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(FINAL)
SAMPLING AND ANALYSIS PLAN

VOLUME II OF II

LABORATORY QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR SITE INSPECTIONS AT SITES 3, 7, 43, 44, 54, 63, 65, 80, AND 82

CAMP LEJEUNE MILITARY RESERVATION JACKSONVILLE, NORTH CAROLINA

OCTOBER 1991

HALLIBURTON NUS
Environmental Corporation

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Versar Laboratories INC

June 3, 1991

VERSAR LABORATORIES, INC.
GENERIC QUALITY ASSURANCE PLAN

DOCUMENT 2.1
REVISION 5

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1.0 INTRODUCTION TO VERSAR LABORATORIES, INC.

Versar Laboratories, Inc. is a fully equipped analytical chemistry laboratory that provides a broad range of analytical services and interpretive support for environmental studies. These services include chemical analyses for organic and inorganic compounds in a wide variety of sample matrices collected from sources such as air, surface water, groundwater, drinking water, wastewater, soil, industrial processes, industrial wastes, sludges, unidentified hazardous wastes, and tissues. Additional services include program management for environmental studies, sampling, analytical method development studies, laboratory data validation, and referee laboratory services. These services are provided by a staff of approximately 120 in the laboratory facilities located in Springfield, Virginia.

This Quality Assurance Plan describes the procedures used at Versar Laboratories, Inc. to provide all clients with proven, high quality services. This Quality Assurance Plan is prepared using the "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" EPA-600/4-83-004, February 1983 (QAMS-005/80) as a guideline. Incorporated into the plan are QA elements from the USEPA "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," EPA-600/4-79-019. It is a generic plan designed to provide clients with a description of the procedures that will be used to document and report accuracy, precision, representativeness, comparability, and completeness of the analytical services provided. It is also intended to be used as a template for developing project specific plans. Since this is a generic laboratory quality assurance plan and not a quality assurance project plan, there are some differences in the format as specified in QAMS-005/80. All relevant required elements of the 16-point plan have been addressed in this document. Additional elements have been added, which are required to make this a more complete generic laboratory plan.

Many items within the analytical chemistry process must be controlled in order to assure that the data quality objectives of a program are met. The process must begin with the initial plan to undertake work. The laboratory staff reviews carefully any projected

work assignment and undertakes work only after sufficient review and approval have been accomplished.

To ensure responsiveness to a client's needs, a Client Service Package (CSP) is developed by a laboratory project coordinator for the client. The CSP is designed after assessing the full range of the client's analytical needs, from regulatory requirements to reporting requirements. The CSP may be quite simple, requiring only standard methods, routine services, and routine internal quality control. However, the CSP may be extremely complex requiring custom laboratory services, methods development, especially rigorous quality control and/or a written quality assurance project plan.

Written standard operating procedures are developed within each section of the laboratory to provide the laboratories with policy and systems to control activities that have a significant impact on the accuracy or validity of results.

Training is provided internally and externally to assure that adequate knowledge and skills are developed by the analysts to provide the level of service that is demanded in the environmental analytical field.

Schedule and status control is provided to assure that the laboratory provides its clients with timely and cost effective analyses. The laboratory employs a Laboratory Information Management System to track samples through the operation. Samples and incoming work are entered into the system upon arrival. The sample information is stored in a data base which is accessible to the managers and the quality assurance staff for scheduling, tracking and monitoring.

Sample control is implemented upon arrival. All shipments are carefully inspected upon arrival. The condition of the shipment is recorded on a shipment condition report. Samples are assigned a control number and are assigned an appropriate storage location. Samples requiring refrigeration are placed in refrigerators at 4 degrees centigrade until analysis.

Facilities security control is maintained through a computerized card entry system. All entrances to the analytical laboratory are locked and accessible only by employees with an individual magnetic card identification plate.

Analytical Test Control is maintained through the quality control program which ensures that each method is carried out according to specification. Prior to analysis the work assignment is carefully planned. Work is performed only by trained technicians and analysts. The method is tested and verified to be operational prior to sample analysis. Standards and reagents are prepared and maintained to the method specification. Calibration is accomplished by the method procedures and verified to be within acceptable linearity and sensitivity ranges. Each set of samples has a defined quality control requirement. All samples are processed with the appropriate controls. The controls consist of reagent blanks, duplicate samples, reference standards, spiked samples, interference checks, etc. The control data is reviewed by the analysts and the supervisors and data is validated by the QC results prior to reporting.

Document control systems are in place to ensure that all documents created during a project are kept in a secure place for retrieval. Records are maintained in a legal manner and are kept in archival storage for 3 years or as long as is required by the program.

Surveillance is used to verify that the laboratory is performing as stated and required. Inspections of the laboratory are performed including both routine monitoring and surveillance of functional operational procedures performed, and unannounced surprise audits. Performance samples are analyzed routinely to verify that the methods are performing up to the required standards, and are used to statistically determine appropriate operational boundaries for daily testing.

Control of measuring equipment is performed as required by the methods and by good laboratory practice. Instrument manufacturers guidelines are followed. Service and routine preventive maintenance are performed as required. Standards for calibration are

obtained from certified and traceable sources and tested against second sources to verify validity.

Control of non-conformances is managed through the offices of the laboratory managers. Documentation of corrective action and deficiencies found are maintained in the project or Quality Assurance files. Weekly staff meetings are the forum for planning and reporting laboratory progress and status. Issues presented for development are discussed and the meeting provides a mechanism for quality control training. Finally, performance based discussions of laboratory quality assurance and quality control problems are held resulting in corrective action plans and reviews.

2.0 VERSAR LABORATORIES, INC. OPERATIONS QUALITY ASSURANCE MANAGEMENT, ORGANIZATION AND RESPONSIBILITY

Versar Laboratories, Inc. management organization is shown in Figure 2-1. The laboratory quality assurance management functions are the responsibility of Mr. George Oss, President of Versar Laboratories, Inc.; Mr. Scott Powers, the Laboratory Quality Assurance Officer and Technical Director; Dr. Reza Karimi, Organic Laboratory Director, and Mr. William Nivens, Inorganic Laboratory Director.

Mr. Oss has overall business and operational responsibility for all Versar Laboratories, Inc. operations. He manages the business activities of the environmental analytical laboratories. His primary focus is the business management, strategic planning, and operational control for all programs.

Mr. Powers is responsible for the implementation and enforcement of the QA/QC program. The quality assurance activities that he performs include overall quality assurance program management, program QA overview, QA reporting to corporate management, systems performance audits and development/review of project quality assurance plans. He provides the president with quality assurance oversight of all the analytical laboratory operations. He prepares a weekly quality assurance report to the president.

Dr. Reza Karimi, Director of the Organic Laboratory, manages the three organic laboratory sections: the Organic Extraction Laboratory, the Applied Chromatography Laboratory, and the GCMS Laboratory. He directs the daily operations and is responsible for all organic analytical chemistry activities.

Mr. William Nivens, Director of the Inorganics Laboratory, manages the three inorganic laboratory sections: the Metals Laboratory, the General Chemistry Laboratory, and the Asbestos Laboratory. He directs the daily operations and is responsible for all inorganic analytical chemistry activities.

Mr. Ray Anderson, Director of Client Services, manages overall client service activities and projects. He directs the activities and assignments of the program

management staff; manages, reviews and prepares related quotations and proposals; and interfaces with client and laboratories relative to client-sponsored projects to assure compliance with contractual requirements, data quality objectives, and schedules.

