels, spoons, and stainless steel hand augers, sampling triers, and grain samplers.

Waste pile sampling equipment check list:

- Sampling plan
- Maps/plot plan
- Safety equipment, as specified in the Health and Safety Plan
- Compass
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket or bowl
- Appropriate size sample jars
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and seals
- Field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel
- Continuous flight (screw) augers
- Bucket auger
- Post hole auger
- Extension rods
- T-Handle
- Thin-wall tube sampler with cutting tips
- Sampling trier
- Grain sampler

6.0 REAGENTS

No chemical reagents are used for the preservation of waste pile samples; however, decontamination solutions may be required. If decontamination of equipment is required, refer to the Sampling Equipment Decontamination SOP, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Review all information available on the waste pile and expected or unknown contaminants.

2. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.

3. Obtain necessary sampling and monitoring equipment.

4. Decontaminate or pre-clean equipment, and ensure that it is in working order.

5. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.

6. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

7. Use stakes or flagging to identify and mark

all sampling locations. Specific site factors, including extent and nature of contaminant should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

7.2.1 Sampling with Shovels and Scoops

Collection of samples from surface portions of the pile can be accomplished with tools such as spades, shovels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop, or equivalent can be used to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by sample team members. Use of a flat, pointed mason trowel to cut a block of the desired material can be helpful when undisturbed profiles are required. A stainless steel scoop, lab spoon, plastic spoon, or equivalent will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with implements such as garden trowels.

The following procedure is used to collect the surface samples:

1. Carefully remove the top layer of material to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned stainless steel scoop, plastic spoon, trowel, or equivalent remove and discard a thin layer of material from the area which came in contact with the spade.

3. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent, and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling with Bucket Augers and Thin-Wall Tube Samplers

These samplers consist of a series of extensions, a "T" handle, and a bucket auger or thin-wall tube sampler (Appendix A, Figure 1). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the bucket auger. If a core sample is to be collected, the auger tip is then replaced with a thin-wall tube sampler. The sampler is then lowered down the borehole, and driven into the pile to the completion depth. The sampler is withdrawn and the core collected from the thin-wall tube sampler.

Several augers are available. These include: bucket, continuous flight (screw), and post hole augers. Bucket augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights, which are usually at five (5) foot intervals. The continuous flight augers are satisfactory for use when a composite of the complete waste pile column is desired. Post hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy areas.

The following procedure will be used for collecting waste pile samples with the bucket augers and thin-wall tube samplers:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris. It may be advisable to remove the first three to six inches of surface material for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated materials onto a plastic sheet spread near the hole. This prevents accidental brushing of loose

material back down the borehole when removing the auger or adding drill rod extensions. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the borehole. When sampling directly from the auger, collect the sample after the auger is removed from the borehole and proceed to Step 10.

5. Remove auger tip from drill rods and replace with a pre-cleaned thin-wall tube sampler. Install proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the pile. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rod extensions to facilitate coring as the vibrations may cause the borehole walls to collapse.

7. Remove the tube sampler, and unscrew the drill rod extensions.

8. Remove the cutting tip and the thin-wall tube sampler.

9. Discard the top of the core (approximately one-inch), as this represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the bucket auger to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the bucket auger and thin-wall tube sampler between samples.

7.2.3 Sampling with a Trier

This sampling device consists of a trier, and a "T" handle. The trier is driven into the waste pile and used to extract a core sample from the appropriate depth.

The following procedure will be used to collect waste pile samples with a sampling trier:

1. Insert the trier (Appendix A, Figure 2) into the material to be sampled at a 0E to 45E angle from horizontal. This orientation minimizes spillage of the sample. Extraction of the samples might require tilting of the sample containers.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are being collected, place samples from the other sampling intervals into the homogenization container and mix thoroughly. When compositing is complete, place the sample

into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling with a Grain Sampler

The grain sampler (Appendix A, Figure 3) is used for sampling powdered or granular wastes or materials in bags, fiber drums, sacks, similar containers or piles. This sampler is most useful when the solids are no greater than 0.6 cm (1/4") in diameter.

This sampler consists of two slotted telescoping brass or stainless steel tubes. The outer tube has a conical, pointed tip at one end that permits the sampler to penetrate the material being sampled. The sampler is opened and closed by rotating the inner tube. Grain samplers are generally 61 to 100 cm (24 to 40 in.) long by 1.27 to 2.54 cm (1/2 to 1 in.) in diameter and are commercially available at laboratory supply houses.

The following procedures will be used to collect waste pile samples with a grain sampler:

1. With the sampler in the closed position, insert it into the granular or powdered material or waste being sampled from a point near a top edge or corner, through the center, and to a point diagonally opposite the point of entry.
2. Rotate the sampler inner tube into the open position.
3. Wiggle the sampler a few times to allow material to enter the open slots.
4. Place the sampler in the closed position and withdraw from the material being sampled.
5. Place the sampler in a horizontal position with the slots facing upward.
6. Rotate the outer tube and slide it away from the inner tube.
7. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA/OSHA and corporate health and safety procedures.

12.0 REFERENCES

Test Methods for Evaluating Solids Waste (SW-846), Third Edition, Vol. II Field Manual U.S. EPA Office of Solid Waste and Emergency Response, Washington, D.C. November, 1986.

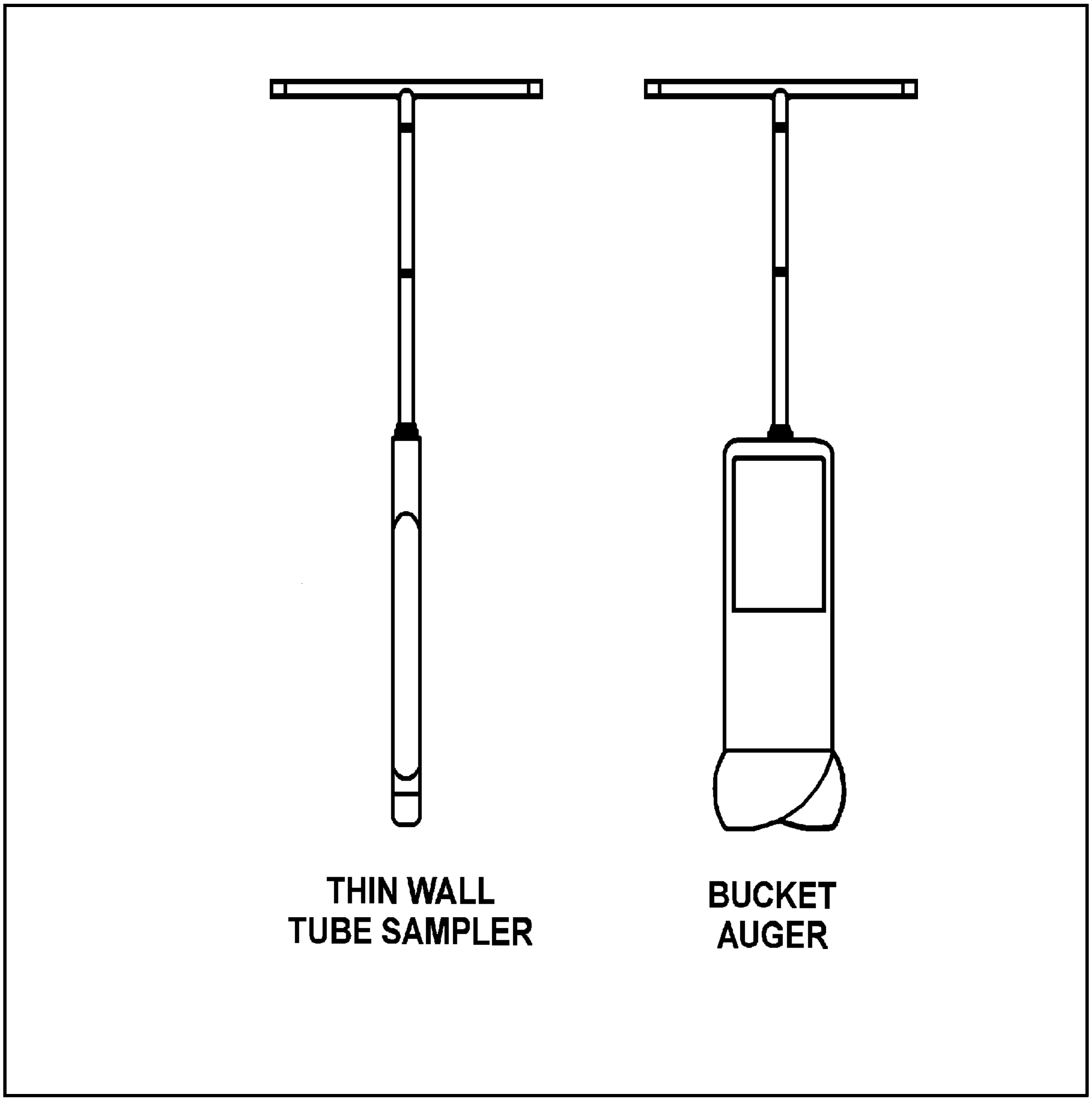
Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, April 1, 1986.

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

APPENDIX A

Figures

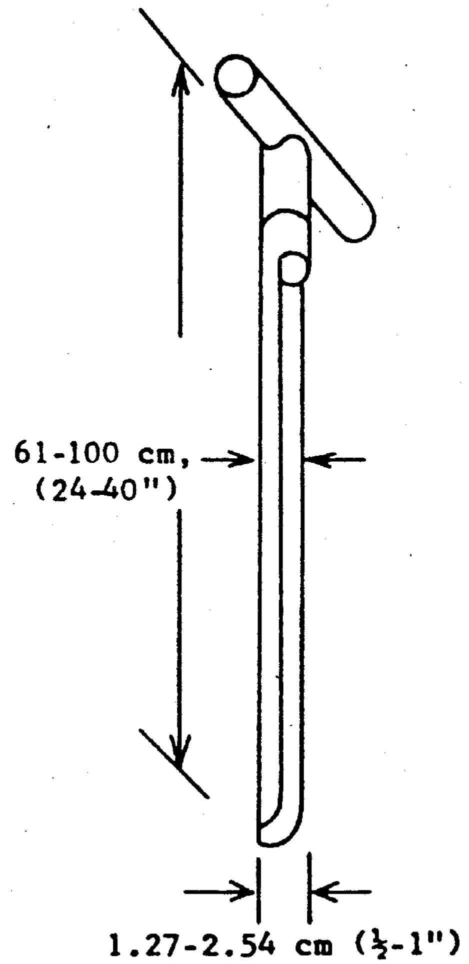
FIGURE 1. Sampling Augers



APPENDIX A (Cont’d)

Figures

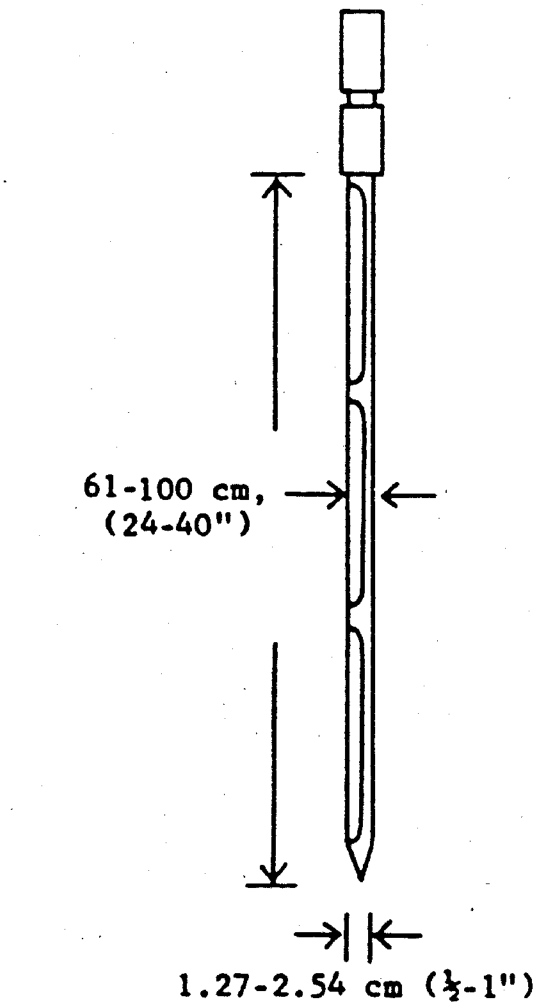
FIGURE 2. Sampling Trier



APPENDIX A (Cont'd)

Figures

FIGURE 3. Grain Sampler



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

TEDLAR® BAG SAMPLING

CONTENTS

* These sections affected by this revision.

SUPERCEDES: SOP #2102; Revision 0.0; 10/21/94; U.S. EPA Contract 68-C4-0022.

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to define the use of Tedlar® bags in collecting gaseous grab samples. Tedlar® bags are used to collect volatile organic compounds (VOCs) including halogenated and non-halogenated species. The sensitivity of the method is primarily dependent on the analytical instrument and the compounds being investigated.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

When collecting gaseous samples for analysis it is often necessary to obtain a representative grab sample of the media in question. The Tedlar® bag collection system allows for this and consists of the following items:

C Tedlar® bag, complete with necessary fittings
C Vacuum box
C Vacuum pump(s)
C Teflon® and Tygon® tubing

The Tedlar® bag is placed into the vacuum box and the fitting is attached to the sampling port and Teflon® tubing. The Teflon® tubing is the path through which the gaseous media will travel. The pump is attached to the Tygon® tubing, which is connected to the vacuum fitting on the vacuum box. The pump evacuates the air in the vacuum box, creating a pressure differential that causes the sample to be drawn into the bag. The sample introduced into the Tedlar® bag never passes through the pump. The flow rate for the pump must be defined prior to sampling (usually 1 liters/minute [LPM] for bag sampling).

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Tedlar® bags most commonly used for sampling have a 1-liter volume capacity. After sampling, the Tedlar® bags are stored in either a clean cooler or an opaque plastic bag at ambient temperature to prevent photodegradation. It is essential that sample analysis be undertaken within 24-48 hours following sample collection since VOCs may escape or become altered.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination is a major concern since many of the compounds in question will be present in the parts per billion range. In order to minimize the risk of cross contamination, the following factors should be considered:

1. Proximity of the bags to sources of potential contamination during transportation and storage. The further away from the source(s) the bags are, the less likely the chances of external contamination.

2. Bags must be attached only to clean Teflon® tubing.

3. Once the bag has been collected, affix the sample label to the edge of the bag. Adhesives found in the label may permeate the bag if placed on the body of the bag. Fill out labels with a ballpoint pen as permanent markers contain volatile compounds that may contaminate the sample.

4. Due to the chemical structure of Tedlar®, highly polar compounds will adhere to the inner surface of the bag. Also, low molecular weight compounds may permeate the bag. Real-time monitors such as the organic vapor analyzer (OVA), photoionization detector (HNu), and combustible gas indicator (CGI) may be used as screening devices prior to sampling. This information is documented on the sample label to assist individuals performing the sample analysis.

The Tedlar® bag sampling system is straightforward and easy to use. However, there are several things to be aware of when sampling.

1. The seal between the top half and the bottom half of the vacuum box must be air tight in order to allow the system to work.

2. Check the O-ring gasket to see if it is in place with the proper fit. O-rings that have been stretched out will not remain in place, thus requiring constant realignment.

3. Check that all the fittings associated with the vacuum joints are securely in place. The fittings can be pushed loose when inserting the valve stem into the Teflon tubing.

4. Occasionally, a corner of the Tedlar® bag will jut out between the two halves of the vacuum box, thus impairing the seal. Since the bags will hold only a given volume, over-inflation will cause the bags to burst.

5.0 EQUIPMENT/APPARATUS

- Vacuum box
- Vacuum pumps
- Teflon® tubing
- O-rings
- Tedlar® bags
- Chain of custody records and custody seals
- Sample collection documentation (sample labels, air sampling worksheets, logbooks)

- Large opaque plastic bags
- Ultra-zero air

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan. Prior to selecting sample locations, an underground utility search must be completed. The local utility companies can be contacted to mark the locations of the underground lines. Request the homeowner to mark any underground sprinklers, if present.

6. Use stakes or flagging to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Field Operations

Tedlar® bags are stored in boxes of ten. The valve is in the open position when stored. Occasionally, a piece of debris will clog the valve, necessitating the closing of the valve stem to clear. The valve stem is closed by pulling the stem out. If the valve stem is difficult to pull, it helps to spin the valve stem simultaneously.

1. Remove the Tedlar® bag from the carton.

2. Insert the valve stem into the Teflon tube which runs through the vacuum box (Figure 1, Appendix A).

3. Place the Tedlar® bag in the vacuum box. Seal the vacuum box by applying pressure to the

top and bottom (ensure that the O-ring is in place and unobstructed).

4. Connect the sampling pump to the evacuation tube.
5. Connect the intake tube to the desired source or place the intake tube into the media of concern.
6. Turn on the sampling pump.
7. Allow the bag to fill (visual observation and sound of laboring pump).
8. Turn off the sampling pump and remove the evacuation tube from the pump.
9. Remove bag and pull the valve stem out.
10. Lock the valve stem.
11. Label the bag using either a tag or a sticker placed on the edge of the bag. Do not write on the bag itself. Record the date, time, sample location and any instrument readings.
12. Place Tedlar® bag in a clean cooler or opaque trash bag to prevent photodegradation.
13. When transferring the Tedlar® bags, a chain of custody form must accompany the samples. Personnel should be aware that some of the compounds of concern will degrade within a few hours of sampling.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 General QA Procedures

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instruction as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.
3. Depending upon the Work Plan (WP) requirements, a background sample consisting of upgradient/downgradient, beginning/ending of day or combination, may be collected. It may

also be desirable to change sample train tubing between sample locations.

9.2 Field Blanks

A field blank detects contamination during the handling and shipping process. The field blank must be associated with an actual sampling event. For each day of sampling not to exceed 20 samples, a Tedlar® bag is filled with ultra-zero air at the beginning of the day. The field blank is handled in the same manner as the samples.

9.3 Trip Blanks

Each cooler containing Tedlar® bag samples must contain one Tedlar® bag of ultra-zero air, acting as a trip blank, when samples are shipped to an outside laboratory. A chain of custody record must accompany each cooler of samples and should include the blank that is dedicated to that group of samples.

9.4 Lot Blanks

For each lot of Tedlar® bags, a minimum of one bag must be filled with ultra-zero air and analyzed for the parameter(s) of interest. This procedure will ensure cleanliness prior to the start of he sampling effort.

9.5 Duplicate Samples

A minimum of 5% should be collected in duplicate.

10.0 DATA VALIDATION

Results of the quality control samples (trip and lot blanks) will be evaluated for contamination. This information will be utilized to qualify the environmental sample results according to the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA), and corporate health and safety procedures.

12.0 REFERENCES

Gilian Instrument Corporation. 1983. *Instruction Manual for Hi Flow Sampler:HFS113, HFS113T, HFS113U, HFS113UT.*

New Jersey Department of Environmental Protection. 1992. *Field Sampling Procedures Manual*. Hazardous Waste Programs.

United States Environmental Protection Agency. 1995. *Superfund Program Representative Sampling Guidance. Volume 2: Air (Short-Term Monitoring).* EPA 540-R-95/140. Interim Final.

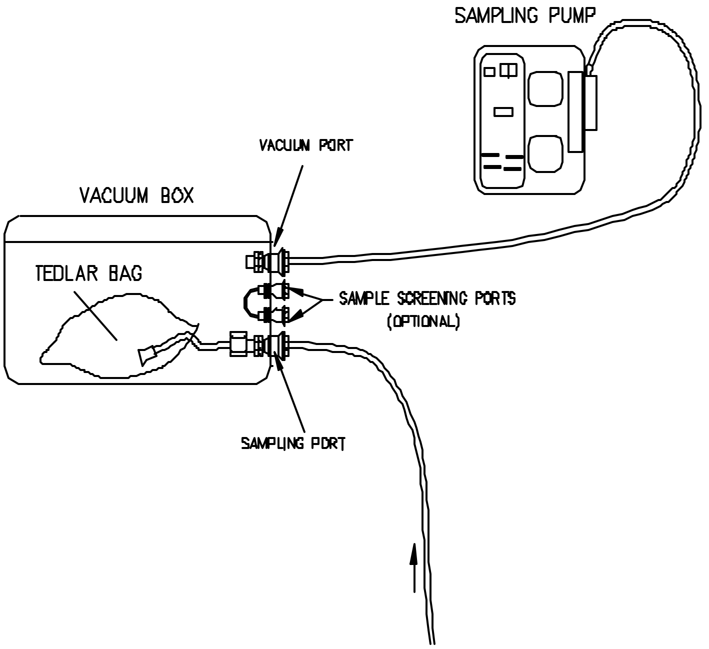
United States Environmental Protection Agency. 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods*. 2nd ed. EPA-600/4-84-076.

13.0 APPENDICES

A - Figure

APPENDIX A
Figure
SOP #2102
September 2001

Figure 1.-Tedlar Bag Sampling Apparatus



CHARCOAL TUBE SAMPLING IN AMBIENT AIR

SOP#: 2103
DATE: 10/24/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of the Standard Operating Procedure (SOP) is to define the procedure for charcoal tube sampling which is utilized to identify specific contaminants in ambient air. The greatest selectivity of activated charcoal is towards non-polar organic solvent vapors, (e.g., carbon tetrachloride, chlorobenzene and toluene). Organic compounds that are gaseous at room temperature, reactive, polar, or oxygenated (aldehyde alcohols and some ketones), are either not adsorbed (relatively early breakthrough), or inefficiently desorbed.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Charcoal tube sampling is performed by drawing a known volume of air through a charcoal adsorption tube. As air is drawn through the tube during sampling, gases and vapors adsorb onto the surface of the charcoal. After sampling, the tubes are delivered to the laboratory for analysis.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Charcoal used for sampling is housed in a glass tube that has been flame sealed. Charcoal tubes most often used contain 150 mg or 600 mg of charcoal. The smaller 150-mg tube is 7-cm long with a 4-mm inner diameter (ID) and a 6-mm outer diameter (OD) containing two sections of 20/40 mesh activated charcoal separated by urethane foam. The adsorbing section contains 100-mg of charcoal, the backup section 50-mg of charcoal. The larger 600-mg tube is 11-cm long with a 6-mm ID and a 8-mm OD containing two sections of 20/40 mesh activated charcoal separated by urethane foam. The adsorbing section contains 400 mg of charcoal, the backup section contains 200-mg of charcoal. A greater volume of air can be drawn through the larger tube thereby providing a greater sensitivity.

To preserve and store samples:

1. Place plastic caps on the charcoal tube ends.
2. Place the sample in a whirl bag. If collocated samples have been collected, place both tubes in one whirl bag.
3. If the sample tube must be stored for more than a week, refrigeration is recommended. Maximum recommended holding time is two weeks.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Low sampling flow rates, and high temperature and humidity may cause a decrease in the adsorption capacity of activated carbon. Contaminants from the front portion of the tube may migrate to the back portion of the tube. Refrigeration may minimize this migration.

5.0 EQUIPMENT

5.1 Equipment List

C Personal Sampling Pump
C Dowel Rods
C Single or Dual Rotameter (with stand and desired precalibrated flow rate)
C Charcoal Tubes (600 mg or 150 mg)

- Tygon Tubing (for attaching the tube holder system to the suction side of the pump)
- Sleeves (or support tubes to hold tubes in place)
- Single or Dual Manifold Flow Controller
- Tube Holder End (to support and seal the sampling tube within the plastic housing)
- Glass Tube Cracker
- Resealable Bags
- Whirl Bags
- Plastic End Caps
- Air Sampling Worksheets and Sample Labels
- Chain of Custody Records
- Screwdriver Set

5.2 Equipment Source

Tubes are commercially available from SKC, Inc. and from Mine Safety Appliance Co., both of Pittsburgh, Pennsylvania.

SKC: 1-800-752-8472
Mine Safety Appliance Co.: 1-800-MSA-2222

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain and organize the necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order. Precalibrate sampling pumps as described in Section 7.2.

4. Prepare scheduling and coordinate with staff, client, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging tape, or other appropriate means to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Calibration Procedures

To save time in the field, sampling pumps can be precalibrated in the office prior to arriving at the site. The calibration must be checked in the field prior to, and upon completion of sampling.

1. Assemble the calibration train as shown in Figure 1 (Appendix A), using a rotameter, sampling pump, manifold (only if the desired flow rate is below 750 cc/min), a tube holder system (sleeve and tube holder end), and a calibration tube. The calibration tube is a representative tube from the same lot of tubes that is used for sampling.

2. Turn on the pump and adjust the flow using the flow adjust mechanism on the manifold (if used) or on the pump itself until the float ball on the rotameter is aligned with the rotameter's precalibrated flow rate value. A sticker on the rotameter should indicate this value.

3. Affix a sticker to the manifold (if used) and pump indicating the precalibrated flow rate and sampling media.

4. Remove the calibration tube from the sleeve. The pump and manifold (if used) are calibrated as a unit and should not be separated until the samples have been collected.

7.3 Field Operation

1. Mobilize to the clean zone and calibrate the appropriate number of sampling pumps as described in Section 7.2. If the pumps were precalibrated, the calibration should be checked in the same manner. Fine tuning of the flow may be required.

2. Mobilize to the sampling location.

3. Crack the charcoal tube ends using a glass tube cracker.

4. Insert the charcoal tube in the sleeve with arrow pointing in the direction of air flow (the smaller section is used for a backup and is positioned nearest the sampling pump).

5. Screw the tip onto the sleeve so the charcoal tube is held in place.

6. Attach the sleeve(s) to a single or double manifold. At higher flow rates (>750 cc/min), charcoal tubes can run straight without a manifold.

7. To set up the sampling train, attach one end of the Tygon tubing (approx. 2 foot) to the tip of the sleeve or manifold. Attach the other end of the tubing to the inlet plug on the pump, Figure 2 (Appendix A). Refer to Figures 3 and 4 (Appendix A), respectively, for illustrations of sampling trains without a manifold and with a dual manifold (for collocated samples).

8. Adjust time on the pump to the required sample time.

9. Place the charcoal tube in a position free from obstruction on a dowel rod or stand.

10. Record weather data (e.g., ambient temperature, barometric pressure, relative humidity, and wind direction) on the Air Sampling Worksheet or in the logbook.

11. Turn on the pump.

12. After the pump has run the full time, check the fault button to determine if the pump ran for the scheduled time.

13. Verify calibration by connecting a rotameter with Tygon tubing and turning on the pump. Record the final flow rate on the Air Sampling Worksheet.

7.4 Post Operation Procedures

1. Record the sampling time on the Air Sampling Worksheet.

2. Remove the charcoal tube from the sleeve.

3. Cap charcoal tubes with plastic caps immediately after sampling. Never use rubber caps.

4. Place the sample in a whirl bag labeled with sample ID#, total volume, and required analysis. If collocated samples have been collected, place each tube in a separate whirl bag and assign a unique sample ID # to each tube.

5. Indicate all applicable information on the Air Sampling Worksheet (e.g., sample volume, ID #, location, date, and weather parameters).

6. If the sample tube must be stored for more than a week, refrigeration is recommended.

7. Prepare samples, including QC samples, for transport by packing them in a shipping container with bubble wrap or styrofoam pieces. Complete a Chain of Custody record in accordance with appropriate Chain of Custody Procedures.

The following methods are typically used for the analysis of charcoal tubes: NIOSH Methods(1,2,3) 1501, Aromatic Hydrocarbons; 1500, Hydrocarbons BP 36E-126EC; and 1003, Halogenated Hydrocarbons. Other analytical parameters may be required. The appropriate analytical methodology should be determined prior to field activities.

8.0 CALCULATIONS

The total volume of a sample is calculated by multiplying the total sample time by the flow rate. The total volume for each sample should be indicated on the Chain of Custody record.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general QA procedures apply:

1. All data must be documented on Air Sampling Worksheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as

supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

The following specific QC activities apply:

1. Provide one field blank per sampling event or per 20 samples, whichever is greater. The field blank should be handled in the same manner as the sampling tube (break, seal, and transport) except that no air is drawn through it.

2. Collect one collocated sample per sampling event or per 10 samples, whichever is greater. Collocated samples are two samples collected adjacent to each other during the same time period at the same flow rates.

3. Include a minimum of one lot blank tube per manufacturer's lot of tube utilized per sampling event. These tubes are taken directly from the charcoal tube box. Do not break the ends.

10.0 DATA VALIDATION

Results of the quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potential hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

Specific hazards unique to charcoal tube sampling include:

1. Sharp edges associated with the tubes after they have been "cracked."

2. Walking and working surfaces, as well as possible heights, associated with access to sampling locations.

12.0 REFERENCES

(1) Eiler, Peter M., ed. NIOSH Method 1501, Aromatic Hydrocarbons. In: *NIOSH Manual of Analytical Methods*, Third Edition, U.S. Gov.'t Printing Office, Washington, D.C., 1987. p. 1501-1.

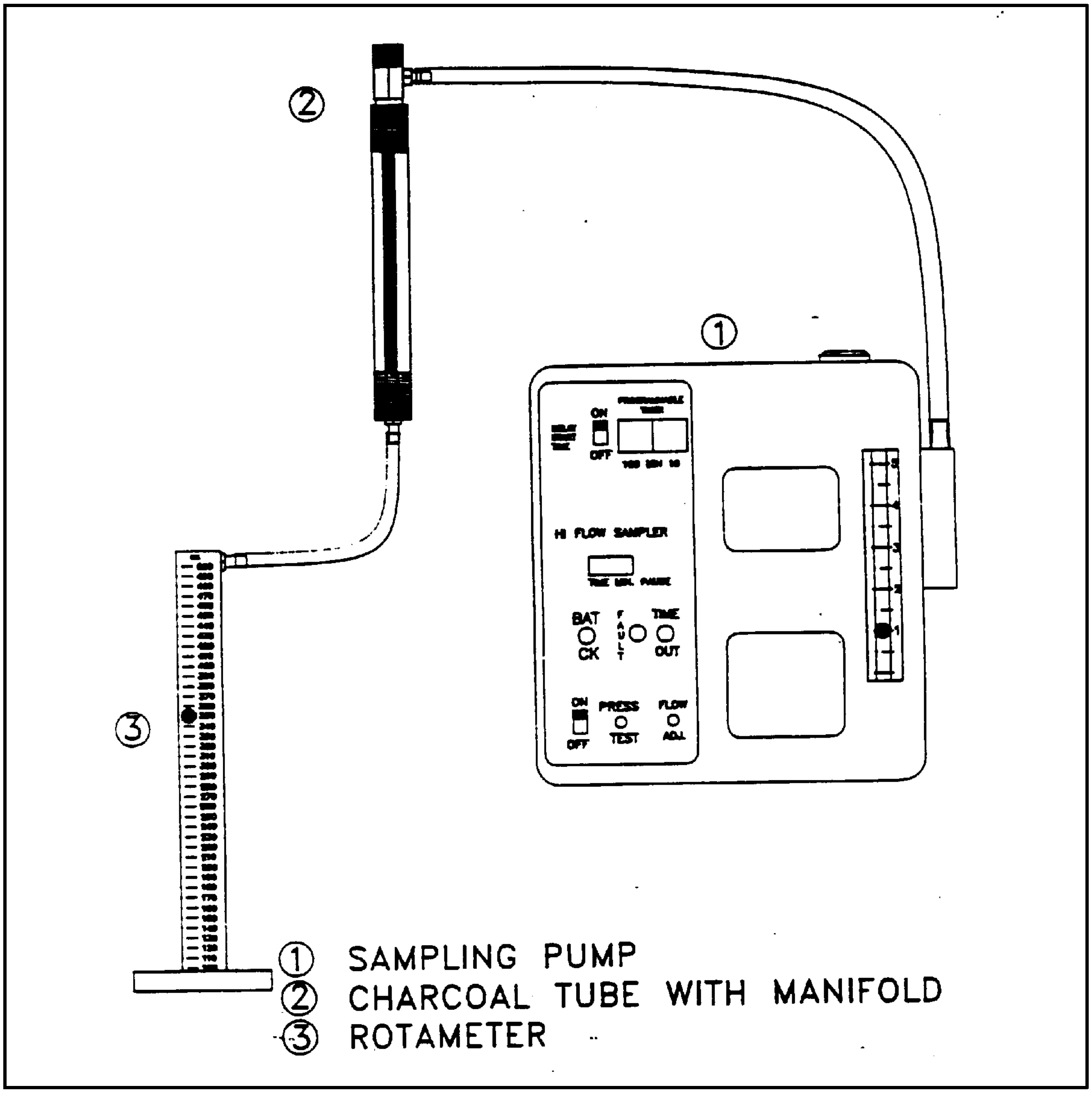
(2) Eiler, Peter M., ed. NIOSH Method 1500, Hydrocarbons, BP 36-126EC. In: *NIOSH Manual of Analytical Methods*, Third Edition, U.S. Gov.'t Printing Office, Washington, D.C., 1987. p. 1500-1.

(3) Eiler, Peter M., ed. NIOSH Method 1003, Halogenated Hydrocarbons. In: *NIOSH Manual of Analytical Methods*, Third Edition, U.S. Gov.'t Printing Office, Washington, D.C., 1987. p. 1003-1.

APPENDIX A

Figures

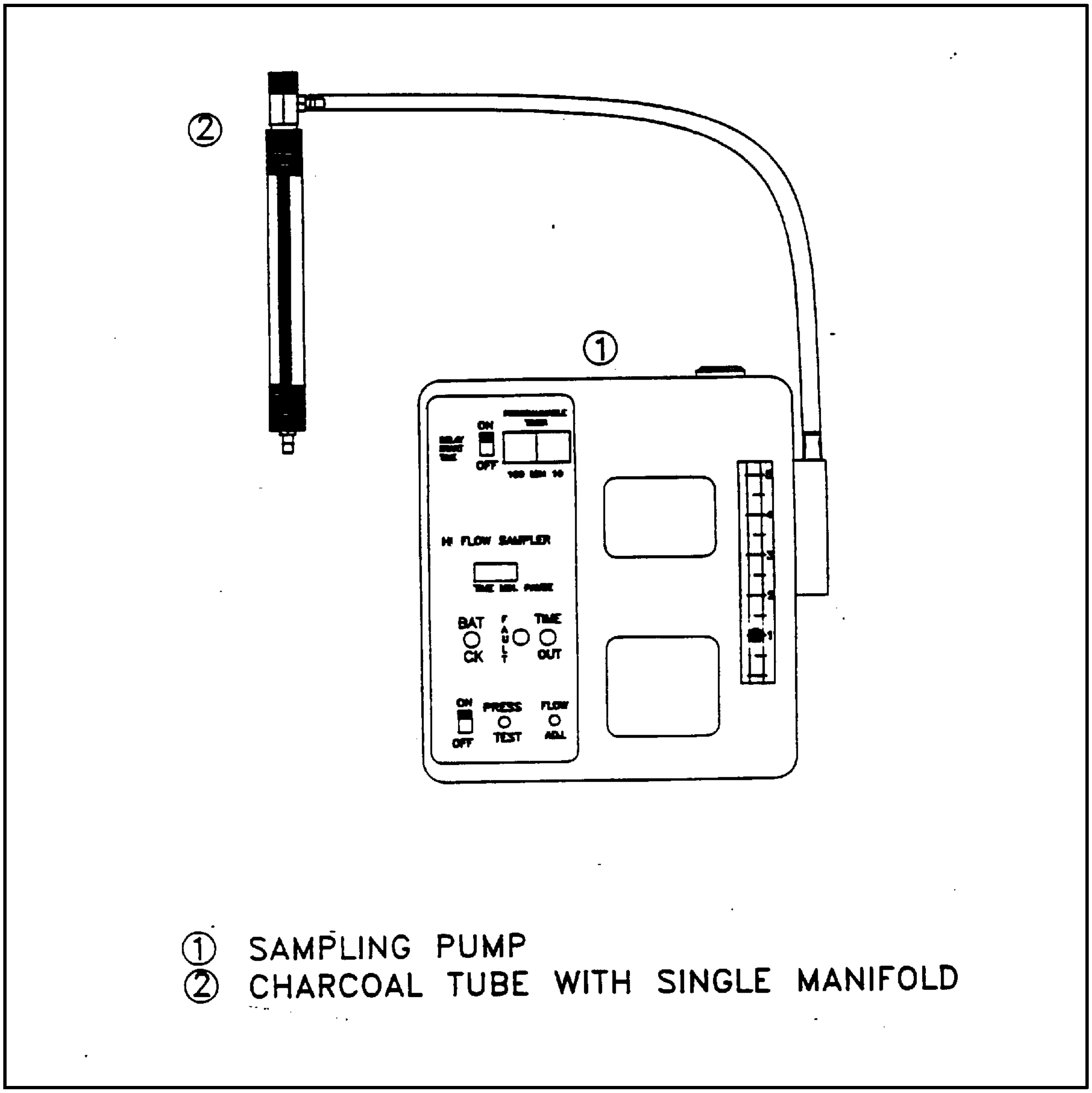
FIGURE 1. Calibration Train



APPENDIX A (Cont'd)

Figures

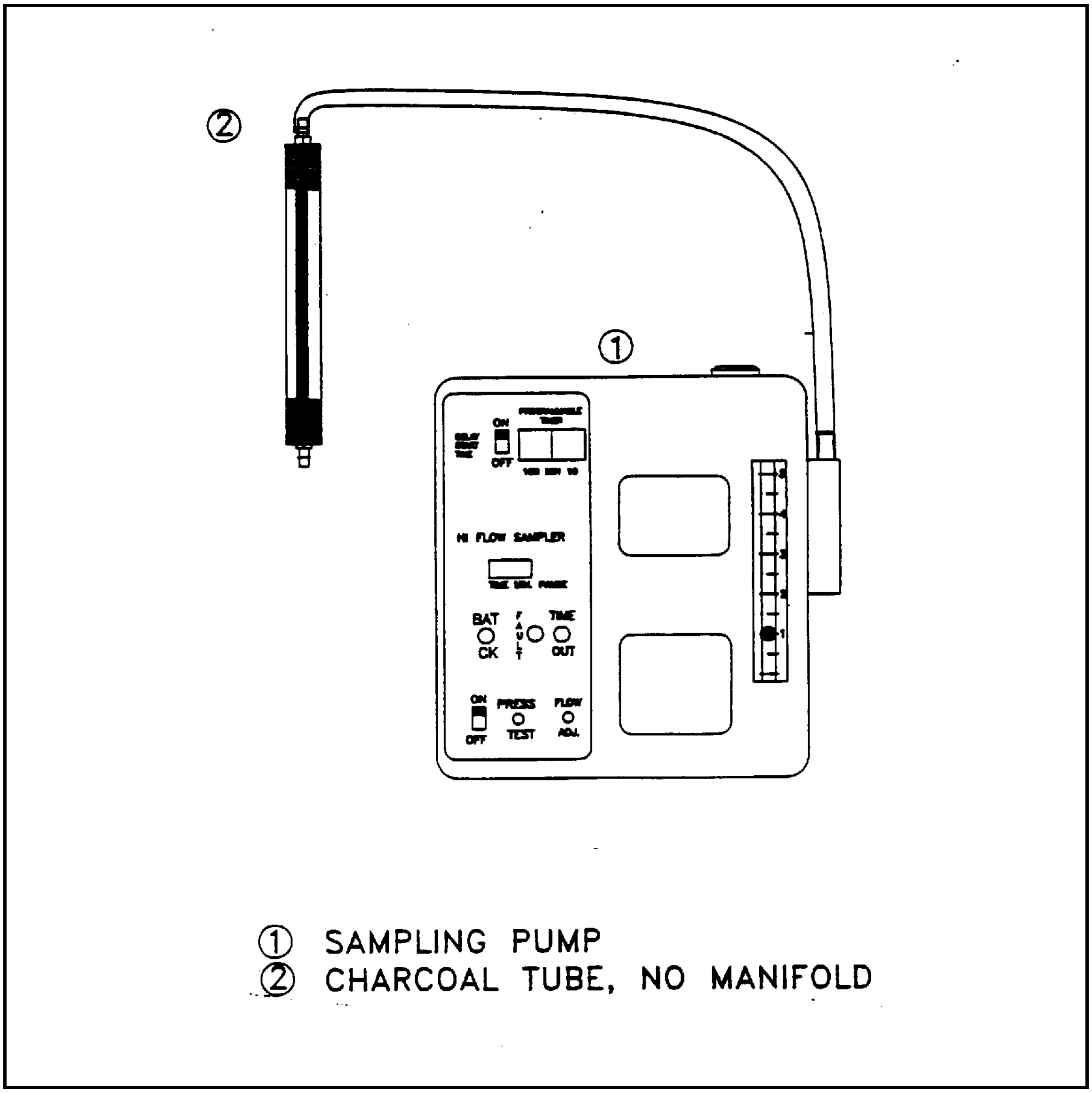
FIGURE 2. Charcoal Tube Sampling Train (Single Manifold)