Mr. Eli Patxot, Business Development Manager, has overall responsibility for development of marketing strategy and implementation of tactical sales plans. In this role, he acts as both the sales/marketing manager and field sales representative.

Mr. John Crumrine, Vice President of Administration, is responsible for financial analysis for Versar Laboratories, Inc. He develops capital and operating budgets, tracks financial performance, and designs internal reporting systems for lab management. Mr. Crumrine analyzes utilization of lab resources to improve laboratory productivity, and oversees the Laboratory Information Systems Group.

Mr. Jerry Newsome, Manager of Human Resources, is responsible for personnel management of Versar Laboratories, Inc. He develops, implements, coordinates and manages policies and programs covering the following: employment, salary administration, employee relations, manpower development and training, placement, benefits and employee services.

Mr. Frank Sindler, CIH, is the director of the Industrial Hygiene Laboratory operations. As director he coordinates the combined field and laboratory programs and provides industrial hygiene expertise.

Versar Laboratories, Inc.

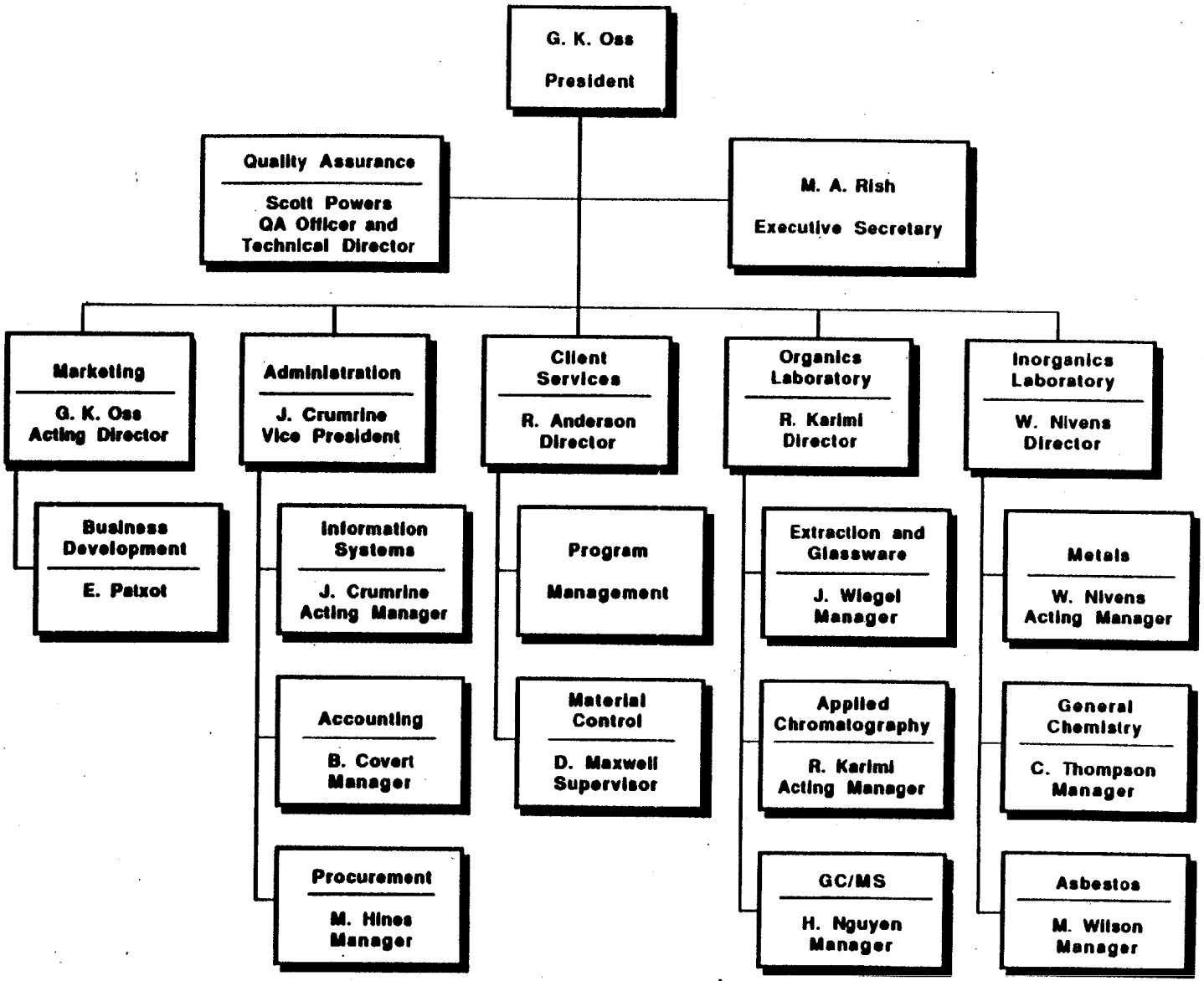

Figure 2-1
ORGANIZATION CHART

3.0 QUALITY ASSURANCE/QUALITY CONTROL

Versar Laboratories, Inc. operates under a rigorous quality assurance and quality control program designed to meet or exceed EPA requirements. This program ensures that all data generated are complete, precise, accurate, and legally defensible. The program includes documented standards of performance which are approved by the laboratory Quality Assurance Officer. In order to maintain a high level of professional acceptability, the laboratory maintains numerous state and federal agency certifications which require the performance of the laboratory to be continuously tested and evaluated through participation in independent round robin studies, through numerous on-site audits, and through performance sample analyses.

3.1 QA/QC Program Description

In order to better serve our clients, we provide a five-level approach to quality assurance/quality control. The level of QC to be used on a project is defined in the Client Service Package which is created at job inception and will be delineated at sample log-in on the batch log-in sheet by the program manager/coordinator. At all five levels, laboratory practices, documentation, and custody procedures will be maintained at the highest level of performance. The five QA/QC levels are:

Level 1 - Custom minimum quality control

Level 2 - Standard Versar Quality Control Plan (SVQCP)

Level 3 - Batch specific routine quality control

Level 4 - Drinking Water Quality Control Plan (DWQC)

Level 5 - Program/method specific quality control

QUALITY CONTROL TABLE

	Frequency				
Levels:	1	2	3	4	5
1. Method Reagent Blank	Per Batch	Per Batch	Per Batch	Per Batch	Per Batch
2. Duplicate or Duplicate Matrix Spike	0%	5%	5-100%	10%	5-100%
3. Matrix Spike	0%	5%	5-100%	10%	5-100%
4. Method Standard	0%	5%	5-100%	10%	5-100%
5. Surrogate Spikes (GC and GC/MS only)	0%	100%	100%	100%	100%

Level 1

At Level 1, minimum quality control can be provided for clients requiring screening level or merely qualitative data. Method reagent blanks are the only required QC audits. Custom GC/MS tuning calibration or method modifications can be provided. This level is provided only when deemed professionally adequate by the client and Versar Laboratories' staff, and when it meets program objectives. The data will be flagged as screening level/qualitative data indicating that minimum QC was provided (no direct accuracy or precision statement can be made) and/or that method modifications were used. This level of data is not recommended for regulatory, legal, or enforcement activities. Also, under "Ultra Rush" requests minimum audits may be employed to meet deadline and reporting requirements at the request of the client.

Level 2

At Level 2, routine internal QC is provided by the Standard Versar Quality Control Program (SVQCP). For routine laboratory services, accuracy and precision audits will be

included with every 20 samples of the same sample type, and method reagent blanks will be provided with each batch of samples. This level is recommended for routine monitoring and routine investigatory studies, land transfer assessments, and ongoing sampling and analysis programs.

Level 3

At Level 3, batch-specific QC will be provided for all batches of 20 or less samples. For batch-specific QC, the audits are the same as for the routine internal QC under the Level 1 SVQCP. This service is required for "nonroutine" services, as determined by the quality assurance officer or by each laboratory section, or at the request of the client for routine services, should the program require that laboratory QC audits be performed on project-specific samples. This level is recommended for regulatory, legal, and enforcement cases.

Level 4

At Level 4, QC is provided on batches of ten samples or less. Quarterly duplicate reference samples will be analyzed to provide precision and accuracy for verification of laboratory control limits. This level of QC is required for all drinking water analyses.

Level 5

At Level 5, we offer project-specific and method-specific quality assurance/quality control. This may include QA/QC delineated in project plans required by a contractual agreement or custom designed and provided to the client by Versar Laboratories, Inc. Project QC controls and objectives, required internal and/or external systems and performance audits, on-site inspections, and documentation requirements and deliverables are defined for each program according to the required specifications.

4.0 QUALITY ASSURANCE OBJECTIVES

Versar's overall quality assurance objectives are to meet the analytical needs of the client with respect to accuracy, precision, completeness, representativeness, comparability, legal defensibility, and timeliness. EPA precision and accuracy criteria are used as method specific criteria to accept or reject analytical data. In the absence of contract-specific contract-required QC requirements, quality control charts are used to define acceptance criteria for precision and accuracy. Versar will meet the needs of the client for precise, accurate data by adhering to these criteria or other reasonable and valid criteria.

Precision and accuracy are determined from the results of the routine laboratory QC audits. The audits are duplicates (or matrix spike duplicates), matrix spikes, and method standards. The overall laboratory quality assurance objectives for precision and accuracy are listed in Table 4-1. A complete list of precision, accuracy, completeness, and detection limit objectives can be provided upon request.

Precision is defined as the measure of the mutual agreement among individual measurements of the same chemical constituent in a sample (duplicates) secured under the same analytical protocols. Laboratory precision will be expressed as relative percent difference (RPD) of the duplicate sample values.

$$RPD = \frac{|a - b|}{(a + b)/2} \times 100$$

a = first sample value of duplicate analysis
b = second sample value of duplicate analysis

Accuracy is defined as the degree to which the analytical measurement reflects the true concentration level present. Accuracy will be measured as percent recovery for matrix spikes as the primary criteria and percent recovery of the surrogate spikes as a secondary QC criteria for GC/MS analyses.

TABLE 4-1

QUALITY ASSURANCE OBJECTIVES*

Parameter Class	Matrix	Precision	Accuracy Spike % Recovery	Completeness
Metals	Water/Soil	20%	+/- 25%	95%
Wet Chemistry	Water/Soil	20%	+/- 20%	95%
Volatile Organics	Water Soil	20% 30%	+/- 20% +/- 30%	95% 95%
Semivolatile Organics	Water Soil	30% 40%	+/- 30% +/- 40%	95% 95%
Asbestos	Bulk/Air	50%	NA	95%

*See Appendix I for specific parameter listing of DQOs.

$$\text{Percent Recovery} = \frac{SSR - SR}{SA} \times 100$$

SSR = Spiked sample result
SR = Sample result
SA = Spike added from spiking standard

Analytical completeness is the percentage of reported analytical data that is usable. Versar will achieve a high level of analytical completeness by ensuring that the work is performed by well trained analysts who know the program-specific objectives. Versar has a detailed record keeping system that documents the details of each analysis. This ensures that the analytical data will be defensible. Versar's objective for completeness is 95 percent.

An alternative means to quantify completeness can be used as shown in the following formula. This is useful for monitoring the performance of individual tests.

$$\text{Completeness} = 100 \times \frac{\text{No. of Acceptable QC Data}}{\text{Total No. of QC Data}}$$

Representativeness should be considered an objective to be achieved rather than a characteristic which can be described in quantitative terms. Representativeness can be defined as the degree to which the data accurately and precisely represents the true. Representativeness is addressed by the use of a logical and thorough sampling and analysis project plan which is based on all available knowledge of the site.

Comparability is a measure of the confidence with which one data set can be compared to another. The following measures should be taken to ensure the comparability of the data.

- Appropriate selection of sampling and analysis procedures.
- Standardized written sampling and analysis procedures.
- Standard handling and shipping procedures should be used for all collected samples.
- Results will be reported in consistent units.

5.0 SAMPLING PROCEDURES

Versar's Standard Operating Procedures for sampling entitled "Monitoring Services Department Minimum Standards of Operation and Performance" (MSOP 1.0 through 18.0) are a compilation of current state of the art procedures developed by various sources and of procedures that have been developed throughout field experience. References are listed at the end of this section. In general, our accepted procedures are derived from EPA's NPDES sampling criteria, EPA's Effluent Guidelines Division's sampling procedures, and from years of operating the specific equipment that Versar typically uses in the field. Sampling is usually performed by Versar's Technical Operations Division.

Versar Laboratories, Inc. (VLI) also provides sampling containers at the request of clients for collection of samples to be analyzed at VLI. In order to assure that the sample bottles are clean, all sample bottles provided are new and are never reused. Containers are Eagle Pitcher Level 1, which are cleaned by EPA procedures and quality control tested. VLI maintains on file documentation of analyte-free status of all lots of sample bottles in the form of a Certificate of Analysis, and traceability to lot number is maintained for all bottles shipped on the bottle kit request form. Trip blanks are normally sent with the sample bottles for quality control purposes. Table 5-1 (page 7 of this section) lists the EPA-approved containers, the appropriate preservatives, and the holding times for some frequently performed analyses. The appropriate decontamination procedures for field sampling equipment are covered in the Monitoring Services MSOPs.

The following sampling procedures are followed unless otherwise specified by combined quality assurance/work plans, a short-form quality assurance plan, or by field supervisors.

5.1 Grab Samples

A grab sample is defined as a discrete sample collected over a period of time that is shorter than 15 minutes. The information gained from a grab sample is limited in that it only represents existing conditions at the time of collection. For that reason, grabs are not the preferred method of collection unless we are attempting to:

(a) Confirm composite sample characteristics.

(b) Provide minimum and maximum concentration information.

(c) Characterize waste streams at a specific point in time.

(d) Collect a manually composited sample.

In addition, there are specific parameters that must be collected as grab samples because of physical, chemical, or biological degradation. These parameters are:

- pH
- Temperature
- Dissolved oxygen
- Residual chlorine
- Fecal coliform
- Oil and grease
- Cyanide
- Phenols
- Volatile organics, THMs

Volatile organics (VOA and THM) samples should be collected directly into the 40 ml VOA vials. Duplicate VOAs should always be collected and filled in the same manner. When filling, avoid entrainment of air. A valid VOA sample is one where no bubble appears when the filled, capped vial is inverted.

5.2 Composite Samples

Versar typically uses three techniques to collect composite samples. These techniques are:

1. Manually composited, discrete grab samples.

2. Manually composited, discrete automatic samples.

3. Automatically composited samples.

Regardless of the method of collection, there are minimum standards to be adhered to.

1. A composite sample must be made up of at least eight aliquots.

2. Each aliquot must be at least 100 mls in volume.

3. If the flow of the waste stream is known to vary by more than 15 percent from the average flow, every attempt should be made to collect samples proportional to the flow.

4. Sample aliquots must be refrigerated immediately after collection; automatic samples must be refrigerated during collection.