APPENDIX A (Cont'd)

Figures

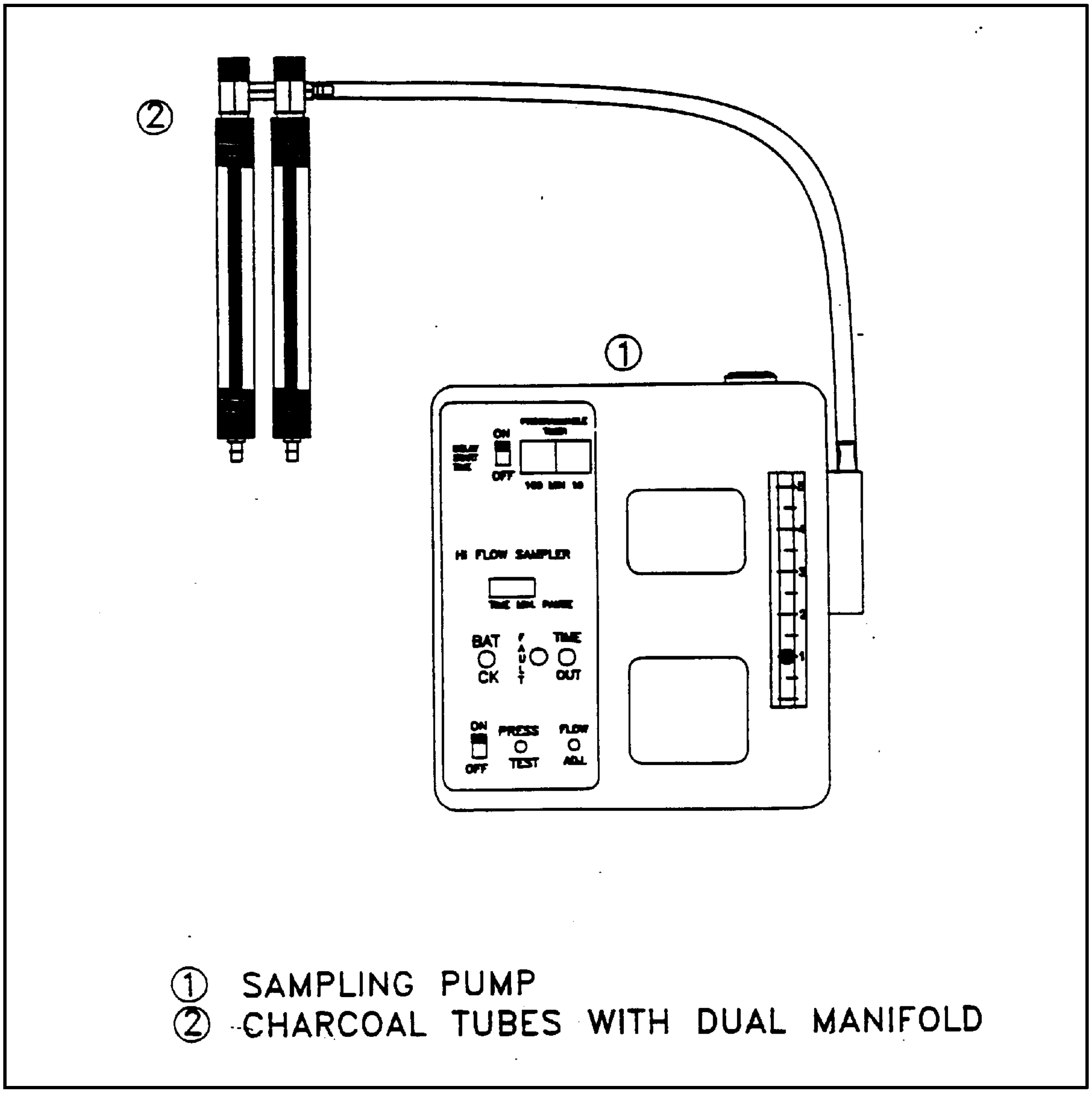
FIGURE 3. Charcoal Tube Sampling Train (No Manifold)



APPENDIX A (Cont'd)

Figures

FIGURE 4. Charcoal Tube Sampling Train (Dual Manifold for Collocated Sampling)



TENAX/CMS TUBE SAMPLING

SOP#: 2104
DATE: 10/19/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to define the procedure for air sampling using Tenax/Carbonized Molecular Sieve (CMS) tubes which identify specific contaminants in air. Compounds that can be determined by Tenax are non-polar organics having boiling points in the range of approximately 80E-100EC. Compounds which can be determined by CMS are non-polar and non-reactive organics having boiling points in the range 15EC to 120EC. However, not all compounds falling into these categories can be determined. Table 1 (Appendix A) lists many of the compounds which can be detected using Tenax/CMS. Analysis is performed by thermal desorption into a gas chromatograph/mass spectrometer (GC/MS).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Tenax/CMS tube sampling is performed by drawing a known volume of air through a Tenax absorbent followed by a CMS adsorbent. Volatile organic compounds are captured on the adsorbent while major inorganic atmospheric constituents pass through or are only partially retained. After sampling, the tube is returned to the laboratory for analysis using U.S. EPA Methods TO1 and TO2.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Tenax/CMS tubes contain a granular inert chemical compound with adsorbent properties. A flame-sealed outer glass tube protects the inner tube from contamination. This outer glass tube must be broken and the Tenax/CMS tube must be removed prior to sampling. The Tenax/CMS tube is 6.0 mm outside diameter (O.D.) and 4 mm inside diameter (I.D.) containing one section of 150-mg Tenax, 35/60 mesh and one section of 150-mg CMS 60/80 mesh.

After sampling is complete, the Tenax/CMS tubes are stored in culture tubes. Therefore, prior to site work, the culture tubes should be cleaned and prepared using the following procedure:

1. A plug of precleaned glass wool (methanol rinsed, baked in an oven at 120EC) is placed in the bottom of each tube.
2. The culture tubes are placed in an oven for at least two hours at 120EC. The Teflon lined caps are not baked.
3. The culture tubes are removed from the oven and allowed to cool.
4. The culture tubes are placed in a resealable bag or whirl bag.

Refrigerate the samples and keep out of sunlight. Storage for more than four weeks is not recommended.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination of the Tenax/CMS tubes with the compound(s) of interest is a common problem. To minimize this problem, the user must be extremely careful in the preparation, storage, and handling of the tube throughout the sampling and analysis process. To avoid contamination from skin oils, a lint-free glove must be used when handling Tenax/CMS tubes.

5.0 EQUIPMENT/APPARATUS

5.1 Equipment List

- Calibrated personal sampling pump
- Dual rotameter with stand and precalibrated flow rate
- Tenax/CMS tubes, preferably of the same lot number
- Flexible tygon tubing (for attaching the tube holder system to the suction side of the pump)
- Universal tube holder system
  - Dual variable manifold flow controller
  - Tube holder end with rubber boot adaptor
  - Sleeves - clear plastic housings
- Glass cracker
- Lint-free gloves
- Glass wool
- Teflon tape
- Culture tubes
- Screwdrivers
- Resealable bags
- Whirl bags
- Air Sampling Worksheets
- Chain of Custody records

5.2 Equipment Sources

Tenax/CMS tubes may be obtained from Supelco Inc., Bellefonte, PA, at (800) 247-6628; Technical Service (814) 359-3441 and MSA, 1-800-MSA-2222.

6.0 REAGENTS

Methanol is used in the laboratory to clean the culture tubes which hold the Tenax/CMS samples. This is performed prior to site work.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain and organize the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order. Precalibrate sampling equipment, if possible.
4. Prepare scheduling and coordinate with staff, client, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan.
6. Use stakes, flagging tape, or other appropriate means to mark all sampling locations. If necessary, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Calibration Procedures

Assemble the calibration train as shown in Figure 1 (Appendix B) using a dual rotameter, sampling pump, dual manifold, and representative Tenax/CMS tubes. The same lot number of Tenax/CMS tubes are used for both sampling and calibration.

1. Adjust the sampling pump to the low flow mode.
2. Remove the cap ends on the flow controller manifold. To adjust the flow, turn the needle valve with a small screwdriver (counter-clockwise to increase, clockwise to decrease).
3. Turn the flow adjust screw on each manifold until the float ball on the rotameter is lined up with the precalibrated flow rate value. A sticker on the rotameter should indicate this value.
4. Affix a sticker to the manifold and pump indicating the calibrated flow rate and media.
5. Remove the representative Tenax/CMS tubes from the sleeves.

The pump and manifold (including boots) are calibrated as a unit and should not be separated until the samples have been collected. See Table 2 (Appendix A) for recommended flow rates and sample volumes.

7.3 Field Operation

1. Calibrate the appropriate number of pumps with manifolds as described in Section 7.2. If the pumps were precalibrated, the calibration should be checked in the same manner. Fine tuning of the flow may be required.

2. Crack the outer glass tubes using a glass cracker.

3. Use a clean, lint-free cloth or gloves to remove the Tenax/CMS tubes from the outer glass housings.
4. Insert the Tenax/CMS tubes into a boot, with the CMS sections closest to the manifold.

5. Attach protective sleeves over the tubes. Do not enclose the Tenax/CMS tube ends.

6. Set up the sampling train, by attaching one end of the Tygon tubing (approx. two feet) to the manifold; and the other end to the inlet plug on the pump (Appendix B, Figure 2).

7. Place the sampling tubes in the breathing zone. The pump and tubes can be placed on a drum or hooked to a fence. A wooden dowel rod can also be used.

8. Place the tubes in either a vertical or horizontal position.

9. Adjust the pump time.

10. Turn on the pump.

11. Record weather data (e.g., ambient temperature, barometric pressure, relative humidity and wind direction) on the Air Sampling Worksheet.

12. Check the pump at the midpoint of the sampling period if longer than four hours.

7.4 Post-Operation Procedures

1. At the end of the sampling period, record the run time on the Air Sampling Worksheet.

2. Check the flow rate by attaching a rotameter with Tygon tubing and turning the pump on. Record the final flow rate on the Air Sampling Worksheet.

3. Remove the Tenax/CMS tubes from sleeves using a lint-free cloth or gloves.

4. Place the Tenax/CMS tubes in a culture tube. Pack with glass wool. Tenax/CMS tubes from the same manifold and identical flow rates must be placed in the same culture tube.

5. Place a sample sticker indicating sample ID# on the culture tube. Do not put a sample sticker on the Tenax/CMS tube itself as this will contaminate the tube.

6. Attach the culture tube lid and wrap the lid/tube interface with Teflon tape.

7. Place the culture tubes into a resealable bag or a whirl bag.

8. Keep the samples refrigerated and out of sunlight. Storage for more than four weeks is not recommended.

9. Prepare the samples, including QC samples, for transport by packing them in shipping containers with bubble wrap or styrofoam pieces. Complete a Chain of Custody record in accordance with the appropriate Chain of Custody Procedures.

8.0 CALCULATIONS

The total volume of a sample is calculated by multiplying the total sample time by the flow rate. The total volume for each sample should be indicated on the Chain of Custody record.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

The following specific QC activities apply:

1. Provide one field blank per 20 samples. This tube is handled in the same manner as a sampling tube (break, seal, and transport), except that no air is drawn through this tube.

2. Provide a minimum of one lot blank tube per sampling episode. These tubes are taken directly from the Tenax/CMS tube box. Do not break the outer glass housing. Place in a resealable bag and keep with other samples.

3. All sample stations should have duplicate sample tubes.

10.0 DATA VALIDATION

Results of the quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potential hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

Specific hazards associated with Tenax/CMS tube sampling include:

1. Small pieces of glass flying during "cracking" of the tube.

2. Access to sampling locations.

3. Environmental contaminants being sampled.

12.0 REFERENCES

U.S. EPA, *Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air*, EPA 600/4-84/041, December, 1984.

U.S. EPA, *Characterization of Hazardous Waste Sites - A Methods Summary: Volume II, Available Sampling Methods*, 2nd Edition, EPA 600/4-84/76, December, 1984.

APPENDIX A

Tables

TABLE 1. Air Analysis by GC/MS

Compound
Vinyl Chloride
Trichlorofluoromethane
1,1-Dichloroethene
Methylene Chloride
Trans-1,2-Dichloroethene
1,1-Dichloroethane
Bromochloromethane(1)
1,1,1-Trichloroethane
Carbon Tetrachloride
Benzene
1,2-Dichloroethane
Trichloroethylene
Toluene
Tetrachloroethylene
Ethylbenzene
m-Xylene
o-Xylene
Styrene
p-Bromofluorobenzene
Meta-Ethyltoluene
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
Dibromomethane
Trichloromethane
Bromodichloromethane
Chloroethane
Chloromethane

(1) Surrogate - Surrogates are injected into the Tenax/CMS tube to determine adsorption efficiencies.

APPENDIX A (Cont'd)

Tables

TABLE 2. Recommended Flow Rates and Sample Volumes

<u>Flow Rates</u>

Maximum	50 cc/min
Optimal	30-40 cc/min
Minimum	10 cc/min

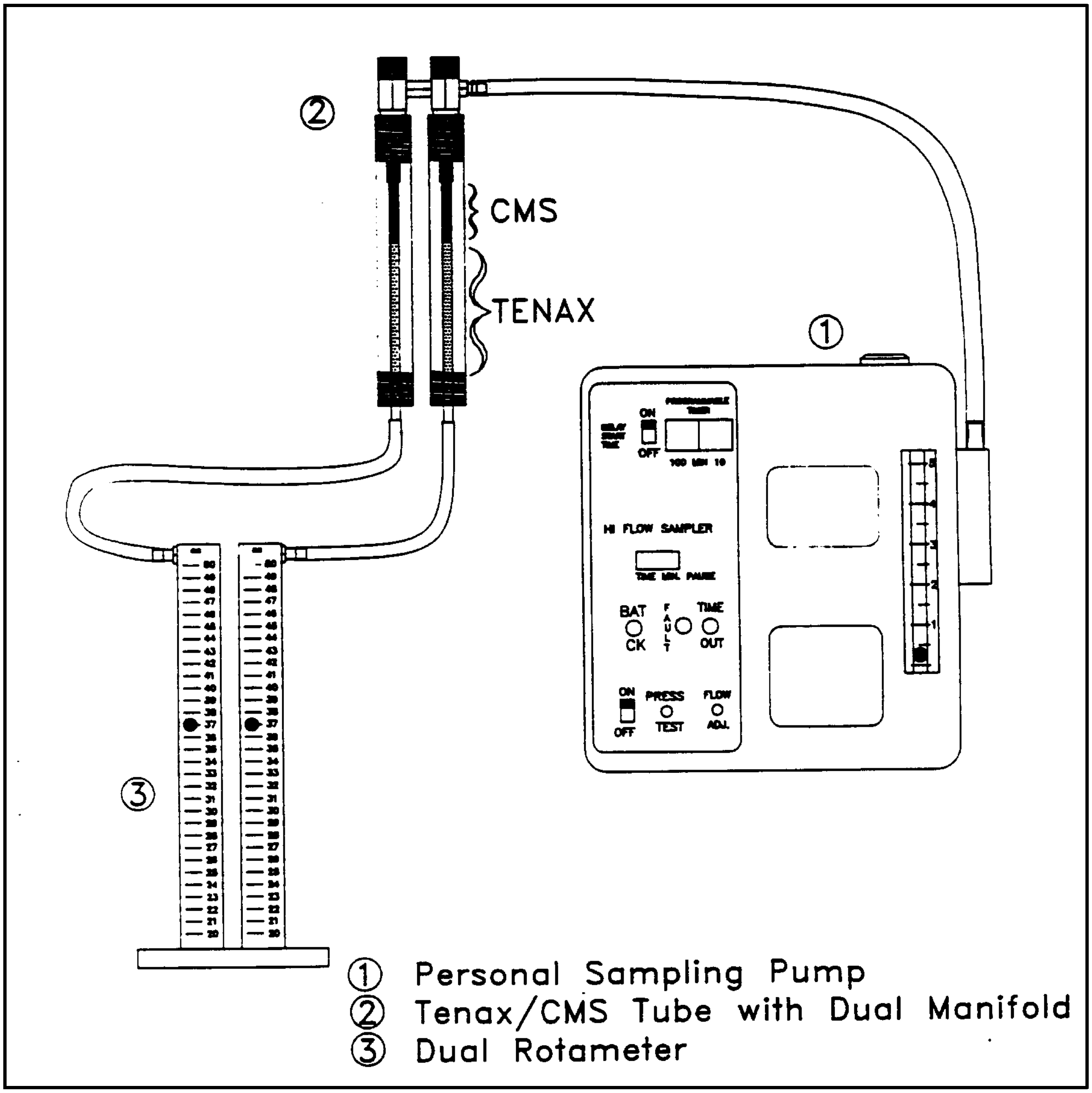
<u>Volumes</u>

Maximum	5 liters
Optimal	2 liters
Minimum	0.5 liters

APPENDIX B

Figures

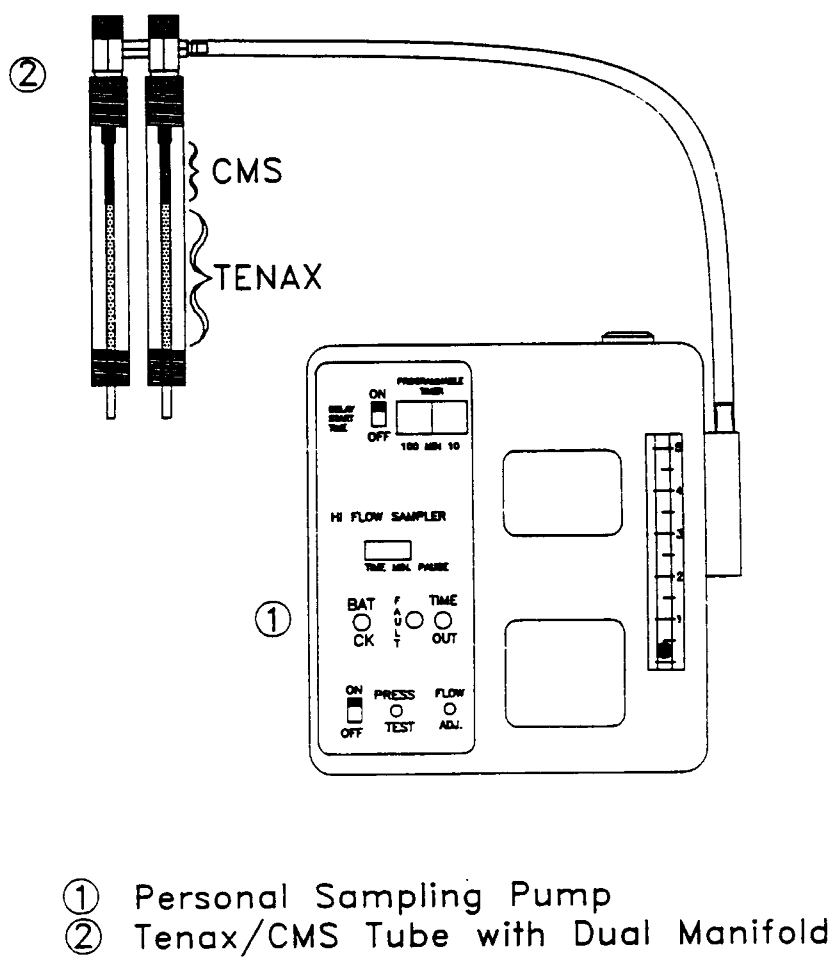
FIGURE 1. Tenax/CMS Calibration Train



APPENDIX B (Cont'd)

Figures

FIGURE 2. Tenax/CMS Sampling Train



PHOTOIONIZATION DETECTOR (PID) HNU

SOP#: 2114
DATE: 10/06/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for using a photoionization detector (PID). The PID is a portable, nonspecific, vapor/gas detector employing the principle of photoionization to detect a variety of chemical compounds, both organic and inorganic, in air. This procedure is applicable to the HNU PI-101, HNU ISPI-101, and HW-101 used for air monitoring.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

The PID is a useful general survey instrument at hazardous waste sites. A PID is capable of detecting and measuring real-time concentrations of many organic and inorganic vapors in air. A PID is similar to a flame ionization detector (FID) in application; however, the PID has somewhat broader capabilities in that it can detect certain inorganic vapors. Conversely, the PID is unable to respond to certain low molecular weight hydrocarbons, such as methane and ethane, that are readily detected by FID instruments.

The PID employs the principle of photoionization. The analyzer will respond to most vapors that have an ionization potential less than or equal to that supplied by the ionization source, which is an ultraviolet (UV) lamp. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and form a positive ion. This will occur when the ionization potential of the molecule in electron volts (eV) is less than the energy of the photon. The sensor is housed in a probe and consists of a sealed ultraviolet light source that emits photons with an energy level high enough to ionize many trace organics, but not enough to ionize the major components of air (e.g., nitrogen, oxygen, carbon dioxide). The ionization chamber exposed to the light source contains a pair of electrodes, one a bias electrode, and the second the collector electrode. When a positive potential is applied to the bias electrode, an electro-magnetic field is created in the chamber. Ions formed by the adsorption of photons are driven to the collector electrode. The current produced is then measured and the corresponding concentration displayed on a meter, directly, in units above background. Several probes are available for the PID, each having a different eV lamp and a different ionization potential. The selection of the appropriate probe is essential in obtaining useful field results. Though it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases and, therefore, indicates an integrated response to the mixture.

Three probes, each containing a different UV light source, are available for use with the HNU. Energies are 9.5, 10.2, and 11.7 eV. All three detect many aromatic and large molecular hydrocarbons. The 10.2 eV and 11.7 eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as it is more durable than the 11.7 eV probe and detects more compounds than the 9.5 eV probe.

Gases with ionization potentials near to or less than that of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials higher than that of the lamp will not be detected. Ionization potentials for various atoms, molecules, and compounds are given in

Table 1 (Appendix A). The ionization potential of the major components of air, oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to about 15.6 eV and are not ionized by any of the three lamps.

Table 2 (Appendix A) illustrates ionization sensitivities for a large number of individual species when exposed to photons from a 10.2 eV lamp. Applications of each probe are included in Table 3 (Appendix A).

While the primary use of the HNU is as a quantitative instrument, it can also be used to detect certain contaminants, or at least to narrow the range of possibilities. Noting instrument response to a contaminant source with different probes can eliminate some contaminants from consideration. For instance, a compound's ionization potential may be such that the 9.5 eV probe produces no response, but the 10.2 eV and 11.7 eV probes do elicit a response.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 PID Instrument Limitations

1. The PID is a nonspecific total vapor detector. It cannot be used to identify unknown substances; it can only roughly quantify them.

2. The PID must be calibrated to a specific compound.

3. The PID does not respond to certain low molecular weight hydrocarbons, such as methane and ethane. In addition, the HNU does not detect a compound if the probe has a lower energy than the compound's ionization potential.

4. Certain toxic gases and vapors, such as carbon tetrachloride and hydrogen cyanide, have high ionization potentials and cannot be detected with a PID.

5. Certain models of PID instruments are not intrinsically safe. The HNU PI-101 and HW-101 are not designed for use in potentially flammable or combustible atmospheres. Therefore, these models should be used in conjunction with a Combustible Gas Indicator. The ISPI-101 is intrinsically safe, however.

6. Electrical power lines or power transformers may cause interference with the instrument and thus cause measurement errors. Static voltage sources such as power lines, radio transmissions, or transformers may also interfere with measurements.

7. High winds and high humidity will affect measurement readings. The HNU may become unusable under foggy or humid conditions. An indication of this is the needle dropping below zero, or a slow constant climb on the read-out dial.

8. The lamp window must be periodically cleaned to ensure ionization of the new compounds by the probe (i.e., new air contaminants).

9. The HNU measures concentrations from about 1-2000 ppm, although the response is not linear over this entire range. For example, if calibrated to benzene, the response is linear from about 0-600 units above background. This means the HNU reads a true concentration of benzene only between 0 and 600. Greater concentrations are detected at a lower level than the true value.

10. This instrument is not to be exposed to precipitation (rain). The units are not designed for this service.

11. Do not use this instrument for head space analysis where liquids can inadvertently be drawn into the probe.

4.2 Regulatory Limitations

Transport of calibration gas cylinders by passenger and cargo aircraft must comply with International Air Transport Association (IATA) Dangerous Goods

Regulations or the U.S. Code of Federal Regulations, 49 CFR Parts 100-177. A typical calibration gas included with a PID is isobutylene. It is classified as a non-flammable gas, UN #1556 and the proper shipping name is Compressed Gas. It must be shipped by cargo aircraft only.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for PID operation:

- PID (HNU)
- Operating manual
- Probes: 9.5 eV, 10.2 eV, or 11.7 eV
- Battery charger for PID
- Spare batteries
- Jeweler's screwdriver for adjustments
- Tygon tubing
- NBS traceable calibration gas
- "T" valve for calibration
- Field Data Sheets/Site Logbook
- Intake assembly extension
- Strap for carrying PID
- Teflon tubing for downhole measurements
- Plastic bags for protecting the PID from moisture and dirt

Note: Battery charge status - This instrument may be kept on continuous charge without battery damage.

6.0 REAGENTS

- Isobutylene standards for calibration
- Benzene reference standard
- Methanol for cleaning ionization chamber (GC grade)
- Mild soap solution for cleaning unit surfaces
- Specific gas standards when calibrating to a specific compound
- Light source cleaning compound Cat. No. PA101534-A1 (For use only with 9.5 and 10.2 lamps)

The HNU is calibrated in accordance with the operations manual using isobutylene as the calibration standard. The operations manual may also be referred to for alternate calibration to a specific compound.

7.0 PROCEDURES

7.1 Preparation

Check out and ensure the proper operation of the PID, as appropriate, using the equipment checklist provided in Sections 5.0 and 6.0 and the steps listed below.

7.2 Start-Up Procedures

1. Allow the temperature of the unit to equilibrate to its surrounding. This should take about five minutes.

2. Attach the probe to the read-out unit. Match the alignment key, then twist the connector clockwise until a distinct locking is felt. Make sure the microswitch (red button) is depressed by the locking ring.

3. Turn the FUNCTION switch to the battery check position. Check to ensure that the indicator reads within or beyond the green battery arc on the scale plate. If the indicator is below the green arc, or if the red LED comes on, the battery must be charged prior to using.

4. To zero the instrument, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15-20 seconds to ensure that the zero adjustment is stable; if not, then readjust.

5. Check to see that the SPAN POTENTIOMETER is set at the appropriate setting for the probe being used (i.e., 9.8 for the 10.2 eV probe, 5.0 for the 11.7 eV probe, 1 for the 9.5 eV probe. Note: The setting may vary based on the intensity of the light source).

6. Set the FUNCTION switch to the desired range (i.e., 0-20, 0-200, 0-2000).

7. Listen for the fan operation to verify fan function.

8. Look for ultraviolet light source in the probe to verify function. Do not look at light source from closer than six inches with unprotected eyes, observe only briefly.

9. Check instrument with an organic point source, such as a magic marker, prior to survey to verify instrument function.

10. Routinely during the day, verify the useful battery life by turning the function switch to BATT and schedule the instrument's use accordingly.

7.3 Field Operation

7.3.1 Field Calibration

1. Follow the start-up procedure in Section 7.2.

2. Set the FUNCTION switch to the range setting which includes the concentration of the calibration gas.

3. Attach a regulator to a disposable cylinder of calibration gas. Connect the regulator to the probe of the HNU with a piece of clean tygon tubing. Open the valve on the regulator.

4. After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is within ±15% of the response value, then the instrument can be field calibrated to the response value using the external SPAN ADJUSTMENT control. The SPAN ADJUSTMENT control should be adjusted to a lower setting until the correct reading has been obtained. The lower the number on the SPAN ADJUSTMENT conrol, the greater the instrument sensitivity. If the SPAN ADJUSTMENT control has to be adjusted below a setting of 4.00, the unit should be red-tagged and returned for repairs.

5. If the meter reading is greater than ±15% of the response value of the calibration gas used, then the instrument should be red-tagged and returned for re-calibration.

6. Record the following information in the site logbook: the instrument ID number (U.S. EPA decal or serial number if the instrument is a rental), the initial and final span settings, the date and time, concentration and type of calibration gas used, and the name of the person who field calibrated the instrument.

7. If the PID does not start up, check out, or calibrate properly, the instrument should not be used. Under no circumstances is work requiring air monitoring with a PID to be done without a proper functioning instrument.

8. In some field applications, with the exception of the probe's inlet and exhaust, the PID should be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation.

7.3.2 Operation

1. All readings are to be recorded in the site logbook. Readings should be recorded, following background readings, as "units above background," not ppm.

2. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual. The instructions in the operating manual should be followed explicitly in order to obtain accurate results.

3. Position the probe assembly close to the area to be monitored because the low sampling rate allows for only very localized readings. Under no circumstances should the probe tip assembly be immersed in fluid.

4. While taking care to prevent the PID from being exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the site Health and Safety Plan. The PID survey should be conducted at a slow to moderate rate of speed and the intake assembly (the probe) slowly swept from side to side. There is a three to five second delay in read-out depending upon the instruments sensitivity to the contaminant.

5. During drilling activities, PID monitoring is performed at regular intervals downhole, at the headspace, and in the breathing zone. In addition, where elevated organic vapor levels are encountered, monitoring may be performed in the breathing zone during actual drilling. When the activity being monitored is other than drilling, readings should emphasize breathing zone conditions.

6. When the activity is completed or at the end of the day, carefully clean the outside of the PID with a damp disposable towel to remove any visible dirt.

7.4 Post Operation

1. Turn FUNCTION Switch to OFF.

2. Return the PID to a secure area and check the calibration (Section 7.3.1.) before charging. Connect the instrument to charger and plug in the charger. The probe must be connected to the readout unit to charge the HNU.

3. Complete logbook entries, verifying the accuracy of entries and signing/initialing all pages. Following completion of a series of "0" readings, verify the instrument is working as in Section 7.3.1.

4. Check the equipment, repair or replace damaged equipment, and charge the batteries.

7.5 Equipment Calibration

1. Follow the start-up procedure in Section 7.2.

2. Set the FUNCTION switch to the range setting which includes the concentration of the calibration gas.

3. Attach a regulator to a cylinder of calibration gas. Connect the regulator to the probe of the NHU with a piece of clean tygon tubing. Open the valve on the regulator.

4. After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is greater than ±15% of the actual concentration, an internal calibration is necessary. Unlock the SPAN POTENTIOMETER dial before adjusting it. Adjust the SPAN POTENTIOMETER to the span setting recommended for the probe being used (i.e., 9.8 for the 10.2 eV probe, 5.0 for the 11.7 eV probe, 1 for the 9.5 eV probe). To calibrate the instrument, unscrew the bottom support screw and lift the instrument out of the case. Locate and adjust the trimpot "R-32" (near the top of the printed circuit board) by inserting a small screwdriver and gently turning. When the instrument gives the correct reading for the calibration gas being used, reassemble it.

5. Record the following information in the calibration logbook: the instrument identification number (U.S. EPA barcode number or serial number if the instrument is a rental), the initial and final span settings, the date and time, concentration and type of calibration gas used, and the name of the person who calibrated the instrument. Affix a sticker to the instrument indicating the person who performed the calibration, the date of calibration, and the due date of the next calibration.

6. Turn the FUNCTION switch to OFF and connect the instrument to the charger. The probe must be connected to the readout unit to ensure that the unit accepts a charge.

8.0 CALCULATIONS

The HNU is a direct reading instrument. Readings are interpreted as units above background rather than ppm.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in

accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, or corporate health and safety practices.

The HNU is certified by OSHA standards for use in Class 1, Division 2, Groups A, B, C, and D locations.

12.0 REFERENCES

HNU Systems, Inc. 1975. "Instruction Manual for Model PI-101 Photoionization Analyzer."

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation, revised November 1, 1985.

U.S. Environmental Protection Agency. 1984. "Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition", EPA-600/4-84-076, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada.

International Air Transport Association Dangerous Goods Regulations

APPENDIX A

Tables

TABLE 1. Ionization Potentials

SOME ATOMS AND SIMPLE MOLECULES

Molecule	IP(Ev)	Molecule	IP (eV)
H	13.595	I_2	9.28
C	11.264	HF	15.77
N	14.54	HCl	12.74
O	13.614	HBr	11.62
Si	8.149	HI	10.38
S	10.357	SO_2	12.34
F	17.42	CO_2	13.79
Cl	13.01	COS	11.18
Br	11.84	CS_2	10.08
I	10.48	N_2O	12.90
H_2	15.426	NO_2	9.78
N_2	15.580	O_3	12.80
O_2	12.075	H_2O	12.59
CO	14.01	H_2S	10.46
CN	15.13	H_2Se	9.88
NO	9.25	H_2Te	9.14
CH	11.1	HCN	13.91
OH	13.18	C_2N_2	13.8
F_2	15.7	NH_3	10.15
Cl_2	11.48	CH_3	9.840
Br_2	10.55	CH_4	12.98

PARAFFINS AND CYCLOPARAFFINS

Molecule	IP (eV)
Methane	12.98
Ethane	11.65
Propane	11.07
n-Butane	10.63
I-Butane	10.57
n-Pentane	10.35
ii-Pentane	10.32
2,2-Dimethylpropane	10.35
n-Hexane	10.18
2-Methylpentane	10.12
3-Methylpentane	10.08
2,2-Dimethylbutane	10.06
2,3-Dimethylbutane	10.02
n-Heptane	10.08
2,2,4-Trimethylpentane	9.86
Cyclopropane	10.06
Cyclopentane	10.53
Cyclohexane	9.88
Methylcyclohexane	9.85

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

ALKYL HALIDES

Molecule	IP (eV)	Molecule	IP (eV)
HCl	12.74	1-bromo-2-methylpropane	10.09
Cl_2	11.48	2-bromo-2-methylpropane	9.89
CH_4	12.98	1-bromopentane	10.10
Methyl chloride	11.28	HI	10.38
Dichloromethane	11.35	I_2	9.28
Trichloromethane	11.42	Methyl iodide	9.54
Tetrachloromethane	11.47	Diiodomethane	9.34
Ethyl chloride	10.98	Ethyl iodide	9.33
1,2-Dichloroethane	11.12	1-iodopropane	9.26
1,3-Dichloropropane	10.85	2-iodopropane	9.17
1-chlorobutane	10.67	1-iodobutane	9.21
2-chlorobutane	10.65	2-iodobutane	9.09
1-chloro-2-methylpropane	10.66	1-iodo-2-methylpropane	9.18
2-chloro-2-methylpropane	10.61	2-iodo-2-methylpropane	9.02
HBr	11.62	1-iodopentane	9.19
Br_2	10.55	F_2	15.7
Methyl bromide	10.53	HF	15.77
Dibromomethane	10.49	$CFCl_3$ (Freon 11)	11.77
Tribomomethane	10.51	CF_2Cl_2 (Freon 12)	12.31
CH_2BrCl	10.77	CF_3Cl (Freon 13)	12.91
$CHBr_2Cl$	10.59	$CHClF_2$ (Freon 22)	12.45
Ethyl bromide	10.29	CF_2Br_2	11.67
1,1-dibromoethane	10.19	CH_3CF_2Cl (Genetron 101)	11.98
1-bromo-2-chloroethane	10.63	$CFCl_2CF_2Cl$	11.99
1-bromopropane	10.18	CF_3CCl_3 (Freon 113)	11.78
2-bromopropane	10.075	$CFHBrCH_2Br$	10.75
1,3-dibromopropane	10.07	CF_2BrCH_2Br	10.83
1-bromobutane	10.13	CF_3CH_2l	10.00
2-bromobutane	9.98	$n\text{-}C_3F_7l$	10.36
1-chloropropane	10.82	$n\text{-}C_3F_7CH_2Cl$	11.84
2-chloropropane	10.78	$n\text{-}C_3F_7CH_2l$	9.96
1,2-dichloropropane	10.87	CF_2Br_2	11.07

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

ALIPHATIC ALCOHOL, ETHER, THIOL, AND SULFIDES

Molecule	IP (eV)
Water	12.59
Methyl alcohol	10.85
Ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.16
n-butyl alcohol	10.04
Dimethyl ether	10.00
Diemthyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
Hydrogen Sulfide	10.46
Methanethiol	9.440
Ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
Dimethyl sulfide	8.685
Ethyl methyl sulfide	8.55
Diethyl sulfide	8.430
di-n-propyl sulfide	8.30

ALIPHATIC ALDEHYDES AND KETONES

Molecule	IP (eV)
Carbon Dioxide	13.79
Formaldehyde	10.87
Acetaldehyde	10.21
Propionaldehyde	9.98
n-butyraldehyde	9.86
Isobutyraldehyde	9.74
n-valeraldehyde	9.82
Isovaleraldehyde	9.71
Acrolein	10.10
Crotonaldehyde	9.73
Benzaldehyde	9.53
Acetone	9.69
Methyl ethyl ketone	9.53
Methyl n-propyl ketone	9.39
Methyl i-propyl ketone	9.32
Diethyl ketone	9.32
Methyl n-butyl ketone	9.34
Methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
Cyclopentanone	9.26
Cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

ALIPHATIC ACIDS AND ESTERS

Molecule	IP (eV)
Carbon Dioxide	13.79
Formic acid	11.05
Acetic acid	10.37
Propionic acid	10.24
n-butyric acid	10.16
Isobutyric acid	10.02
n-valeric acid	10.12
Methyl formate	10.815
Ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
Isobutyl formate	10.46
Methyl acetate	10.27
Ethyl acetate	10.11
n-propyl acetate	10.04
Isopropyl acetate	9.99
n-butyl acetate	10.01
Isobutyl acetate	9.97
Sec-butyl acetate	9.91
Methyl propionate	10.15
Ethyl propionate	10.00
Methyl n-butyrate	10.07
Methyl isobutyrate	9.98

ALIPHATIC AMINES AND AMIDES

Molecule	IP (eV)
Ammonia	10.15
Methyl amine	8.97
Ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
Dimethyl amine	8.24
Diethyl amine	8.01
Di-n-propyl amine	7.84
Di-i-propyl amine	7.73
Di-n-butyl amine	7.69
Trimethyl amine	7.82
Triethyl amine	7.50
Tri-n-propyl amine	7.23
Formamide	10.25
Acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

OTHER ALIPHATIC MOLECULES WITH N ATOM

Molecule	IP (eV)
Nitromethane	11.08
Nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
Acetontrile	12.22
Propiontrile	11.84
n-butyronitrile	11.67
Acrylonitrile	10.91
3-butene-nitrile	10.39
Ethyl nitrate	11.22
Methyl thiocyanate	10.065
Ethyl thiocyanate	9.89
Methyl isothiocyanate	9.25
Ethyl isothiocyanate	9.14

OLEFINS, CYCLO-OLEFINS, ACETYLENES

Molecule	IP (eV)
Ethylene	10.515
Propylene	9.73
1-butene	9.58
2-methylpropene	9.23
Trans-2-butene	9.13
Cis-2-butene	9.13
1-pentene	9.50
2-methyl-1-butene	9.12
3-methyl-1-butene	9.51
3-methyl-2-butene	8.67
1-hexene	9.46
1,3-butadiene	9.07
Isoprene	8.845
Cyclopentene	9.01
Cyclohexene	8.945
4-methylcyclohexene	8.91
4-cinylcylohexene	8.93
Cyclo-octatetraene	7.99
Acetylene	11.41
Propyne	10.36
1-butyne	10.18

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

SOME DERIVATIVES OF OLEFINS

Molecule	IP (eV)
Vinyl chloride	9.995
Cis-dichloroethylene	9.65
Trans-dichloroethylene	9.66
Trichloroethylene	9.45
Tetrachloroethylene	9.32
Vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
$CF_3CCl=CClCF_3$	10.36
n-$C_5F_{11}CF=CF_2$	10.48
Acrolein	10.10
Crotonaldehyde	9.73
Mesityl oxide	9.08
Vinyl methyl ether	8.93
Allyl alcohol	9.67
Vinyl acetate	9.19

HETEROCYCLIC MOLECULES

Molecule	IP (eV)
Furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
Tetrahydrofuran	9.54
Dihydropyran	8.34
Tetrahydropyran	9.26
Thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
Pyrrole	8.20
Pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85
Tribromoethylene	9.27