5. Sample aliquots must be appropriately preserved (see Table 1) immediately after collection.

6. Volumes of automatically collected samples must be confirmed by placing a graduated cylinder under the sample delivery tube. Do not rely upon automatic sample volume settings.

7. Samples should be collected at a well-mixed location in the stream at a depth of 0.4 to 0.6 total depth.

8. Manual flow (or depth) measurements must be taken to confirm flow meter operation at least on set-up and take-down and preferably more frequently.

9. A sample becomes a sample upon combination of the last aliquot. At that time, holding time limitations begin.

10. When splitting composite samples, the composite container must be well shaken before each portion is poured. Samples to be analyzed for solids should be poured first.

11. Other than proper preservatives, nothing should be placed into the sample. This includes pH paper or probe. To confirm proper preservation of pH, pour a small portion of preserved sample into a beaker and test with pH paper or probe.

12. Preservatives may be added to containers during bottle kit preparation prior to shipment to the field.

13. Every effort should be made to collect a sample aliquot at least every 30 minutes.

In general, field quality control procedures are specified by program requirements and are therefore beyond the scope of this plan. Certain equipment set-up procedures do include QC procedures and shall be strictly followed. In all cases, actual procedures used or deviated from the work plan or standard procedures shall be documented in field notebooks and discussed in trip reports.

5.3 Glassware and Container Cleaning Procedures

5.3.1 Specifications

All glassware is cleaned by the procedures below and checked before using. A clean glass surface wets evenly and does not spot. Broken, cracked, or defective glassware should not be used. Damaged specialty glassware should be saved for repair by a contract glass blower. Low-cost or heavily damaged items should be discarded. Broken glassware should be rinsed or otherwise decontaminated if necessary, then placed in trash receptacles.

Class A volumetric glassware, marked with a large A, meets ASTM specifications and should be used for everything unless you are certain larger tolerances are acceptable.

5.3.2 Cleaning Procedures

5.3.2.1 Trace Metals Labware Cleaning Procedures

A. Volumetric Flasks:

1. Rinse once in tap water.
2. Rinse once in deionized water.
3. Rinse twice with 1:1 HNO_3 (nitric acid).
4. Rinse three times with deionized water.
5. Place in drying chamber with stopper in place.
6. Inspect for cleanliness and return to laboratory.

B. All Other Glassware:

1. Scrub glassware with soap and water.
2. Rinse once in tap water.
3. Rinse once in deionized water.
4. Rinse twice with 1:1 HNO_3.
5. Rinse all glassware three times with deionized water.
6. Place all glassware on cart until dry.
7. Inspect for cleanliness and return to laboratory.

5.3.2.2 Organic Laboratory Glassware Washing Procedure[1]

Prior to delivering dirty glassware to the glassware washing facility, discard sample/contents, remove stoppers and stopcocks, and rinse with the final solvent used, then rinse with tap water.

Washing Procedures:

1. Wash glassware with hot water and soap. Use a clean brush to scrub all inside surfaces.
2. Rinse six times with warm tap water until all soap is removed.
3. Rinse six times with deionized water.
4. Rinse three times with pesticide grade acetone.[2]
5. Bake in blue M oven at 450°C overnight.
6. Should additional cleaning methods be required for getting unusually dirty glassware clean, the staff member who submitted the glassware is contacted.

5.3.2.3 Procedures for Cleaning General Inorganic Chemistry Laboratory Glassware

1. Remove any markings on glassware with technical grade acetone.
2. Wash glassware with warm phosphate-free soapy water.
3. Rinse three or four times with tap water.
4. Rinse two times with 1:1 HCL.
5. Rinse four or five times with deionized water.
6. Inspect for cleanliness.

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[1]Federal Register, Method 608, December 3, 1979, page 69501

[2]Use Teflon-squeeze bottles. All solvent waste must be collected and transferred to the flammable solvent waste drum.

NOTES:

1. Phosphorus glassware (marked by red line) should not be washed with any soap.

2. TKN digestion flasks should be covered with aluminum foil.

3. To remove stains in hard to clean glassware, chromerge or saturated KOH ethanol can be used.

4. All glassware must be dry before returning to laboratory for storage.

5. Rinse all glassware three times with deionized water.

6. Place all glassware on cart until dry.

7. Inspect for cleanliness and return to laboratory.

TABLE 5-1
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Container[a,b]	Preservative[c,d]	Holding Time[e]
		Inorganic Tests	
Acidity	250 ml P or G	Cool, 4°C	14 days
Alkalinity	250 ml P or G	Cool, 4°C	14 days
Asbestos	P or G	Not Applicable	Not Applicable
Biochemical Oxygen Demand (BOD)	1 liter P or G	Cool, 4°C	48 hours
Carbon (Inorganic)	250 ml G w/Teflon	Cool, 4°C	24 hours
Carbon (Organic)	250 ml G w/Teflon	Cool, 4°C H_2SO_4, ph <2	28 days
Color	100 ml P or G	Cool, 4°C	48 hours
Cyanide[f]	1 liter P or G	Cool, 4°C NaOH, pH >12 0.6g ascorbic acid[g,h]	14 days[i]
Fluoride	1 liter P only	Cool, 4°C	28 days
Nitrogen:			
Ammonia	500 ml P or G	Cool, 4°C H_2SO_4, pH <2	28 days
Kjeldahl (total)	500 ml P or G	Cool, 4°C H_2SO_4, pH <2	28 days
Nitrite	250 ml P or G	Cool, 4°C H_2SO_4, pH <2	48 hours

TABLE 5-1 (Continued)
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Container[a,b]	Preservative[c,d]	Holding Time[e]
Nitrate	250 ml P or G	Cool, 4°C	48 hours
Oil and Grease	1 liter G w/Teflon	Cool, 4°C H_2SO_4 or HCl, pH <2	28 days
Orthophosphate	500 ml P or G	Cool, 4°C filter immediately	48 hours
pH	100 ml P or G	Cool, 4°C	Analyze immediately[j]
Phenols (Total)	500 ml G w/Teflon	Cool, 4°C H_2SO_4, pH <2	28 days
Phosphorus (Elemental)	500 ml G w/Teflon	Cool, 4°C	48 hours
Phosphorus (Total)	500 ml P or G	Cool, 4°C H_2SO_4, pH <2	28 days
Specific Conductivity	100 ml P or G	Cool, 4°C	28 days[k]
Sulfide	500 ml P or G	Cool, 4°C and zinc acetate and sodium hydroxide to pH >9	7 days
Total Dissolved Solids (TDS)	500 ml P or G	Cool, 4°C	7 days
Total Suspended Solids (TSS)	500 ml P or G	Cool, 4°C	7 days
Turbidity	500 ml P or G	Cool, 4°C	48 hours
Anions (NO_3, SO_4, Cl, F)	1 liter P or G	Cool, 4°C	28 days