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

AROMATIC COMPOUNDS

Molecule	IP (eV)	Molecule	IP (eV)
Benzene	9.245	Phenyl isothiocyanate	8.520
Toluene	8.82	Benzonitrile	9.705
Ethyl benzene	3.76	Nitrobenzene	9.92
n-propyl benzene	8.72	Aniline	7.70
i-propyl benzene	8.69	Fluoro-benzene	9.195
n-butyl benzene	8.69	Chloro-benzene	9.07
s-butyl benzene	8.68	Bromo-benzene	8.98
t-butyl benzene	8.68	Iodo-benzene	8.73
o-xylene	8.56	o-dichlorobenzene	9.07
m-xylene	8.56	m-dichlorobenzene	9.12
p-xylene	8.445	p-dichlorobenzene	8.94
Mesitylene	8.40	1-chloro-2-fluorobenzene	9.155
Durene	8.025	1-chloro-3-fluorobenzene	9.21
Styrene	8.47	1-bromo-4-fluorobenzene	8.99
o-methyl styrene	8.35	o-fluorotoluene	8.915
Ethynylbenzene	8.815	m-fluorotoluene	8.915
Napthalene	8.12	p-fluorotoluene	8.785
1-methylnapthalene	7.69	o-chlorotoluene	8.83
2-methylnapthalene	7.955	m-chlorotoluene	8.83
Biphenyl	8.27	p-chlorotoluene	8.70
Phenol	8.50	o-bromotoluene	8.79
Anisole	8.22	m-bromotoluene	8.81
Phenetole	8.13	p-bromotoluene	8.67
Benzaldehyde	9.53	o-iodotoluene	8.62
Acetophenone	9.27	m-iodotoluene	8.61
Benzenethiol	8.33	p-iodotoluene	8.50
Phenyl isocyanate	8.77	Benzotrifluoride	9.68
		o-fluorophenol	8.66

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

MISCELLANEOUS MOLECULES

Molecule	IP (eV)
Ethylene oxide	10.565
Propylene oxide	10.22
p-dioxane	9.13
Dimethoxymethane	10.00
Diethyoxymethane	9.70
1,1-dimethoxyethane	9.65
Propiolactone	9.70
Methyl disulfide	8.46
Ethyl disulfide	8.27
Diethyl sulfite	9.68
Thiolacetic acid	10.00
Acetyl chloride	11.02
Acetyl bromide	10.55
cyclo-$C_6H_{11}CF_3$	10.46
$(n\text{-}C_3F_7)(CH_3)C{=}O$	10.58
Trichlorovinylsilane	10.79
$(C_2F_5)_3N$	11.7
Isoprene	9.08
Phosgene	11.77

APPENDIX A (Cont'd)

Tables

TABLE 2. Relative Photoionization Sensitivities for Gases

Chemical	Relative Sensitivity	Examples
Aromatic	10	Benzene, Toluene, Styrene
Aliphatic Acid	10	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	7-9	MEK, MiBK, Acetone, Cyclohexanone
Unsaturated	3-5	Acrolein, Propylene, Cyclohexanone, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C5-C7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	
Paraffin (C1-C4)	0	Methane, Ethane

NOTE: Relative sensitivity = meter reading when measuring 10 ppm of the listed gas with instrument with 10.2 eV probe calibrated for 10 ppm of benzene, span pot setting = 9.8 for direct reading of benzene.

APPENDIX A (Cont'd)

Tables

TABLE 3. Typical Applications of Interchangeable Probes

	Ionization Potentials	Relative Sensitivity	
p-Xylene	8.44	0.10	0.104
p-Chlorotoluene	8.70	0.09	0.112
Toluene	8.82	0.09	0.112
o-Chlorotoluene	8.83	0.075	0.112
Ethyl Acetate	9.19	0.075	0.112
Benzene	9.24	0.10	0.10
Methyl Mercaptan	9.24	0.10	0.072
Pyridine	9.32	0.075	0.122
Allyl Alcohol	9.67	0.10	0.111
Crotonaldehyde	9.88	0.075	0.104
Amyl Alcohol	9.80	0.09	0.116
Cyclohexane	9.88	0.075	0.104
Vinyl Chloride	9.95	0.085	0.112
Butanol	10.94	0.09	0.176
Ammonia	10.15	0.06	0.160
Acetic Acid	10.37	0.04	0.560
Ethylene	10.52	0.0	0.320
Ethylene Oxide	10.56	0.0	0.298

$$\text{Relative sensitivity} = \frac{\text{Response with 9.5 or 11.7 eV probe}}{\text{Response with 10.2 eV probe}}$$

AIR SAMPLING FOR METALS
[NIOSH Method 7300, Elements]

SOP#: 2119
DATE: 10/07/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to define the proper sample collection technique for air sampling for elements (metals), as well as delineate the typical working range of the method and indicate potential interferences. Elements covered by this method include the metals listed in Table 1 (Appendix A).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Air sampling for elements (metals) involves passing a known quantity of air across a mixed cellulose ester (MCE) filter. The particulate phase of the air, with a nominal size of greater than or equal to 0.8 microns (µm), is trapped in the filter.

This method requires air sampling utilizing 37 millimeter (mm), 3-stage cassettes loaded with 0.8 um MCE filters and support pads. The approximate minimum and maximum sample volumes required for detection of the metals of interest are listed in Table 1 (Appendix A).

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

No preservatives or special storage conditions are required. However, the samples should be stored with the filter upright and transported at or near ambient conditions to prevent significant deterioration of the samples. When transporting and handling the samples, prevent impact and vibrations which would dislodge particulates from the filters.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

A potential problem with the sampling method is over-loading of the filter. This can disrupt flow, consequently producing falsely low analytical results. Periodic checking of the filter and pump can predict this condition and sample cassettes can be changed during the sampling period. The multiple filters would be analyzed as one sample with the total volume indicated on the Chain of Custody record.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for air sampling for elements:

C Low or medium volume air pumps
C Tygon tubing
C 0.8 µm MCE filters with support pads
C 37 mm 3-stage cassettes
C Hose-barb filter adapters
C Air flow calibration standard (calibrated rotameter or bubble meter)
C Screw driver set
C Air Sampling Worksheets and sample labels
C Chain of Custody records
C Particulate monitoring equipment (RAM)
C Protective clothing
C Whirl bags

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain and organize the necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order. Precalibrate sampling equipment, if possible.

4. Prepare scheduling and coordinate with staff, client, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan.

6. Use stakes, flagging tape, or other appropriate means to mark all sampling locations. If necessary, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7. Make an estimate of the airborne concentrations of the elements of concern. It may be possible to extrapolate the concentration of particulates by assuming similar percentages of metals are present in the airborne particulates as in the soils. However, it should be noted that this is only a rough estimate. If estimation of the airborne concentration of metals is not possible, then sample volumes should remain within the limits recommended in Table 1 (Appendix A).

8. Arrange for sample analysis by an appropriately certified laboratory and check with the laboratory for any special requirements (e.g., additional lot blanks).

7.2 Calibration

Calibrate the required number of sampling pumps in the following manner:

1. Assemble the calibration train as shown in Figure 1 (Appendix A) using a representative 37 mm, 3-stage filter cassette loaded with a 0.8 µm MCE filter and support pad (outlet plug removed), tygon tubing, a hose-barb filter adapter, a rotameter, and an air sampling pump. Depending on the required flow rate, a low volume or a medium volume sampling pump may be required. Refer to Figure 2 (Appendix A) for an illustration of the components of the filter cassette.

2. Turn on the pump and adjust the flow using the flow adjust mechanism until the float ball on the rotameter is aligned with the rotameter's precalibrated flow rate value. A sticker on the rotameter should indicate this value.

3. Affix a sticker to the pump indicating flow rate and media.

7.3 Sampling

1. Assemble the sampling trains with clean filter cassettes (Figures 3 and 4, Appendix A).

2. Verify the pump calibration by removing the inlet plug from the cassette, attaching a rotameter with Tygon tubing and turning on the sampling pump. Ensure that all connections are tight. Record the actual flow rate on the Air Sampling Worksheet. Replace the inlet plug until ready to sample.

3. Set the sampling pump timer (low volume pumps) for the appropriate sampling time as determined by the Work Assignment Manager, or record the elapsed timer readings (medium volume pumps) on the Air Sampling Worksheet. This will be dictated by the type of sampling pump being utilized.

4. Deploy the sampling pumps as indicated in the sampling plan, following site health and safety procedures.

5. Remove the cassette cap or inlet plug from the cassette. Sampling for elements can be conducted with the cassettes open-faced (cassette cap removed) or closed-faced (only inlet port plug removed). Open-faced is preferred because it permits an even loading of the filter cassette and should be used

whenever high particulate concentrations are expected. This allows greater particulate loading of the filter. However, either method is acceptable since the entire filter is used during sample analysis. Closed-faced sampling is typically performed when there is a possibility that the sample may be shaken and particulates may be lost.

6. Turn on the sampling pump and allow it to run for the sampling period determined by the Work Assignment Manager.

7.4 Post Sampling

1. Verify the sampling period by reading the sample run time (low volume pumps) or by checking the elapsed time on the counter (medium volume pumps). Record the sampling time on the Air Sampling Worksheet and turn off the pump.

2. Verify the pump calibration by attaching a rotameter with Tygon tubing and turning on the sampling pump. Record the actual flow rate on the Air Sampling Worksheet. Insert the inlet plug.

3. Remove the sampling cassette from the sampling train and insert the outlet plug.

4. Complete the Air Sampling Worksheet and calculate the sample volume.

5. Label the sample and place it in a whirl bag for transport to the laboratory for analysis.

6. Prepare the samples (including QC samples) for transport by packing them in a shipping container with bubble wrap or styrofoam pieces. Complete a Chain of Custody record in accordance with applicable Chain of Custody Procedures.

8.0 CALCULATIONS

The total volume of a sample is calculated by multiplying the total sample time by the flow rate. The total volume for each sample must be indicated on the Chain of Custody Record.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general QA procedures apply:

1. All data must be documented on Air Sampling Worksheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

The following specific QC activities apply:

1. Provide one field blank per sampling event or per 20 samples, whichever is greater. The field blank should be handled in the same manner as the sampling cassette (remove/replace cap and plug, and transport) except that no air is drawn through it.

2. Collect one collocated sample per sampling event or per 10 samples, whichever is greater. Collocated samples are two samples collected adjacent to each other during the same time period at the same flow rates.

3. Include a minimum of two lot blanks per manufacturer's lot of sampling cassettes utilized per sampling event. Consult with the analytical laboratory to determine if additional lot blanks are required.

10.0 DATA VALIDATION

Results of the QA/QC samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, or corporate health and safety procedures.

12.0 REFERENCES

(1)NIOSH Manual of Analytical Methods, NIOSH Method 7300, Elements (ICP) (Issued 02/15/84).

APPENDIX A

Table

TABLE 1. Metal Concentrations are Anticipated to be at or Near the Threshold Limit Value (TLV)

Element (Symbol)	Minimum Air Volume to be collected - Liters	Maximum Air Volume to be collected - Liters
Silver (Ag)	250	2000
Aluminum (Al)	5(1)	100(1)
Arsenic (As)	5	2000
Beryllium (Be)	1250	2000
Calcium (Ca)	5	200
Cadmium (Cd)	13	2000
Cobalt (Co)	25	2000
Chromium (Cr)	5	1000
Copper (Cu)	5	1000
Iron (Fe)	5	100
Lithium (Li)	100	2000
Magnesium (Mg)	5	67
Manganese (Mn)	5	200
Molybdenum (Mo)	5	67
Sodium (Na)	13	2000
Nickel (Ni)	5	1000
Phosphorus (P)	25(1)	2000(1)
Lead (Pb)	50	2000
Platinum (Pt)	1250	2000
Selenium (Se)	13	2000
Tin (Sn)	5	500
Tellurium (Te)	25	2000
Titanium (Ti)	5	100
Thallium (TI)	25	2000
Vanadium (V)	5	2000
Tungsten (W)	5(1)	200(1)
Yttrium (Y)	5	1000
Zinc (Zn)	5	200
Zirconium (Zr)	5	200

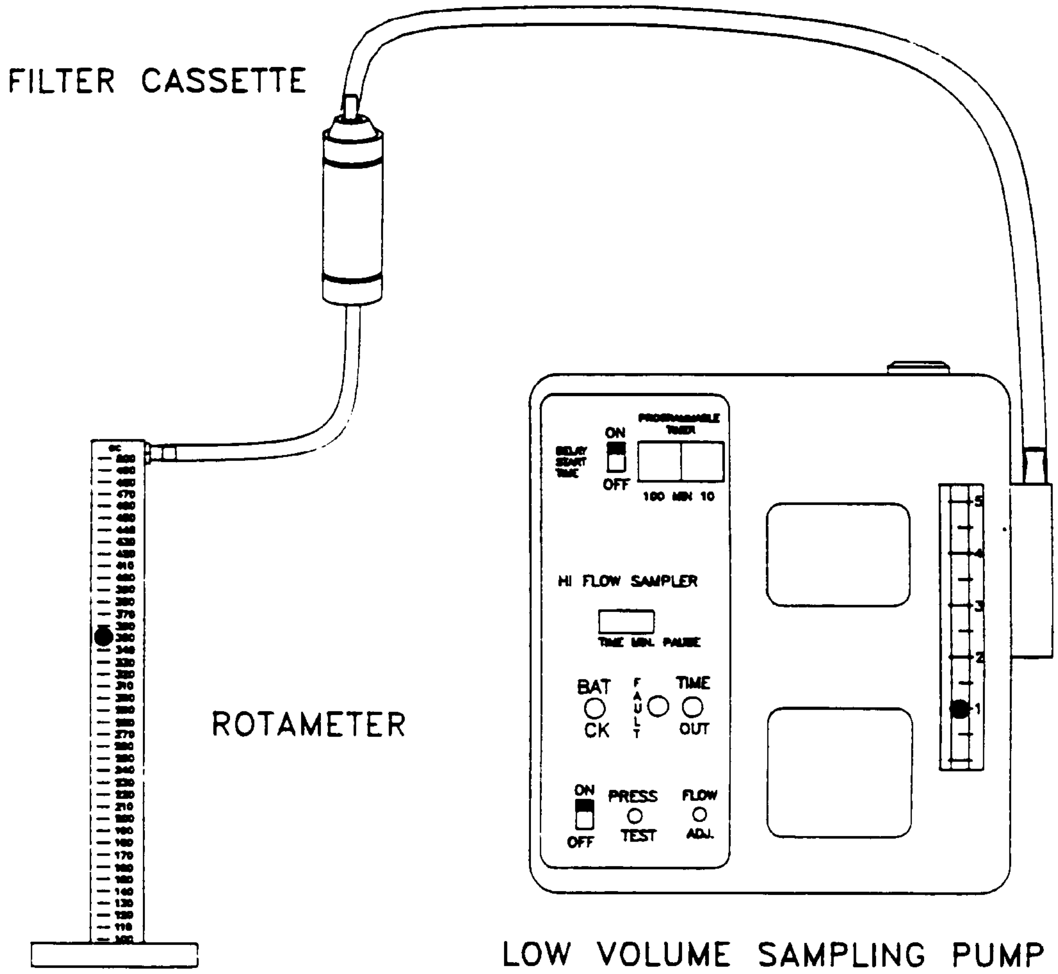
NOTE: Do not exceed a filter loading of approximately 2mg total dust.

(1) Greater volumes may be required if the anticipated concentration is less than the ACGIH TLV.

APPENDIX B

Figures

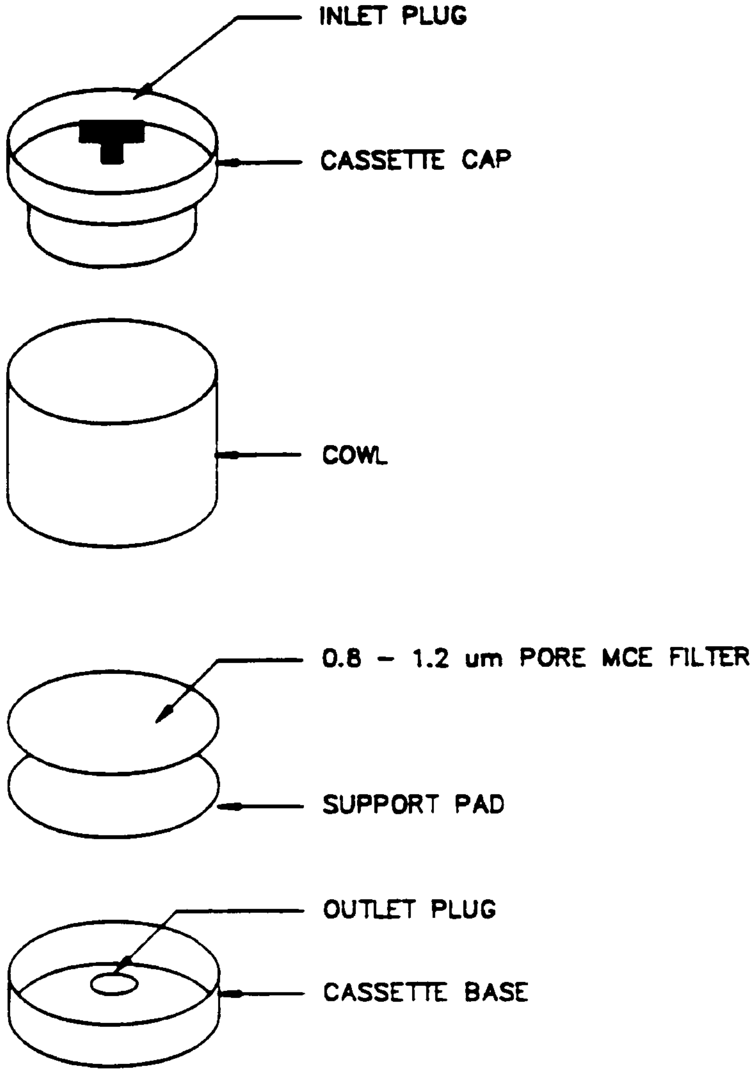
FIGURE 1. Calibration Train with Low Volume Sampling Pump



APPENDIX B (Cont'd)

Figures

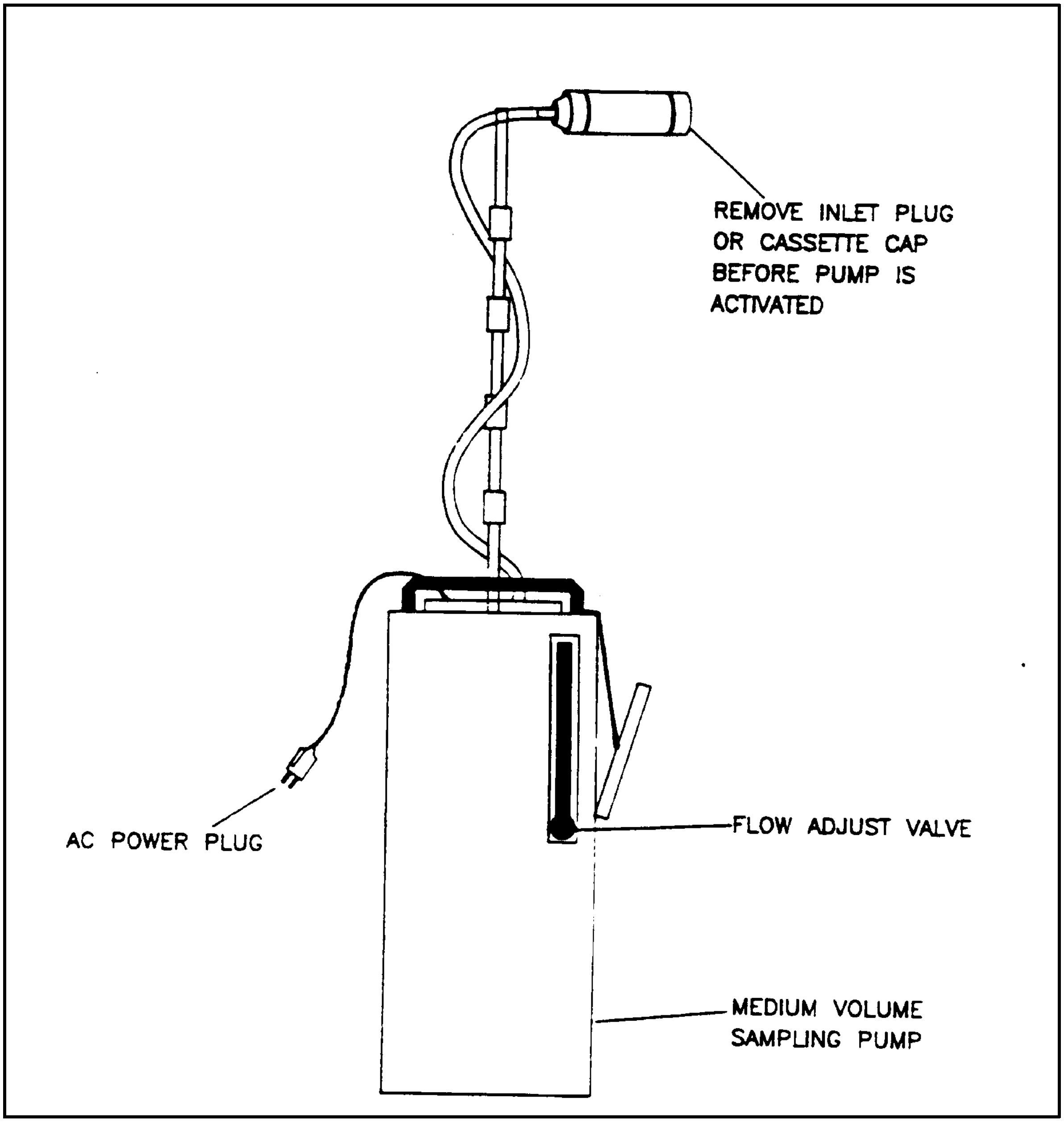
FIGURE 2. Filter Cassette Assembly



APPENDIX B (Cont'd)