TABLE 5-1 (Continued)
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,
AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Container[a,b]	Preservative[c,d]	Holding Time[e]
		Metals	
Extraction Procedure Toxicity Test (EP TOX) [As, Ba, Cd, Cr, Pb, Se, Ag, Hg]	1 liter P or G	Cool, 4°C	6 months (except Hg, 28 days)
Priority Pollutant[l] (PP metals) [As, Se, Pb, Sb, Be, Cd, Cr, Cu, Ni, Ag, Tl, Zn, Hg]	1 liter P or G	Cool, 4°C HNO_3, pH <2	6 months (except Hg, 28 days)
Chromium VI	250 ml P or G	Cool, 4°C	24 hours
Mercury	250 ml P or G	Cool, 4°C[l] HNO_3, pH <2	28 days
Silica	250 ml P only	Cool, 4°C	28 days
		Organic Tests	
Purgeable Halocarbons	2 x 40 ml Teflon septa	Cool, 4°C Ascorbic Acid[g, h]	14 days
Purgeable Aromatics	2 x 40 ml G w/Teflon	Cool, 4°C Ascorbic Acid[g, h] HCl or $NaHSO_4 \cdot H_2O$, pH <2	14 days (7 days without preservative)
THMS	4 x 40 ml Teflon septa	Cool, 4°C Ascorbic Acid[g, h] HCl or $NaHSO_4 \cdot H_2O$, pH <2	14 days (Not valid without preservative)
Purgeable DW VOC	4 x 40 ml Teflon septa	Cool, 4°C Ascorbic Acid[g, h] HCl or $NaHSO_4 \cdot H_2O$, pH <2	14 days (Not valid without preservative)

TABLE 5-1 (Continued)
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,
AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Container[a,b]	Preservative[c,d]	Holding Time[e]
Base Neutral[m] and Acid Extractable Compounds (BNAs)	1 gallon G w/Teflon	Cool, 4°C 0.008% $Na_2S_2O_3$[g]	7 days to extract 40 days to analyze
Polychlorinated[m] Biphenyls (PCBs)	1 gallon G w/Teflon	Cool, 4°C 0.008% $Na_2S_2O_3$[g]	7 days to extract 40 days to analyze
Pesticides[m]	1 gallon G w/Teflon	Cool, 4°C 0.008% $Na_2S_2O_3$[g] pH 5-9[n]	7 days. to extract 40 days to analyze
Nitrosamines[m,o]	1 gallon G w/Teflon	Cool, 4°C 0.008% $Na_2S_2O_3$[g] store in dark	7 days to extract 40 days to analyze
Metals (Total) Matrix - Water	1 liter P or G	Cool, 4°C HNO_3 to pH <2	6 months (except Hg)
Metals (dissolved) Matrix - Water	1 liter P or G	Filter on site Cool, 4°C HNO_3 to pH <2	6 months (except Hg)
Metals (Total) Matrix - Soil	250 ml wide mouth P or G	Cool, 4°C	6 months (except Hg)
Mercury Matrix - Water	250 ml P or G	Cool, 4°C HNO_3 to pH <2	28 days
Mercury Matrix - Soil	250 ml wide P or G	Cool, 4°C	28 days
Cr 6+ Matrix - Water	250 ml P or G	Cool 4°C	24 hours

TABLE 5-1 (Continued)
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,
AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Container[a,b]	Preservative[c,d]	Holding Time[e]
TCLP or EP Toxicity Test Metals Matrix - water/ soil	1 liter P or G/ 500 ml wide mouth P or G	Cool 4°C	6 months (except Hg)

TABLE 5-1 (Continued)
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,
AND HOLDING TIMES FOR AQUEOUS SAMPLES

(a) Polyethylene (P) or glass (G)

(b) All glass containers are to be sealed with either Teflon-lined caps or Teflon-lined septa.

(c) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

(d) When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of this table, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation, has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric Acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.15 or greater); and sodium hydroxide (NaOH) in water solution at concentrations of 0.080% by weight or less (pH about 12.30 or less).

(e) Maximum holding time measured from date of sample collection.

(f) Cyanide - total, amenable to chlorination, and free (weak and dissociable). If cyanide in air is to be analyzed, a 0.1 M solution of NaOH is to be used as the gas scrubbing solution, and no further preservation is necessary.

(g) Should be used only in the presence of residual chlorine.

(h) The presence of residual chlorine can be determined by testing the sample with KI-Starch paper. If chlorine is present, the sample must be treated with ascorbic acid until a negative spot test is obtained, and then an additional 0.5 g of ascorbic acid added. For Cn, the sample must then be filtered and NaOH added to pH >12. For volatiles, VLI uses sodium bisulfate preservative unless HCL is otherwise specified.

(i) Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH >12.

TABLE 5-1 (Continued)
EPA-REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,
AND HOLDING TIMES FOR AQUEOUS SAMPLES

(j) pH should be measured at the time of sample collection whenever possible. If the pH cannot be measured within 24 hours this should be noted.

(k) Specific conductivity should be measured at the time of sample collection whenever possible.

(l) Samples should be filtered immediately onsite before adding preservative for dissolved metals.

(m) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate.

(o) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sample collection.

REFERENCES

1. USEPA SW-846, Office of Solid Wastes, Washington, D.C. 1982.

2. Methods for Chemical Analysis of Water and Wastes, USEPA 600/4-79-020, Revised March 1983.

3. USEPA 40 CFR Part 136, Federal Register, Vol. 49, No. 209, October 26, 1984; Vol. 50, No. 3, January 4, 1985; Vol. 51, No. 125, June 30, 1986; and Vol. 52, No. 171, September 31, 1987.

4. USEPA Inorganics Contract Lab Program, SOW 7/87, July 1988.

5. USEPA Organic Contract Lab Program, SOW 7/87, July 1987.

6. Standard Methods for the Examination of Water and Wastewater, 16th Ed., 1985.

6.0 SAMPLE CUSTODY

Sample custody begins at the time of sample collection. Versar's field sampling and laboratory sample custody procedures are designed to maintain control of all samples and associated documents which may be used as legal evidence from collection to reporting. The entire perimeter of the laboratory is protected with an electronic entry system that records the identity of any individual opening a laboratory door. The sample receiving and tracking system is designed to meet the evidence requirements of all of our clients.

6.1 Field Sample Custody

In the field, sample custody is initiated by recording the sample collection information in the field notebook, affixing a sample label with sample number on the sample container, and placing the sample into an iced cooler, or appropriate container, in the possession of the designated field sample custodian. A line item on the field chain of custody form (Figure 6-1) will immediately be filled out and initialed by the field sample custodian. The following information is recorded on the chain of custody form:

1. Project Number
2. Project Name
3. Sampler's Name
4. Field Sample Number
5. Date
6. Time
7. Type of Sample
8. Station Location
9. Number of Containers
10. Analytical Test Parameters

6.2 Laboratory Sample Receipt

Environmental samples generally arrive at the laboratory in coolers via an overnight courier service. Upon arrival, the shipment is inspected, and a shipment condition report is filled out (Figure 6-2). After the coolers are checked for intact custody seals, the container temperature is checked and recorded, and the samples are unpacked. A chain of custody report should accompany each set of samples received in the laboratory. The

Versar Laboratories INC.

CHAIN OF CUSTODY RECORD

PROJECT NO.	PROJECT NAME					PARAMETERS									INDUSTRIAL HYGIENE SAMPLE Y / N
SAMPLERS: *(Signature)*					(Printed)										
FIELD SAMPLE NUMBER	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS									REMARKS

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
(Printed)		(Printed)	(Printed)		(Printed)

Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks
(Printed)		(Printed)		

Distribution: Original Plus One Accompanies Shipment (white and yellow), Copy to Coordinator Field Files (pink)

FIGUR -1

VERSAR'S CHAIN-OF-CUSTODY RECORD

Versar Laboratories INC.

FIGURE 6-2

SAMPLE RECEIVING CHECKLIST
SHIPMENT CONDITION INSPECTION UPON ARRIVAL

CONTROL NO.: _____ DATE RECEIVED: _____

JOB CODE: _____ DATE INSPECTED: _____

INSPECTED BY: _____ TIME INSPECTED: _____
(Print Name)

PAPERWORK:	YES	NO	INTACT	BROKEN
Hand Delivered	____	____		
Airbill	____	____		
Cooler Custody Seals	____	____	____	____
Bottle Custody Seals	____	____	____	____
Chain of Custody	____	____		
Traffic Reports	____	____		
Sample Tags	____	____		
Tags Listed on Chain of Custody	____	____		

SAMPLE CONDITION:	COOL	AMBIENT	WARM	HOT	DEGREES C
Cooler Temperature	____	____	____	____	____

	YES	NO	
Ice	____	____	MELTED
Bottles Broken	____	____	
Bottles Leaking	____	____	
Preservation pH	____	____	____ ____
	OK	Not OK	Not Checked Not Applicable

SHIPMENT CONDITION:				
	____	____	____	____
	OK	Not OK	Major	Minor

PROBLEMS AND COMMENTS:

_____

_____

_____

_____ _____
Signature Date

Date	Time	RELINQUISHED BY	RECEIVED BY	PURPOSE OF CHANGE OF CUSTODY
		PRINTED NAME	PRINTED NAME	
		SIGNATURE	SIGNATURE	
		PRINTED NAME	PRINTED NAME	
		SIGNATURE	SIGNATURE	
		PRINTED NAME	PRINTED NAME	
		SIGNATURE	SIGNATURE	
		PRINTED NAME	PRINTED NAME	
		SIGNATURE	SIGNATURE	
		PRINTED NAME	PRINTED NAME	
		SIGNATURE	SIGNATURE	

information on the chain of custody is checked against the samples shipped. Every sample shipped should appear on the chain of custody report. If the samples shipped match the chain of custody, the latter is signed and the laboratory assumes responsibility for the samples. If problems are noted with the sample shipment, the problems are noted on the shipment condition report. The chain of custody record is signed, and the problems are written in the remarks box of the form. Except for volatiles, samples that require preservation, will have their pH checked and recorded. For volatile samples that are analyzed 7 days after sample collection, the pH must be checked after the samples are analyzed. For coolers that require actual temperature measurement, the temperature will be measured with a thermometer and recorded on the shipment condition report.

For some contracts there is additional paper work included with a sample shipment. This paper work may be a traffic report or a sample information sheet. There is usually one traffic report for every sample shipped in a particular set. The traffic report gives specific details on the sample it represents, and it must be signed in conjunction with the chain of custody report. Any missing samples, missing sample tags, broken sample bottles, or unpreserved samples are noted on the appropriate documents (i.e., chain of custody, traffic reports, and shipment condition reports). If there are problems with any individual samples, the sample custodian informs the project coordinator about the problems so that he or she can contact the contract representative and arrive at a viable solution to the problem.

6.3 Computer Log-in

All samples received are logged into the Versar Laboratory Information Management System (VLIMS). The following information is entered into the computer:

1. Client Company Name
2. Versar Laboratory Job Code and Number
3. Case Number
4. Sampling Site Name
5. Sample Delivery Group Number

6. Quote Number
7. Charge Number
8. Log-in Persons Initials
9. Laboratory Project Manager Name
10. Receipt Date
11. Internal Due Date
12. External Report Date
13. Disposal Date
14. Batch Comments
15. Field Number
16. Matrix
17. Storage Location
18. Test Code
19. Number of Bottles

6.4 Sample Storage

After log-in, samples are immediately placed in refrigerators at 4°C ± 2°C. Samples are kept in cold storage for 100 days from sample receipt, or until analyzed and project approval is granted for disposal. Longer term storage is available upon request.

6.5 Sample Disposal

On a monthly basis, the storage refrigerators are purged of completed samples. A list of all sample batches that have been stored in excess of 100 days is generated. The disposal list is circulated among the project coordinators who have samples on the list.

Samples on the disposal list which are deemed to be disposable are removed from the storage refrigerators and disposed of in the appropriate manner.

6.6 Laboratory Sample Security and Chain of Custody

All samples are stored in a secure sample storage refrigerator. The storage refrigerators are all located in sample receiving on the laboratory level of the building. Access to the laboratory level of the building and to sample receiving is limited to Versar employees and escorted visitors.

This security is achieved by use of a magnetic card key door locking system. In order to attain access to the laboratory level of the building or sample receiving one must have a magnetic card key. Each card key is uniquely coded to identify the individual employee. Only Versar employees are issued magnetic card keys. Any entry to the laboratory level of the building is logged by the magnetic card key reader and, therefore, all movement into or out of the laboratory level is kept on a permanent record.

Documentation of sample movement to and from the refrigerators and to and from the laboratory sections is provided on the sample chain of custody form shown in Figure 6-3.

All sample log-in information relevant to any sample is secured in the VLIMS through a computer password security system. Access to the database is limited to approved users and editing and modification privileges are restricted to the VLIMS manager and his assistant. The data base is backed up every night, and a full backup completed every week, to ensure protection against tampering and critical damage to the database due to hardware or other failures. A hardcopy of all of the computer sample database is maintained in case of catastrophic computer failure resulting in loss of the electronic records. These records include the batch log-in form, the parameter request sheet, and the shipment condition report.

FIGURE 6-3

SAMPLE CHAIN OF CUSTODY

CONTROL NO. ________ Page __ of __

Date	Time	Relinquished By	Received By	Purpose of Change of Custody
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	
		Printed Name Signature	Printed Name Signature	

7.0 CALIBRATION PROCEDURES AND DETECTION LIMITS

7.1 Calibration

All instruments are calibrated each day that analyses are performed. The calibration procedures described in the appropriate analytical methods will be followed. Where deviations or modifications to these procedures are necessary or requested, documentation of the modifications and the reasons for their implementation will be presented in the analytical report.

The calibration procedures described in the analytical methods are frequently quite lengthy and detailed. They will not be reiterated in this QA plan. Below is an overview of the typical calibration procedures used for the various analytical instruments and methods used at Versar.

Instrument	Procedure
GC and HPLC	Meet chromatographic acceptance criteria (such as degradation, peak shape, sensitivity, signal to noise, and retention time stability). Then do multi point initial calibration followed by daily chromatographic check and calibration check.
GC/MS	Meet MS tuning criteria followed by chromatographic acceptance criteria. Then do multi point initial calibration followed by daily chromatographic check and calibration check.
GPC	Analyze multicomponent solution to verify retention time stability. Analyze blank to verify that carry over is minimal.
pH meter	Three point calibration at pH 4, 7, and 10. Calibration check after every 10 samples.
Conductivity meter	Calibration check daily and every 20 samples.
UV spec	Daily multi point calibration. Check standard every 20 samples.
Technicon	Daily multi point calibration. Check standard every 20 samples.

Instrument	Procedure
TOC	Daily single point calibration in triplicate. Check standard every 20 samples.
TOX	Daily calibration check. Check standard every 20 samples.
IC	Daily multi point calibration. Check standard every 20 samples.
Analytical Balance	Prior calibration check with 50 g, 1 g, and 50 mg class S weights. Other checks as appropriate in expected weighing range.
Thermometers	Checked against NBS thermometer every 6 months.
Flame AA	Daily four-point calibration. Check standard and blank analysis after every 10 samples.
Furnace AA	Daily four-point calibration. Check standard and blank analysis after every 10 samples.
Hg Analyzer	Daily four-point calibration. Check standard and blank analysis after every 10 samples.
ICP	Daily two-point calibration. Interference check sample analysis every 8 hours. Check standard and blank analysis after every 10 samples.

7.2 Detection Limits

Detection limits should be determined for all methods of quantitative analysis to evaluate method performance. Detection limit determinations can be accomplished using a variety of techniques. The specifications, frequency and procedures used for the determination of method detection limits (MDL) and instrument detection limits (IDL) are usually established either by the program (contract), the method protocol, state and federal certification regulations, or NPDES and SPDES permit requirements. These become minimum standards for reporting and quantification that are required for specific program objectives. They may not be a measure of the true detection limit, but rather are a practical application level which the laboratory must demonstrate that it can achieve by the appropriate procedure.

Detection limits for many analytical procedures are frequently highly dependent on the matrix of the sample or material that is tested. Instrument detection limits are established through testing to verify that the equipment and methods are performing to the method specifications. Once that is accomplished, the calibration and blank levels are monitored on a daily basis to verify that sensitivity is maintained and that detection limits are not affected by laboratory reagent contamination. Once that has been accomplished, the detection limit becomes a measure of the individual sample performance with the test. Interferences frequently require sample dilution and or method modifications which change the detection limit.

The method detection limit (MDL) determination contained in the Federal Register, 40 CFR 136 Appendix B (Revision 1.11) is used for the USEPA methods analysis of water and wastewater under the Safe Drinking Water Act (SDWA) and the National Pollutant Discharge Elimination System (NPDES). In the state of New Jersey it is a requirement for certification in EPA 500 and 600 series methods. This MDL method is applicable to a broad range of analytical methods and is device- or instrument-independent.

For methods, such as CLP, instrument detection limits are established prior to sample testing. Minimum detection limits must be met to ensure that sensitivity is not limited by poor instrument performance, but rather only by sample and matrix interaction. The detection limits are determined for each instrument, and instruments that do not meet method performance criteria are either repaired, if there is a problem, or not used if they do not meet the program or method requirements.

The quarterly instrument detection limit (IDL) determination is a USEPA CLP method requirement for inorganics TAL analyses. However, quarterly IDLs are also a NYSDEC requirement for organics superfund TCL analyses. The IDL procedures are contained in the USEPA CLP Inorganics SOW 788 and the USEPA CLP Organics SOW 785.

8.0 ANALYTICAL PROCEDURES

As judged appropriate by senior staff members and when available, approved EPA analytical procedures will be used. When they are not available, alternative sources are used. These may include Standard Methods; methods from other government organizations such as USGS, FDA, USDA, NIOSH, DOE, and DOD; methods from private organizations such as ASTM and AOAC; and methods found in the peer reviewed literature. Most of the methods used routinely at Versar can be found in the following documents listed below. Method writeups for the major routine tests performed are provided in the laboratory section standard operating procedures.

8.1 Analytical Procedure References

1. Test Methods for Evaluating Solid Waste, U.S. EPA, Office of Solid Waste and Emergency Response, November, 1986, SW-846, Third Edition.

2. Federal Register. Vol. 49, No. 209. Friday, October 26, 1984. 40 CFR 136. Guidelines Establishing Test Procedures for the Analysis of Pollutants under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule. Appendix A - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. Appendix B - Definition and Procedure for the Determination of Method Detection Limit. Appendix C - Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

3. U.S. EPA Contract Laboratory Program. Statement of Work for Inorganics Analysis, Multi Media - Multi Concentration. SOW No. 7-88.

4. U.S. EPA Contract Laboratory Program. Statement of Work for Organics Analysis, Multi Media - Multi Concentration. SOW No. 10-86; Revised 1-87, 2-87, and 7-87.

5. U. S. EPA, Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Revised March 1983.

6. U. S. EPA, Handbook for Analytical Quality Control in Water and Wastewater Laboratories. March 1979, EMSL. EPA-600/4-79-019.

7. NIOSH Manual of Analytical Methods, Third Edition. U.S. Department of Health and Human Services. NIOSH Publication 84-100, February, 1984.

8. Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition. Americal Pubic Health Association, 1985.

9. U.S. EPA Contract Laboratory Program. Statement of Work for Inorganics Analysis, Multi-Media - Multi-Concentration. Document No. ILMO1.0. SOW No. 3-90.

10. U.S. EPA Contract Laboratory Program. Statement of Work for Organics Analysis, Multi-Media - Multi-Concentration. Document No. OLMO1.0. SOW No. 3-90.

8.2 Standard Operating Procedures

Versar Laboratories maintains a comprehensive set of Standard Operating Procedures. Standard Operating Procedures (SOPs) are written for use by the laboratory staff to provide step-by-step instructions for each operation performed in the laboratory. The SOPs are either internally written documents describing how a particular method or operation is performed at Versar, or may be an externally written document (such as the Inorganic or Organic CLP SOWs) which must be followed to the letter according to contractual agreements. Laboratory personnel are responsible for recording their operating procedures, and require QA and senior management review approval.

SOPs are the key to documentation and verification that methods and techniques used in the laboratory are appropriate and that work is performed correctly. They are also instrumental in training employees in new techniques and implementation of new methods in the laboratory. Written documents are required in order to minimize misinterpretation, confusion and to verify that the correct interpretation of the method procedures are understood. The written documents should provide the analyst with in-depth thinking about the content of the procedures. It is recommended that the laboratory SOPs be updated biannually. They should include procedural notes about common problems, pitfalls, shortcomings, difficulties, or peculiarities of the procedures which are obtained through the experience of application of the methods to real samples under routine operational conditions. They are to be simple straightforward "how-to-do-it" instructions describing all of the detailed steps of the procedure to be completed.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Versar's data reduction procedures are designed to include multiple levels of data review. Wherever possible, the initial data reduction is computerized. This reduces the frequency of transcription errors and calculation errors. In situations where the data reduction has not been computerized, calculations are performed in permanently bound laboratory notebooks. The data reduction for some analyses includes analyst interpretation of the raw data and manual calculations. When this is required the analysts decisions will be written in ink on the raw data.

9.1 Data Reduction and Data Validation

Data validation begins with the analyst and continues until the data is reported. Every analyst is aware of the internal quality control checks for each sample, and every analyst knows that outliers require corrective action. Thus, most data validation occurs at the moment when the data is generated. At the conclusion of an analysis, the analyst will give the completed analyses to the laboratory supervisor or the data reduction staff. The data is given a second technical review during this process, and a report is prepared. The program manager or a designated data quality manager does a final review and approves the report for release to the client. This three level review process means that Versar's data has been through an extensive data evaluation before it is reported to the client. Data is flagged using CLP convention, and the flags used can be found in Table 9-1. Data validation is performed using U.S. EPA's "Functional Guidelines for Data Validation of Organics, Pesticides and Inorganics." This is performed as a separate QA service and is applied to Versar's own data on request.

After data is reported the raw data and copies of the report are filed for long term storage. In the absence of other instructions, data is stored for three years.

TABLE 9-1
ORGANICS LABORATORY
DATA QUALIFIERS

J - For Tentatively Identified Compounds: Estimated value. This flag is used when estimating a concentration for tentatively identified compounds where a 1:1 response factor is assumed.

For Target Compounds: This flag is used when mass spectral data indicates the presence of a compound but the result is less than the specified detection limit but greater than zero.

B - This flag is used when the analyte is found in the blank as well as the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.

X or T - This flag states that the mass spectrum does not meet criteria for confirmation, but does indicate compound presence.

U - This flag states that the compound was analyzed for but was not detected. The number is the minimum attainable detection limit for the sample.

INORGANICS LABORATORY
DATA QUALIFIERS

Value - If the result is a value greater than or equal to the instrument detection limit but less than the contract required detection limit, report the value in brackets (i.e., [10]). Indicate the analytical method used with P (for ICP/Flame AA) or F (for furnace).