Figures

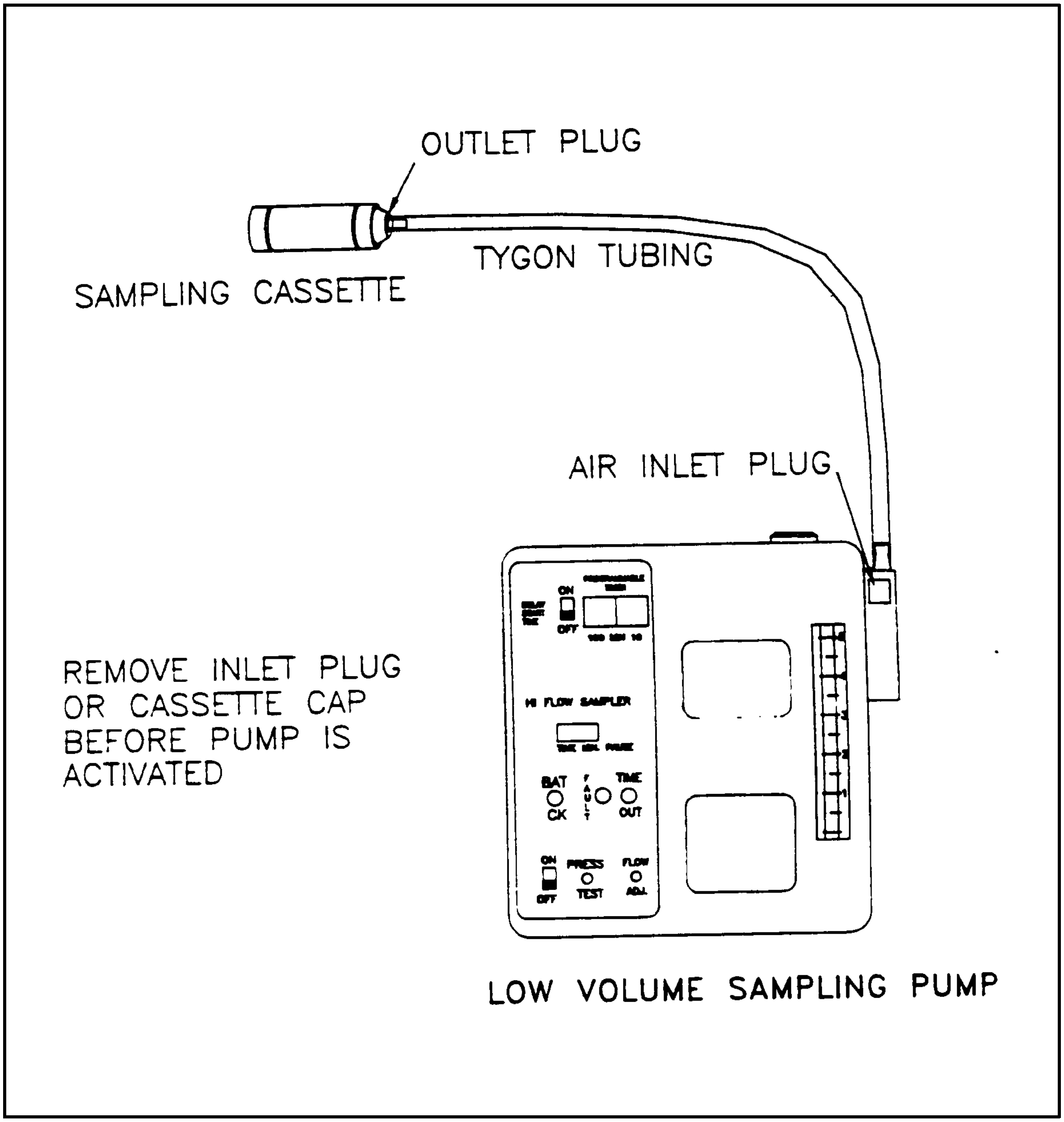
FIGURE 3. Medium Volume Sampling Train



APPENDIX B (Cont'd)

Figures

FIGURE 4. Sampling Train with Low Volume Sampling Pump



HIGH VOLUME POLYURETHANE FOAM SAMPLING

SOP#: 2121
DATE: 08/07/95
REV. #: 0.1

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to outline the protocol for collection of air samples for organochlorine and organophosphate compounds (i.e., dioxins and polychlorinated biphenyls) using the polyurethane foam (PUF) sampling medium. The PUF sampling system is designed to simultaneously collect suspended airborne particulates and to trap airborne pesticide vapors.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Ambient air is drawn into a covered housing then through a glass fiber filter and PUF plug by a high-flow-rate pump operating at approximately 250 liters/minute (L/m) (approximately nine cubic feet/minute [ft^3/m]). This allows total suspended particulates (TSP) to collect on the filter surface. The PUF plug allows collection of vapor which might be stripped from the particulates on the filter.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Prior to sampling, determine whether pre- and post-filter weighing is appropriate based on project needs or client requirements. In addition, obtain pre-cleaned PUF plugs from the analytical laboratory.

After sampling, the PUF plug and filter should be stored in an 8-oz. glass jar. The PUF plug should occupy the bottom portion of the jar and the filter should be folded into quarters and placed on top of the plug. The jar is then wrapped with aluminum foil (shiny side out).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Humidity - Glass fiber filters are comparatively insensitive to changes in relative humidity; however, collected particulate matter can be hygroscopic.

Photosensitivity - PUF plugs are white and turn yellow upon exposure to light. They should be stored in a dark place (i.e., a black trash bag or a cooler) prior to and after sampling.

5.0 EQUIPMENT/APPARATUS

5.1 Sampling Media (Sorbents)

Polyurethane Foam - polyether-type polyurethane foam (density No. 3014, 0.0225 grams/cm^3, or equivalent). This is the type of foam generally used for furniture upholstery, pillows, and mattresses (General Metals Work's part number GPS-116 is recommended, three inch PUF plug, although one and two inch pieces are also available).

Glass Fiber Filter - 102-mm diameter.

5.2 Sampling Equipment

- PS-1 PUF Samplers or Equivalent (platform, legs, motor, magnehelic panel, tubing, venturi, and ball valves)
- Sample modules
- Calibration orifice
- Manometer
- Plastic bags
- Tweezers

- Aluminum foil
- Hexane
- Surgical gloves
- Solvex gloves
- Sample jars
- Trash bags
- Calibration Worksheets
- Air Sampling Worksheets (PUF)
- Logbook
- Computer or calculator to perform calculations
- Calibrated scale (if weighing is required)
- Source of electricity (AC/DC): an electrical source of 100 volts, 15 amps is required

6.0 REAGENTS

Reagents are not used for the preservation of PUF samples. Hexane is required for decontaminating PUF glassware. No other decontamination solutions are required.

7.0 PROCEDURES

7.1 Calibration of Elapsed-Time Meters and Calibration Orifices

Elapsed-Time Meter

Every six months the elapsed-time meter should be checked against a timepiece of known accuracy, either on site or in the laboratory. A gain or loss of >2 min/24-hr period warrants adjustment or replacement of the indicator. The results of these checks should be recorded in the calibration logbook.

Calibration Orifices

Upon receipt and at one-year intervals, calibration orifices should be certified with a positive displacement standard volume meter (such as a Rootsmeter) traceable to the National Bureau of Standards (NBS). This certification will be performed by the manufacturer. Calibration orifices should be visually inspected for signs of damage before each use, and they should be recalibrated if the inspection reveals any nicks or dents in the orifice.

7.2 General Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain and organize the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, client, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.
6. Use stakes or flagging tape to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.3 Sample Module Preparation

1. Pre-clean all sampling equipment with hexane prior to use.
2. Check the lower canister to ensure that the upper and lower orange silicone gaskets are in place (Figure 1, Appendix A).
3. Using tweezers, load the glass cartridge with a pre-cleaned PUF plug, making sure the foam is evenly distributed throughout the cartridge, and install in the lower canister.
4. Screw the filter holder support onto the lower canister, after ensuring that the silicone rubber gasket is in place.
5. Screw the filter holder with support screen onto the filter holder support, after ensuring that the silicone rubber gasket is in place.
6. Install the lower Teflon gasket in the filter holder.
7. Using tweezers to handle the filter, place glass fiber filter (rough side up) into the filter holder.
8. Install the upper Teflon gasket.

9. Ensure that the silicone rubber gasket is present and then install the filter retaining ring and tighten the swing bolts.

10. Ensure that all fittings are snug, yet not overtight (Overtightening will distort the gaskets.).

11. Cover the sample module with the metal cover and place in a cooler.

12. Assemble a field blank in the same manner and store in the same cooler.

It is recommended that two sampling modules are prepared for each sampling system so that the filter and PUF plug exchange may take place in the clean zone. The second set of modules is used for the subsequent sampling round.

7.4 Field Calibration of the Sampler

Calibration of the PUF sampler is performed *without* a PUF plug and *without* the glass fiber filter in the sampling module. However, the empty glass cartridge *must remain* in the module to ensure a good seal through the module.

Calibration of the PUF sampler is performed prior to using the sampling system in the field and after repair or replacement of major components of the sampling system (i.e., motor repair).

1. Assemble the sample module, as described in Section 7.2, without the PUF plug and without the glass fiber filter.

2. Assemble the sampling system by attaching the legs and the magnehelic panel to the platform. Connect the motor to the platform, making sure that the gasket is placed between the motor and the platform.

3. Plug the motor into the timer located on the magnehelic panel.

4. Connect the magnehelic to the venturi with tubing.

5. Place the sampling module into the quick-release fitting and engage by locking the two levers down securely.

6. Connect the calibration orifice to the sample module (Figure 2, Appendix A). Ensure that no

leaks exist between the orifice unit and the sampler.

7. Fill the manometer with colored water and connect it to the calibration orifice pressure tap with tubing.

8. Set the manometer to "zero" as shown in Figure 3 (Appendix A). This is done by sliding the scale either up or down so the "zero" is level with the bottom of the meniscuses.

9. Connect the sampling system to the power source and fully open the ball valve by pushing the red lever up to the "on" position.

10. Fully open the voltage variator by using a screwdriver to turn the screw on the magnehelic gauge panel clockwise.

11. Operate the sampling system for at least 15 minutes to establish thermal equilibrium prior to calibration.

12. Conduct a five point calibration in the range of the desired flow rate as follows:

    a. Adjust the voltage variator (located on the magnehelic gauge panel) and/or the ball valve to obtain a reading of 70 (arbitrary) inches on the magnehelic gauge.

    b. The magnehelic gauge number, 70, is pre-recorded on the Field Calibration Work Sheet (Column #5, Attachment 1, Appendix B). Read and record (Column #4 on the Field Calibration Work Sheet) the total distance between the two meniscuses on the manometer (Figure 3, Appendix A). This is a measure of the pressure drop across the calibration orifice.

    c. Move the ball valve (red lever) to adjust the magnehelic gauge down to 60 (arbitrary) inches. Let the sampler run for at least two minutes to re-establish the run temperature conditions. Repeat step 12 b.

   d. Using the above procedure (steps 12 b. and c.), adjust the ball valve for readings at 50, 40, and 30 inches.

13. Measure the barometric pressure and ambient temperature.

14. Record all data on the Field Calibration Work Sheet (Attachment 1, Appendix B). Perform calculations as described in Sections 8.1, 8.2, 8.3, and 8.4 of this SOP and record the appropriate results on the Field Calibration Work Sheet.

15. Adjust the ball valve to the magnehelic reading required to achieve the target volumetric flow rate as requested by the Work Assignment Manager.

7.5 Sampling

1. Verify that the sampler has been calibrated as described in Section 7.4.

2. Transport the sampler to the desired location. The PUF sampler must be operated in the breathing zone or it may be elevated. The sampler should be located in an unobstructed area, at a distance of twice the height of any obstruction to air flow, if possible, but no closer than two meters to the obstacle. In urban or congested areas, it is recommended that the sampler be placed on the roof of a single story building.

3. If it is not already set up, assemble the sampling system as described in Section 7.4 (Steps 2 to 4). Adjust the exhaust hose so that it faces downwind of the sampler.

4. Put on clean surgical gloves.

5. Place the loaded sampling module into the quick release fitting and engage by locking the two levers down securely. Refer to Figure 4 (Appendix A) for the complete set-up of the sampling system.

6. Remove the metal cover.

7. Record the following information on the Air Sampling Worksheet (Attachment 2, Appendix B): high volume pump number, direction from site, location, sample start time, time/counter (start).

8. Plug in the unit.

9. If necessary adjust the magnehelic gauge to the reading required to achieve the target flow rate by turning the ball valve.

10. Wait approximately two minutes for the magnehelic reading to stabilize.

11. Allow the sampling system to operate for the duration determined by the Work Assignment Manager.

12. If the sampling system is to be in use for an extended period of time (i.e., the duration of sampling is greater than 24 hours), the initial calibration should be audited every 24 hours. This audit is accomplished by checking one point in the calibration curve using the field calibration procedure described in Section 7.4 and using a fully assembled sample module *with* the PUF plug and glass fiber filter installed. If the result of this check is greater than ±7% of the initial calibration value, the sampling system must be recalibrated.

7.6 Unit Shutdown and Sample Collection

1. Record the following information on the Air Sampling Worksheet (Attachment 2, Appendix B): sample stop time, time/counter (stop), the ending magnehelic reading, and whether or not there was a pump fault. Measure the ambient temperature and barometric pressure at the end of the sampling period. This information and the ending magnehelic gauge reading should be recorded on the Field Calibration Work Sheet.

2. Unplug the sampler and remove the sample module.

3. Cover the sample module with the metal cover. Keep the sample module in a vertical position at all times.

4. Place the sample module in a cooler for transport back to the command post. The field blank should also be stored in the same cooler.
5. If additional sampling is scheduled, perform a field calibration audit as described in Section 7.5, #12. The unit must be decontaminated with hexane and chem wipes prior to initiating additional sampling activities. Install a new sampling module and begin sampling as described in Section 7.5. If no additional sampling is scheduled, secure the unit.

6. Wearing surgical gloves and using tweezers, remove the PUF plug and place it in a clean 8-oz. glass jar. Fold the glass fiber filter into quarters and place it on top of the PUF plug. Label the jar appropriately and cover it with aluminum foil (shiny side out). Prepare the sample for transport to the laboratory for analysis, as necessary.

7. Calculate the post-sampling flow rate, the average flow rate, and the total volume sampled (Sections 8.5 and 8.6).

8.0 CALCULATIONS

The total volumes calculated for each sampling unit are corrected to standard conditions (760 millimeters of mercury [mm Hg] and 298 kelvin [K]). This is necessary for reporting the concentrations in a manner consistent with method requirements. The first step in the calibration process is to determine the slope (m) and the y-axis intercept (b) from the Factory Calibration Work Sheet. This is based on the formula y=mx+b. This is calculated either graphically (5-point calibration curve) or by a regression analysis of the data provided on the Factory Calibration Work Sheet. Once the slope and intercept are calculated for the factory calibration data, a calibration curve is developed for each of the sampling units. The important data elements needed to complete this task are the pressure drop readings for each of the arbitrary values (I) (Section 7.4), ambient temperature and ambient pressure. ***If the sampling unit calibration results will be provided in mm Hg instead of inches of water, then Section 8.1 may be skipped because the manufacturer has already calculated the slope (m) and intercept (b) and provided them on the Factory Calibration Work Sheet. This information should be recorded in the appropriate location on the Field Calibration Work Sheet.***

8.1 Determining the Slope (m) and Y-Axis Intercept (b) of the Factory Calibration

1. Obtain the current Factory Calibration Work Sheet from manufacture's calibration kit or Air Team Calibration File. See Figure 5 (Appendix A) for an example.

2. Copy columns #6 & #7 from the Q_{std} section of the Factory Calibration Work Sheet to column #1 & #2, respectively, on the Field Calibration Work Sheet (Attachment 1, Appendix B). Record the ambient temperature, ambient pressure at which the factory orifice calibration was performed, and orifice serial number from the Factory Calibration Work Sheet in the respective locations on the Field Calibration Work Sheet. Return the Factory Calibration Work Sheet to the calibration kit or the proper file.

3. Solve the following formula for every calibration orifice static pressure found in column #1 of the Field Calibration Work Sheet. Record results in column #3 of the Field Calibration Work Sheet. The units of the results are arbitrary. There should be at least five computations.

   Equation:

   y-axis equation orifice = $[\triangle H(P_a/760)(298/T_a)]^{1/2}$

   Where:

   $\triangle H$ = Calibration orifice static pressure in inches of water ("H_2O) (Field Calibration Work Sheet, column #1).
   P_a = Ambient pressure at which the factory orifice calibration was performed in mm Hg.
   T_a = Ambient temperature at which the factory orifice calibration was performed in K.

Example:

ΔH = 2.0 "H_2O, P_a = 760.5mm Hg, T_a = 295 K

y-axis equation orifice = $[(2.0 \text{ "}H_2O)(760.5\text{mm Hg}/760 \text{ mm Hg})(298 \text{ K}/295 \text{ K})]^{1/2}$
y-axis equation orifice = $[2.02]^{1/2}$

y-axis equation orifice = 1.42

4. Graph the results in column #2 of the Field Calibration Work Sheet on the x-axis against the data presented in column #3 of the Field Calibration Work Sheet on the y-axis or perform a regression analysis of the data to determine the slope and (m) and the y-axis intercept (b). Record in the appropriate location on the Field Calibration Work Sheet.

Example: Regression analysis from Lotus 123:

Regression Output:	
Constant	- 0.03
Std Err of Y Est	0.00246358
R Squared	0.99999508
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	9.52
Std Err of Coef.	0.01055231

Where:

Constant = y-Axis intercept (b)
X Coefficient(s) = Slope (m)

8.2 Determining the Slope (m) and a Y-Axis Intercept (b) of the Field Calibration

1. Obtain pressure drop readings from the water manometer and the matching arbitrary magnehelic values (I = 70, 60, 50, 40, 30) from Section 7.4 and record the data on a Field Calibration Work Sheet in columns #4 and #5, respectively. Record the ambient temperature and ambient pressure at which each unit calibration was performed.

2. Solve the y-axis equation using the formula below and using the data found in column #4 on the Field Calibration Work Sheet. Record the results in column #6 of the Field Calibration Work Sheet. The units of the results are arbitrary. There should be at least five computations.

Equation:

y-axis equation sampling unit = $[\Delta H(P_a/760)(298/T_a)]^{1/2}$

Where:

ΔH = Static pressure of the sampling unit in "H_2O (column #4 of the Field Calibration Work Sheet).
P_a = Ambient pressure in mm Hg at time of unit calibration.
T_a = Ambient temperature in K at time of unit calibration.

Example:

ΔH = 6.0 "H_2O, P_a = 756.92mm Hg, T_a = 295 K

y-axis equation sampling unit =
$[(6.0 \text{ "}H_2O)(756.92 \text{ mm Hg}/760 \text{ mm Hg})(298 \text{ K}/295 \text{ K})]^{1/2}$

y-axis equation sampling unit = $[6.06]^{1/2}$

y-axis equation sampling unit = 2.46

3. Determine the volumetric flow rate (Q_{STD}) for each calibration point using the following equation. Record the results in column #7 of the Field Calibration Work Sheet.

Equation:

$$QSTD = 1/m\ [\{\Delta H(P_a/760)(298/T_a)\}^{1/2} - b]$$

Where:

m = Slope from the Factory Calibration Work Sheet graph or regression analysis (Step #4, Section 8.1).
ΔH = Pressure drop in "H_2O recorded on Field Calibration Work Sheet (column #4).

P_a = Ambient pressure in mm Hg at time of field calibration.
T_a = Ambient temperature in K at time of field calibration.
b = y-Axis intercept from the Factory Calibration Work Sheet graph or regression analysis (Step #4, Section 8.1).

Example:

m = 9.52, $\triangle H = 6.0$ "H_2O, P_a = 756.92 mm Hg, T_a = 295 K, b = - 0.03

Q_{STD} = 1/9.52 [{6.0 "H_2O (756.92 mm Hg/760 mm Hg)(298 K/295 K)}$^{1/2}$ -(-0.03)]

Q_{STD} = 1/9.52 [2.46]

Q_{STD} = 0.26 m^3/min

4. Determine the Y_{value} for each calibration point. Record in column #8 on the Field Calibration Work Sheet. The units of the results are arbitrary.

Equation:

Y_{value} of each calibration point = $[I(P_a/760)(298/T_a)]^{1/2}$

Where:

I = Arbitrary value located in column #5 on the Field Calibration Work Sheet.
P_a = Ambient pressure in mm Hg at time of unit field calibration.
T_a = Ambient temperature in K at time of unit field calibration.

Example:

I = 70, P_a = 756.92 mm Hg, T_a = 295 K

Y_{value} of each calibration point = [70(756.92mm Hg/760 mm Hg)(298 K/295 K)]$^{1/2}$

Y_{value} of each calibration point = 8.39

5. Graph the results in column #7 of the Field Calibration Work Sheet on the x-axis against the data presented in column #8 from the Field Calibration Work Sheet on the y-axis or perform a regression analysis to determine the slope (m) and the y-axis intercept (b). Record in the appropriate location on the Field Calibration Work Sheet.

Example: Regression analysis from Lotus 123:

Regression Output:	
Constant	1.64
Std Err of Y Est	0.057770455
R Squared	0.998738313
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	25.66
Std Err of Coef.	0.45593301

Where:

Constant = y-axis intercept (b)
X Coefficient(s) = Slope (m)

8.3 Checking the Linearity of the Calibration

1. Calculate Y_{cal} to determine if the calibration is within the limits of linearity (±5%) using the following formulas. Record the results in column #9 of the Field Calibration Work Sheet.

Equation: $Y_{cal} = mQ_{STD} + b$

Where:

m = Slope of the field calibration curve from the regression analysis of columns #7 & #8.
Q_{STD} = Volumetric flow rate calculated on the Field Calibration Work Sheet (column #7).
b = y-Axis intercept of the field calibration curve from the regression analysis of columns #7 and #8.

Example:

m = 25.66, Q_{STD} = 0.26, b = 1.64

Y_{cal} = [(25.66)(0.26)] + 1.64

Y_{cal} = 8.31

2. Calculate %-difference of the Y_{value} and Y_{cal}. Record the results in column #10 of the Field Calibration Work Sheet. If the results are not with in ±5% recheck your calculations or recalibrate.
Equation:

%-difference = ((Y_{value} - Y_{cal})/Y_{cal})(100)

Where:

Y_{value} = Y_{value} in column #8 of the Field Calibration Work Sheet.
Y_{cal} = Value from previous calculation recorded in column #9 of the Field Calibration Work Sheet.

Example:

%-difference = ((8.39 - 8.31)/8.31)100

%-difference = 0.96%

8.4 Determining Pre-Sampling Volumetric Flow Rate

1. Determine the volumetric flow rate at each calibration point using the following equation and recording the data in column #11 of the Field Calibration Work Sheet.

Equation:

$Q = (1/m)[\{I(P_a/760)(298/T_a)\}^{1/2} - b]$

Where:

I = Arbitrary magnehelic reading recorded on Field Calibration Work Sheet (column #5).
P_a = Ambient pressure in mm Hg at which the sampling unit was calibrated.
T_a = Ambient temperature in K at which the sampling unit was calibrated.
b = y-Axis intercept from the field calibration graph or regression analysis of columns #7 & #8.
m = Slope from the field calibration curve graph or regression analysis of columns #7 & #8.

Example:

I = 70, P_a = 756.92 mm Hg, T_a = 295 K, m = 25.66, b = 1.64

$Q = (1/25.66)[\{70(756.92\text{mm Hg}/760\text{mmHg})(298\text{ K}/295\text{ K})\}^{1/2} - 1.64]$

Q = 0.26 m^3/min

2. Determine the arbitrary set point for a target volumetric flow rate, as follows.

   a. Obtain the target volumetric flow rate in m^3/min from the Work Assignment Manager.

   b. Obtain the ambient barometric pressure and the ambient temperature at the start of the sampling event and record on the Field Calibration Work Sheet.

   c. Using the following equation calculate your arbitrary set point for each sampler. Record in the appropriate location on the Field Calibration Work Sheet.

Equation:

$I = [\{(Q_{target})(m)\} + b]^2 / [(P_a/760)(298/T_a)]$

Where:

Q_{target} = Desired volumetric flow rate (m^3/min.)
m = Slope of the field calibration as determined by the regression of columns #7 & #8.
b = y-Axis intercept of the field calibration as determined by the regression of columns #7 & #8.
P_a = Ambient pressure at which the sample is being taken (mm Hg)
T_a = Ambient temperature at which the sample is being taken (K)

Example:

What is the magnehelic set point (I) for the target flow rate of 0.25 m^3/min.?

m = 25.66, b = 1.64, P_a = 756.92 mm Hg, T_a = 295 K

I = $[(0.25 m^3/\text{min.})(25.66)+1.64]^2/[(756.92/760)(298/295)]$

I = 64.49

3. Determine the initial flow rate, as follows.

   a. Set the magnehelic set point (I) as determined by the previous step.

   b. Use the following equation to check the set point to determine if is the correct set point for the desired flow rate.

Equation:

$Q = (1/m)[\{I(P_a/760)(298/T_a)\}^{1/2} - b]$

Where:

Q = Volumetric flow rate at set point (I).
I = Magnehelic set point (I).
P_a = Ambient pressure at the start of the sampling event.
T_a = Ambient temperature in K at the start of the sampling event.
b = y-Axis intercept from the field calibration graph or regression analysis of column #7 & #8.
m = Slope from the field calibration curve graph or regression analysis of column #7 & #8.

Example:

$I = 64.49$, $P_a = 756.9$mm Hg, $T_a = 295$ K, $m = 25.66$, $b = 1.64$

$Q = 1/25.66[\{64.49(756.9\text{mmHg}/760\text{mmHg})(298\text{ K}/295\text{ K})\}^{1/2} - 1.64]$

$Q = 0.25\ \text{m}^3/\text{min}.$

8.5 Determining Post-Sampling Volumetric Flow Rate

1. Obtain the ambient barometric pressure and the ambient temperature at the end of the sampling event and record on the Field Calibration Work Sheet.

2. Obtain the set point (I) of the magnehelic at the end of the sampling event and record on the Field Calibration Work Sheet.

3. Use the following equation to determine the volumetric flow rate.

Equation:

$Q = (1/m)[\{I(P_a/760)(298/T_a)\}^{1/2} - b]$

Where:

Q = Volumetric flow rate at set point (I).
I = Magnehelic set point (I) at the end of the sampling event.
P_a = Ambient pressure at the end of the sampling event.
T_a = Ambient temperature in K at the end of the sampling event.
b = y-Axis intercept from the field calibration graph or regression analysis of columns #7 & #8.
m = Slope from the field calibration curve graph or regression analysis of columns #7 & #8.

Example:

$I = 50$, $P_a = 758.9$ mm Hg, $T_a = 299$ K, $m = 25.66$, $b = 1.64$

$Q = 1/25.66)[\{50(758.9\text{mmHg}/760\text{mm Hg})(298\text{ K}/299\text{ K})\}^{1/2} - 1.64]$

$Q = 0.21\ \text{m}^3/\text{min}.$

8.6 Determining Total Volume

Average the pre- and post-volumetric flow rates and multiply by the time sampled to determine the volume sampled. Record all information on the Field Calibration Work Sheet.

Example:

$((0.25\text{m}^3/\text{min} + 0.21\text{m}^3/\text{min})/2)480\text{ min} = 110.4\text{ m}^3$

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Provide one field blank per sampling period or one field blank for every 20 samples, whichever is greater. A field blank is treated exactly as a sample except that air is not drawn through the media. PUF plugs should be submitted to the laboratory for cleaning prior to field sampling. If the PUF plugs were cleaned in house, one or two clean plugs should be sent to the laboratory which will be analyzing the samples. Sample spiking may be necessary for pesticide and PCB samples; consult with the Work Assignment Manager.

10.0 DATA VALIDATION

Results of the quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials follow U.S. EPA, OSHA, and corporate health and safety practices.

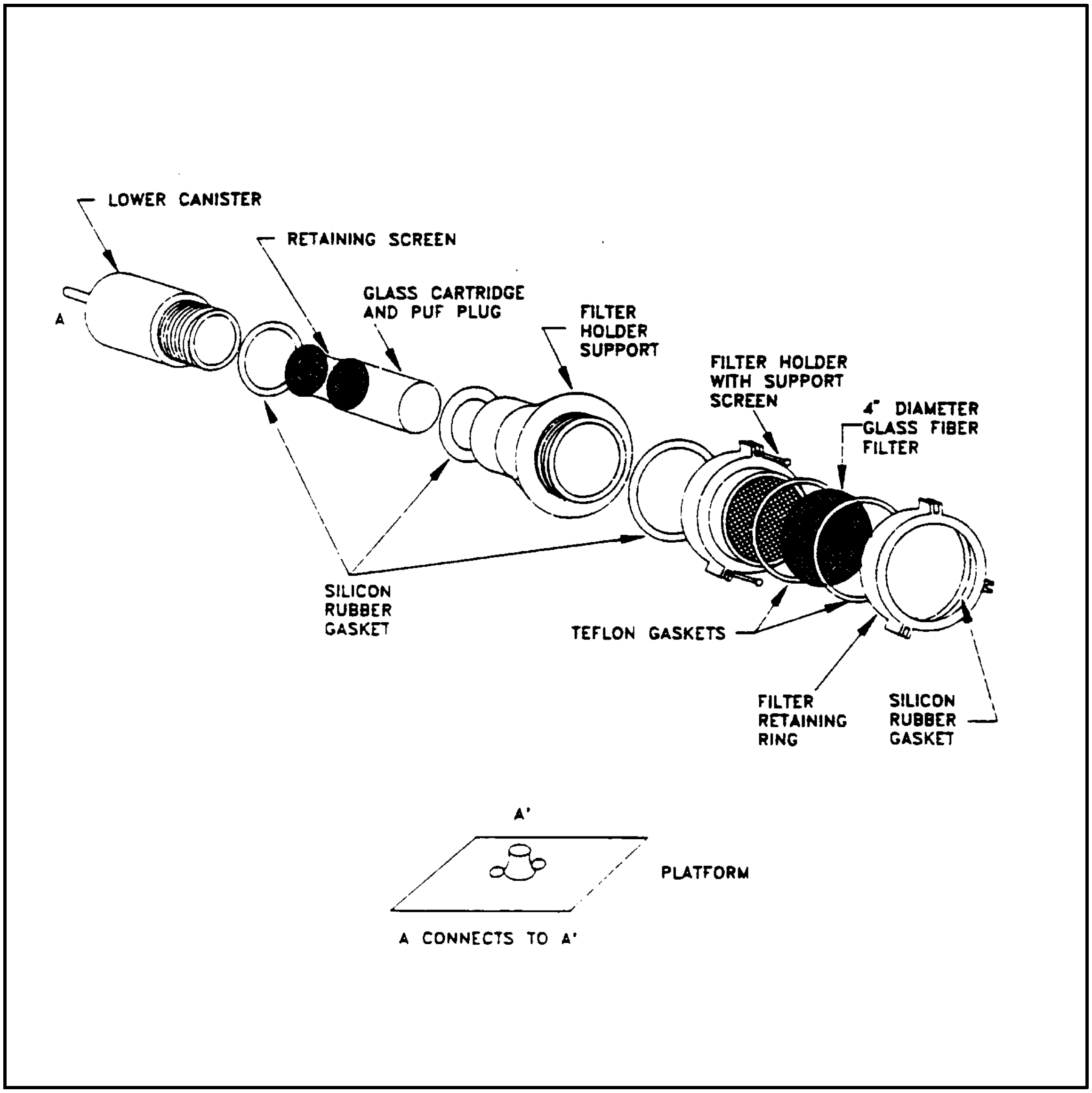
12.0 REFERENCES

Method TO4, Determination of Organochlorine Pesticides and Polychlorinated Biphenyls in Ambient Air, Revision 1.0, April, 1984.

APPENDIX A

Figures

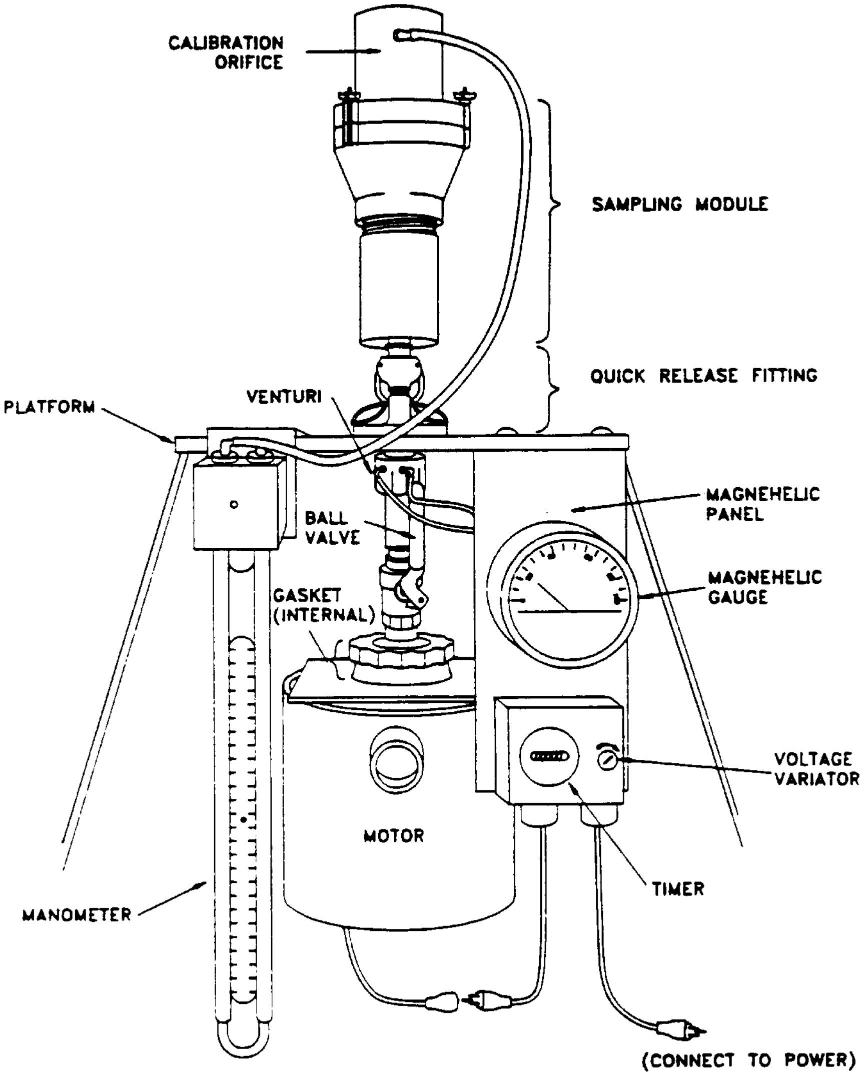
FIGURE 1. Sample Module



APPENDIX A (Cont'd)

Figures

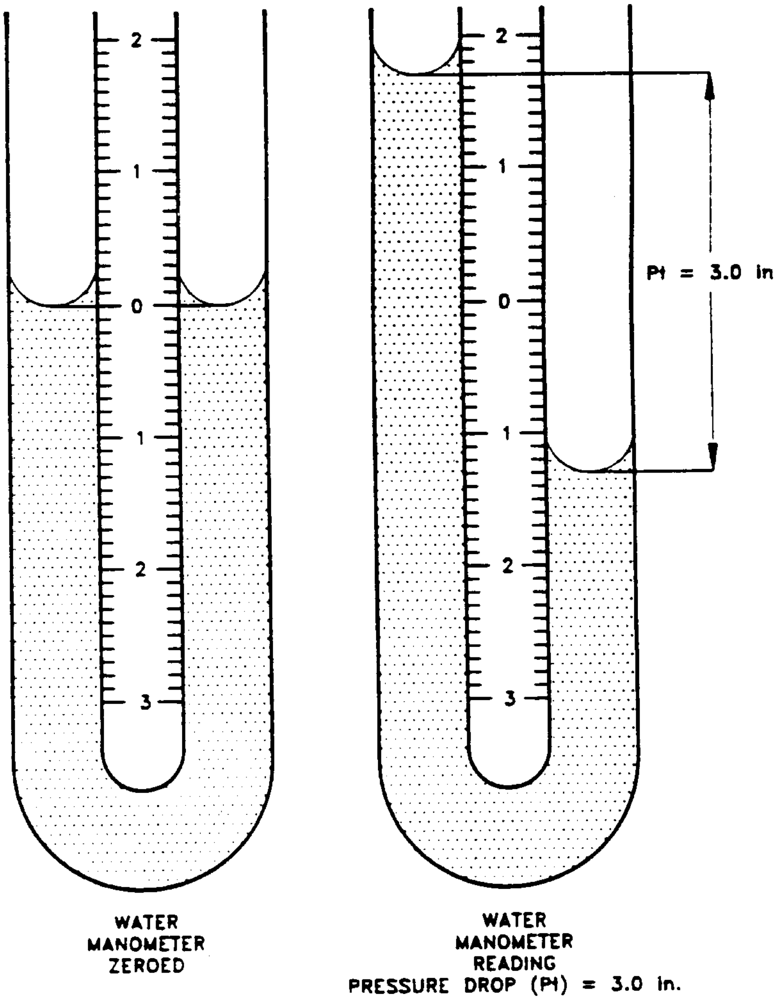
FIGURE 2. Calibration of the PUF Sampler



APPENDIX A (Cont'd)

Figures

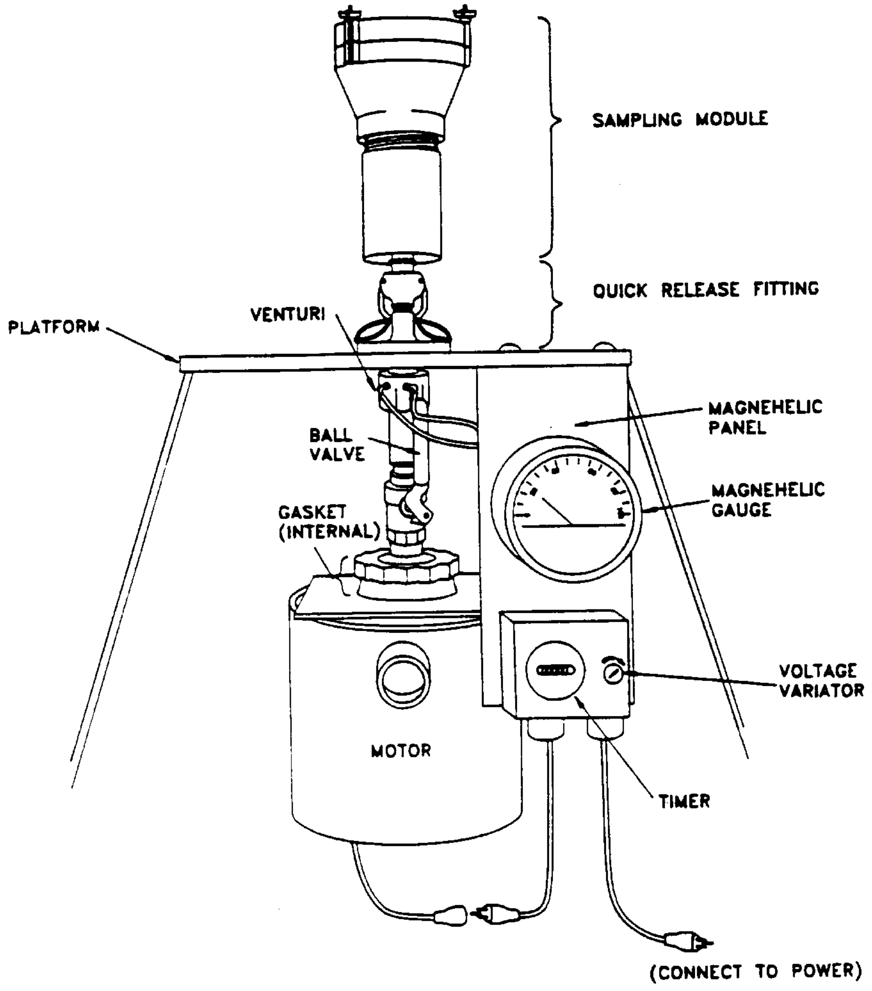
FIGURE 3. Manometer



APPENDIX A (Cont'd)