U - Indicates element was analyzed for but not detected. Report with the detection limit value (e.g., 10U).

E - Indicates a value estimated or not reported due to the presence of interference. Explanatory note included on cover page.

S - Indicates value determined by method of standard addition.

N - Indicates spike sample recovery is not within control limits.

* - Indicates duplicate analysis is not within control limits.

+ - Indicates the correlation coefficient for method of standard addition is less than 0.995.

DF - Dilution factor.

SD - Sample used for ICP serial dilution.

M - Indicates duplicate injection results exceed control limits

W - Post digestion spike for furnace AA is outside control limits (85-115%) while sample absorbance is <50% of spike absorbtion.

Flags excerpted from and established by the US EPA Contract Lab Program (CLP) protocol.

9.2 Analytical Reports and Narratives

An analytical narrative is written for each laboratory report. The purpose of the narrative is to provide an overview of the analysis performed and a discussion of any problems and corrective actions that affect the final results.

In general, narratives should be (1) clear and easy to understand, (2) honest, and (3) polite. We should avoid analytical jargon and long sentences. The best narratives will be short and comprehensible to a technically unsophisticated person, and informative to a technically sophisticated person.

Narratives should be on Versar letterhead, second page with no address at the bottom. The print quality must be good, and whenever possible they should be printed on a laser printer.

9.2.1 Narrative Introduction

The introduction to the narrative should contain:

- the date the narrative was written
- the clients name, project number, and site
- the Versar project number, batch ID, and batch control number
- the sample numbers
- the receipt date
- the analyses requested
- the method(s) used to perform the analyses

A general statement about the results and the quality control data can be included in the introduction. For example, "None of the samples contained cyanide or sulfide above the method detection limit. All quality control results were in control".

9.2.2 Narrative Detail

The body of the narrative should contain:

1. A statement about the condition of the samples upon arrival.

2. A statement about holding times. Were they met? If not which samples are affected? What is the technical impact. If they were not met the details should be explained with a table rather than with a bunch of sentences.

3. A paragraph about spike recoveries and control sample recoveries. Note any outliers and the impact on the interpretation of the data.

4. A paragraph about calibration results and instrument control and stability checks (such as interference checks, retention time checks, tunes). Were the calibration criteria met? If not, what was not met and what is the impact.

5. A paragraph about blank results. If compounds were present in the blank what is the impact on the quality of the data.

6. A paragraph about duplicate precision with a discussion of the impact if the precision did not meet criteria.

7. A discussion of any other significant problems and the impact of the problems. Note that if the problems have no impact, they are not problems in the eyes of our clients.

The body of the narrative should be as brief as possible. If all holding times were met, simply state that all holding times were met. If all criteria were met, the body of the narrative should contain about six short sentences addressing the individual items and stating that the criteria were met. If some of the items in the body of the narrative are open to interpretation or required a lengthy thought process, we should briefly state the problem and our conclusions in the narrative. If a more detailed discussion of the interpretation is necessary, it should be referenced in the narrative and included in the full report with the raw data. These detailed discussions should not be in the narrative or in the data summary report.

The conclusion of the narrative should contain:

1. A summary of any ongoing actions on these samples. If we are reanalyzing anything or if the data needs more work, state this. Provide an expected date of completion and delivery of results. When you do this you are making a commitment to the client, so make sure you can deliver what you promise.

2. A point of contact for any questions.

3. For private clients a sentence thanking them for choosing Versar for their analytical services.

4. A closing statement stating that release of the data has been authorized by the Laboratory Manager or his designee as verified by the signatures.

9.2.3 Narrative Review

Review is a critical need. The word processor spell checker must be used prior to publishing, and proof read the document before delivering to the section chief for sign off. Technical peer review is always recommended, as the author may become blind to obvious mistakes, particularly when rushed.

9.2.4 Narrative Approval Signatures

The narrative should be signed by the author. It also must be reviewed and signed by either the appropriate section chief or, in the absence of the section chief, another person (preferably a supervisor) designated by the section chief. A list of approved sign off personnel should be included in the section SOP. This level of review and approval for release of data should not involve checking the accuracy of the narrative by looking through the data package. We already do enough of that. The review should look for obvious blunders and oversights in the narrative, the quality of the presentation, and the overall clarity. It should verify that problems are accurately and clearly described, that they are appropriately interpreted, and that the data is of quality that can be delivered to the client.

10.0 INTERNAL LABORATORY AND FIELD QUALITY CONTROL CHECKS

10.1 Laboratory Quality Control Checks

Internal quality control checks are part of the day to day operations at Versar. The quality control checks start in the field and are continued in the laboratory by the chemists and technicians who prepare and analyze the samples. The QC results of their analyses are compared against the appropriate quality control criteria. The laboratory supervisors are responsible for ensuring that the work is completed on time, using good laboratory practice, with all quality control checks acceptable. The data processing chemists and the data quality managers also review the analytical data for quality control outliers.

The key to the internal quality control checks in the laboratory are the day to day checks to ensure that the analyses are proceeding within criteria. For routine services, internal quality control checks include:

1. Method Blank
2. Duplicate or Duplicate Matrix Spike
3. Matrix Spike
4. Method Standard
5. Surrogate Spikes

These internal QC checks are vital in evaluation of laboratory performance. Additional QC checks can be applied based on program needs.

10.2 Field Quality Control Samples

At a minimum, field teams are responsible for the preparation and submittal of three types of QC samples:

1. Trip Blank - Fill one (two in the case of VOA samples) of each type bottle per parameter with deionized water, preserve with appropriate agent, transport to the site, handle like a sample, and return to the laboratory for analysis. One set of trip blanks must be included in each cooler used to transport volatile organic samples (soil and water).

2. Field (Equipment Blanks) - To ensure the sampling device has been effectiveley cleaned, fill the device with deionized water or pump deionized water through the device, transfer to sample bottles, preserve, and return to the laboratory for analysis. One set of field blanks for each day of field activity per source of water used in decontamination per 10 percent of the sampling equipment used must be submitted for analysis for the analytes of interest.

3. Field duplicates(Optional) - Prepare two sets of samples from a single source. Label with unique sample numbers and submit to laboratory without giving cross-referencing data to custodian or without identification as duplicates on parameter request sheet.

In many instances, program QAPs specify only select parameters blanks, such as VOA, extractables, and metals. Confirm the QA/QC requirements with the program manager before submitting to the laboratory.

Additionally, requirements for field-generated triplicates (or duplicates) will be waived by program QAPs. Field personnel should confirm this waiver before initiating field activities.

Samples being delivered to Versar after business hours should be placed in the walk-in refrigerator and logged in immediately on the following day unless prior arrangements are made.

Any requests for analysis outside of routine analyses performed by Versar Laboratory Operations should be discussed and arranged with the Laboratory Operations Project Coordinator before samples arrive in the laboratory. In these instances, special attention should be given to proper documentation of all pertinent items on the chain-of-custody forms and batch information sheets.

It will be the responsibility of the program manager or designate to notify all appropriate laboratory personnel of the following items as soon as possible:

- Award of contract
- Sample delivery schedules
- Changes required from the analytical service package

The quality of sample collection and field measurements is assured by compliance with accepted procedures as defined by various sources. In general, combined quality assurance/work plans should be prepared prior to field activities that specifically detail procedures to be followed. If a combined quality assurance/work plan is not developed due to budget or time constraints such as quick response with little or no previous site information being available, or various