Figures

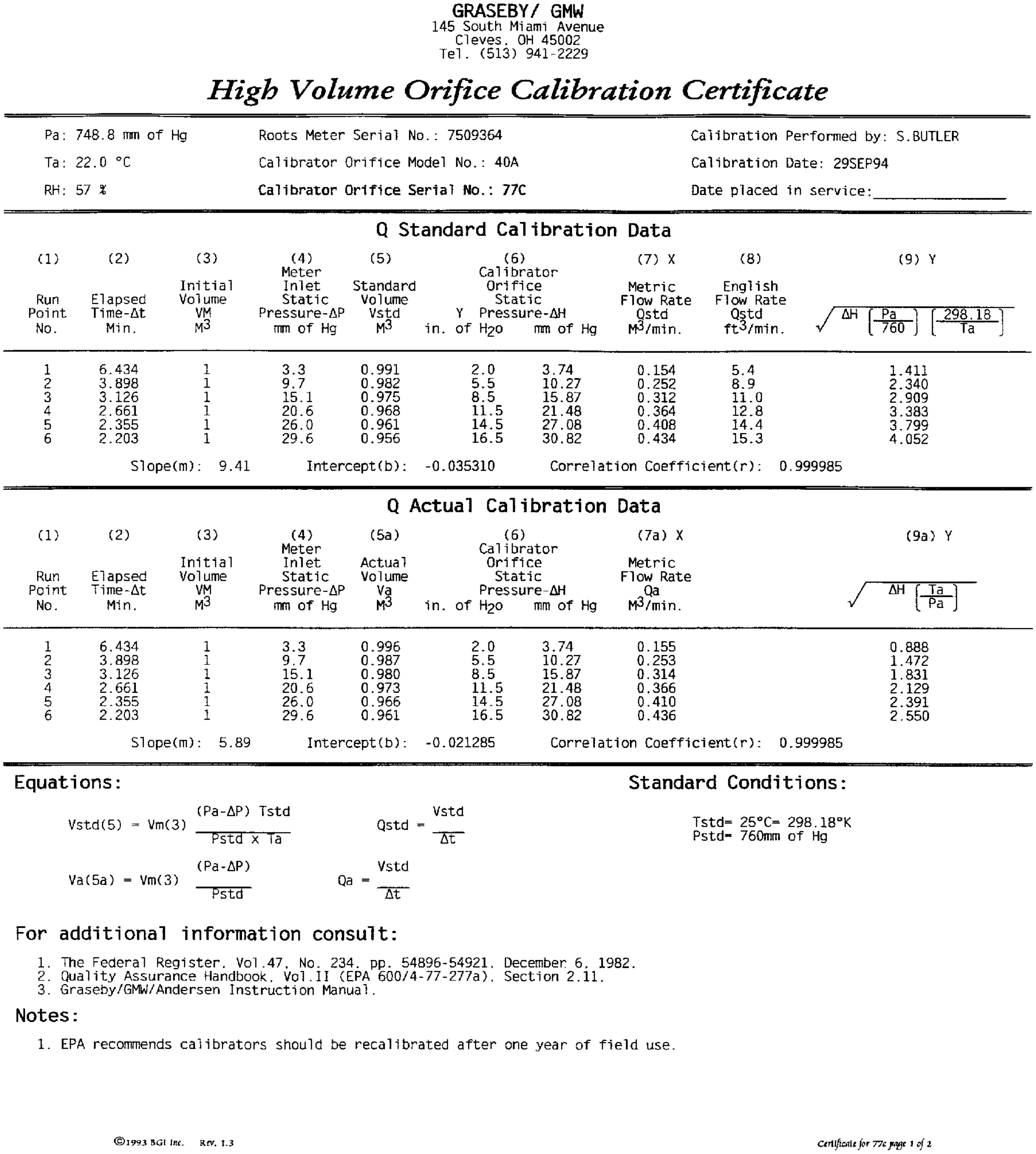
FIGURE 4. PUF Sampler



APPENDIX A (Cont'd)

Figures

FIGURE 5. Factory Calibration Work Sheet



GRASEBY/ GMW
145 South Miami Avenue
Cleves, OH 45002
Tel. (513) 941-2229

High Volume Orifice Calibration Certificate

Pa: 748.8 mm of Hg
Ta: 22.0 °C
RH: 57 %

Roots Meter Serial No.: 7509364
Calibrator Orifice Model No.: 40A
Calibrator Orifice Serial No.: 77C

Calibration Performed by: S.BUTLER
Calibration Date: 29SEP94
Date placed in service:______________

Q Standard Calibration Data

(1) Run Point No.	(2) Elapsed Time-Δt Min.	(3) Initial Volume VM M^3	(4) Meter Inlet Static Pressure-ΔP mm of Hg	(5) Standard Volume Vstd M^3	(6) Calibrator Orifice Static Pressure-ΔH		(7) X Metric Flow Rate Qstd M^3/min.	(8) English Flow Rate Qstd ft^3/min.	(9) Y $\sqrt{\Delta H \left[\frac{Pa}{760}\right]\left[\frac{298.18}{Ta}\right]}$
					Y in. of H_2O	mm of Hg			
1	6.434	1	3.3	0.991	2.0	3.74	0.154	5.4	1.411
2	3.898	1	9.7	0.982	5.5	10.27	0.252	8.9	2.340
3	3.126	1	15.1	0.975	8.5	15.87	0.312	11.0	2.909
4	2.661	1	20.6	0.968	11.5	21.48	0.364	12.8	3.383
5	2.355	1	26.0	0.961	14.5	27.08	0.408	14.4	3.799
6	2.203	1	29.6	0.956	16.5	30.82	0.434	15.3	4.052

Slope(m): 9.41 Intercept(b): -0.035310 Correlation Coefficient(r): 0.999985

Q Actual Calibration Data

(1) Run Point No.	(2) Elapsed Time-Δt Min.	(3) Initial Volume VM M^3	(4) Meter Inlet Static Pressure-ΔP mm of Hg	(5a) Actual Volume Va M^3	(6) Calibrator Orifice Static Pressure-ΔH		(7a) X Metric Flow Rate Qa M^3/min.	(9a) Y $\sqrt{\Delta H \left[\frac{Ta}{Pa}\right]}$
					in. of H_2O	mm of Hg		
1	6.434	1	3.3	0.996	2.0	3.74	0.155	0.888
2	3.898	1	9.7	0.987	5.5	10.27	0.253	1.472
3	3.126	1	15.1	0.980	8.5	15.87	0.314	1.831
4	2.661	1	20.6	0.973	11.5	21.48	0.366	2.129
5	2.355	1	26.0	0.966	14.5	27.08	0.410	2.391
6	2.203	1	29.6	0.961	16.5	30.82	0.436	2.550

Slope(m): 5.89 Intercept(b): -0.021285 Correlation Coefficient(r): 0.999985

Equations:

$$Vstd(5) = Vm(3)\ \frac{(Pa-\Delta P)\ Tstd}{Pstd \times Ta} \qquad Qstd = \frac{Vstd}{\Delta t}$$

$$Va(5a) = Vm(3)\ \frac{(Pa-\Delta P)}{Pstd} \qquad Qa = \frac{Vstd}{\Delta t}$$

Standard Conditions:

Tstd= 25°C= 298.18°K
Pstd= 760mm of Hg

For additional information consult:

1. The Federal Register, Vol.47, No. 234, pp. 54896-54921, December 6, 1982.
2. Quality Assurance Handbook, Vol.II (EPA 600/4-77-277a), Section 2.11.
3. Graseby/GMW/Andersen Instruction Manual.

Notes:

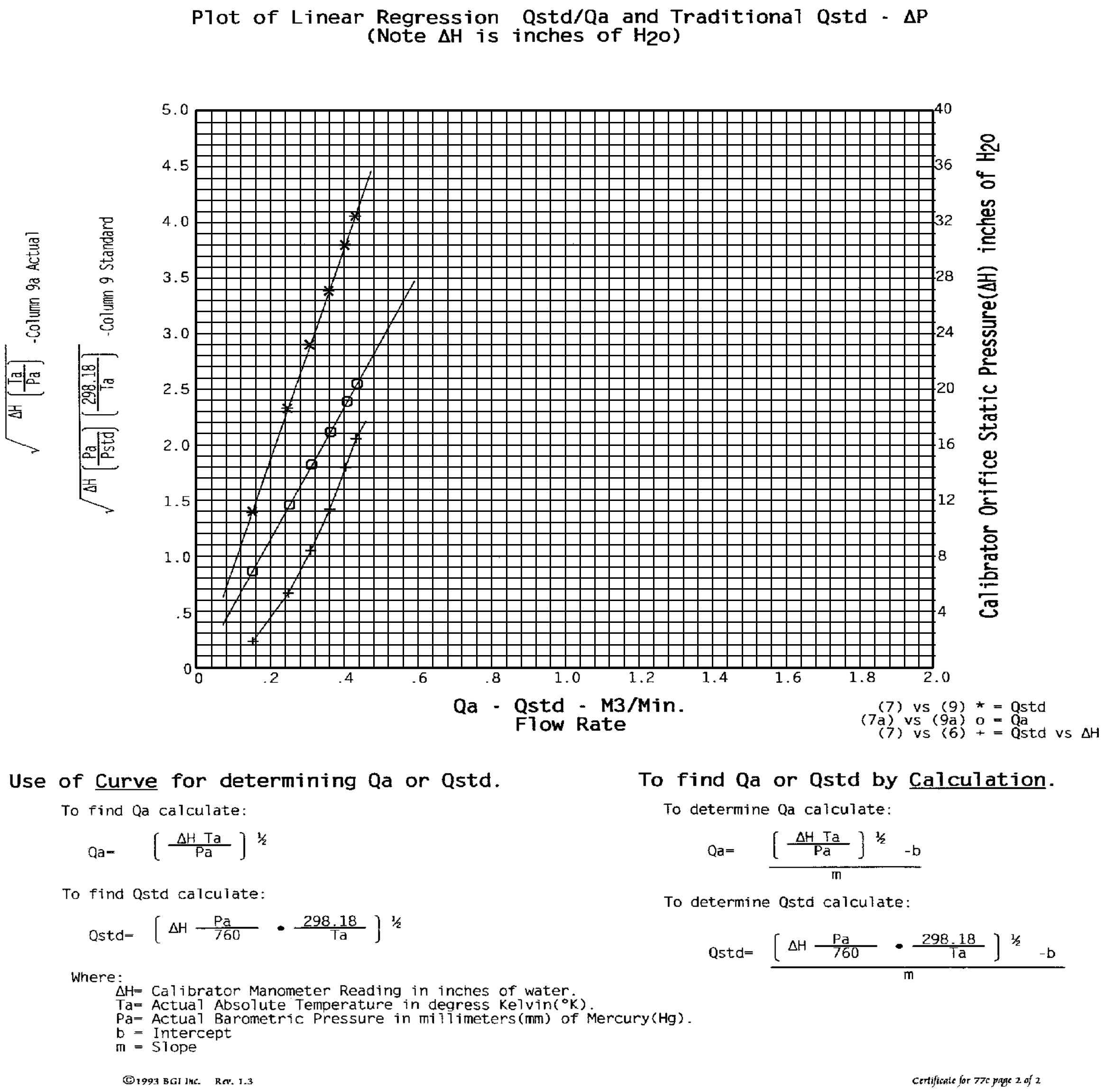
1. EPA recommends calibrators should be recalibrated after one year of field use.

Certificate for 77c page 1 of 2

APPENDIX A (Cont'd)

Figures

FIGURE 5. Factory Calibration Work Sheet (Cont'd)



Plot of Linear Regression Qstd/Qa and Traditional Qstd - ΔP
(Note ΔH is inches of H_2O)

Qa - Qstd - M3/Min.
Flow Rate

(7) vs (9) * = Qstd
(7a) vs (9a) o = Qa
(7) vs (6) + = Qstd vs ΔH

Use of Curve for determining Qa or Qstd.

To find Qa calculate:

$$Qa = \left[\frac{\Delta H\ Ta}{Pa}\right]^{½}$$

To find Qstd calculate:

$$Qstd = \left[\Delta H \frac{Pa}{760} \bullet \frac{298.18}{Ta}\right]^{½}$$

To find Qa or Qstd by Calculation.

To determine Qa calculate:

$$Qa = \frac{\left[\frac{\Delta H\ Ta}{Pa}\right]^{½} - b}{m}$$

To determine Qstd calculate:

$$Qstd = \frac{\left[\Delta H \frac{Pa}{760} \bullet \frac{298.18}{Ta}\right]^{½} - b}{m}$$

Where:
ΔH= Calibrator Manometer Reading in inches of water.
Ta= Actual Absolute Temperature in degress Kelvin(°K).
Pa= Actual Barometric Pressure in millimeters(mm) of Mercury(Hg).
b = Intercept
m = Slope

Certificate for 77c page 2 of 2

APPENDIX B

Attachments

ATTACHMENT 1. Field Calibration Work Sheet

ENVIRONMENTAL RESPONSE TEAM
HIGH VOLUME SAMPLER FIELD CALIBRATION WORK SHEET

Page ___ of ___

Site: ______________________ WA#: ______________________ Date: ______________________

Samplers: ______________________ EPA/ERT WAM:______________________ REAC TL: ______________________

Sampler #: ______________________ Location/Station: ______________________

ORIFICE CALIBRATION INFORMATION
(Obtained from the Factory Calibration Work Sheet)

Ambient Pressure (mmHg): ______________ Ambient Temperature (kelvin): ______________ Serial #: ______________

Unit Calibration Information

Ambient Pressure (mmHg): ______________ Ambient Temperature (kelvin): ______________

Calibration Data			Calibration Curve					Linearity of Calibration Curve		
#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Calibrator Orifice Static Pressure (ΔH)	Metric Flow Rate Q_{std} (m^3/min) (x-axis)	y-axis Equation Orifice	Δ H Sampling Unit ("H_2O)	Pressure Indicator of the Sampling Unit (I) (arbitrary)	y-axis Equation of the Sampling Unit	Q_{std} Orifice Calibration (x-axis)	y-value of Each Calibration Point (y-axis)	y-cal	% Difference (+/- 5%)	Flow Rate for Each Calibration Point

Slope (m) and y-intercept (b) of columns #2 & #3

m = __________ b = __________

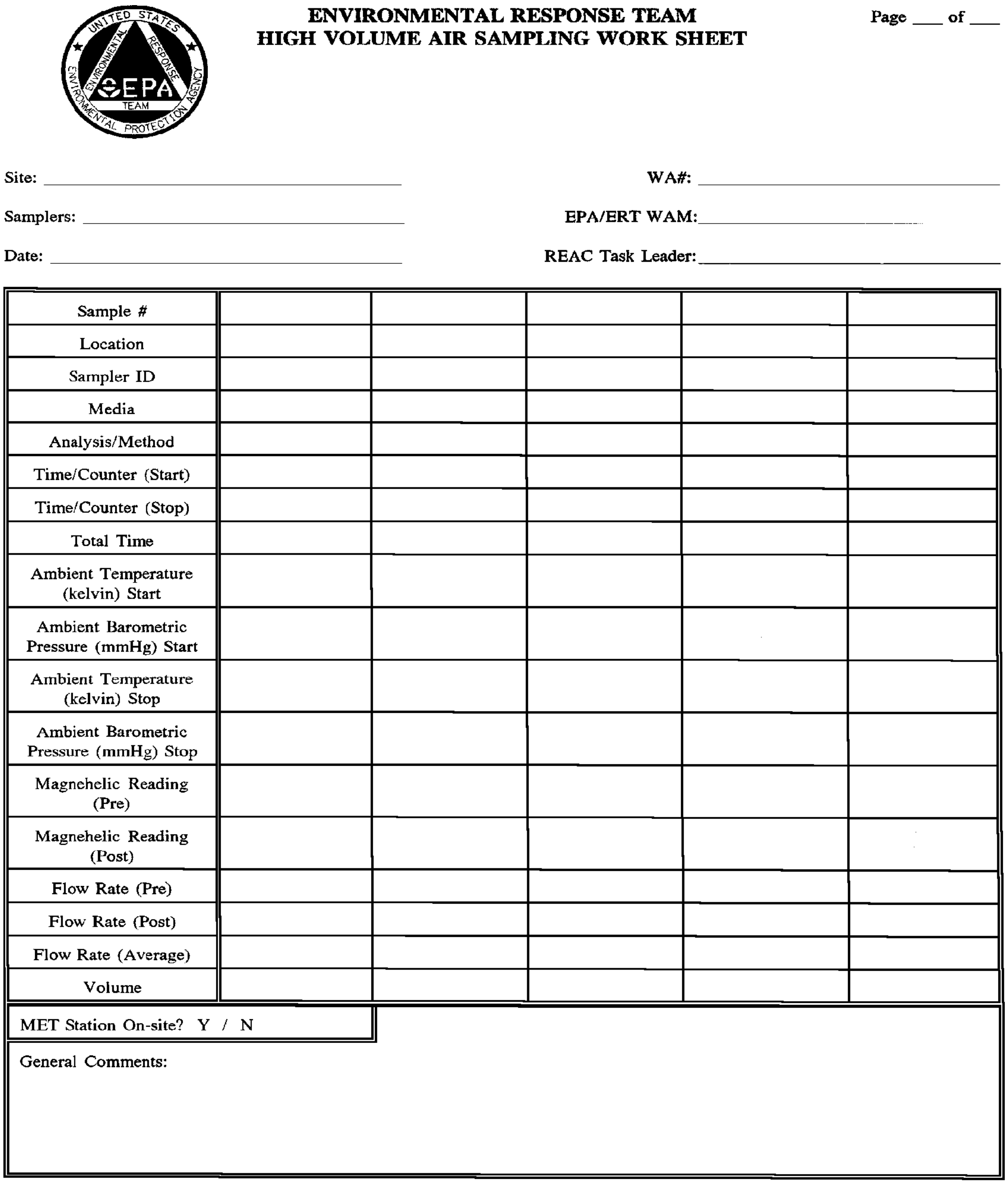
Slope (m) and y-intercept (b) of columns #7 & #8

m = __________ b = __________

APPENDIX B (Cont'd)

Attachments

ATTACHMENT 2. Air Sampling Worksheet



ENVIRONMENTAL RESPONSE TEAM
HIGH VOLUME AIR SAMPLING WORK SHEET

Page ___ of ___

Site: ______________________________

WA#: ______________________________

Samplers: ______________________________

EPA/ERT WAM: ______________________________

Date: ______________________________

REAC Task Leader: ______________________________

Sample #					
Location					
Sampler ID					
Media					
Analysis/Method					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
Ambient Temperature (kelvin) Start					
Ambient Barometric Pressure (mmHg) Start					
Ambient Temperature (kelvin) Stop					
Ambient Barometric Pressure (mmHg) Stop					
Magnehelic Reading (Pre)					
Magnehelic Reading (Post)					
Flow Rate (Pre)					
Flow Rate (Post)					
Flow Rate (Average)					
Volume					

MET Station On-site? Y / N

General Comments: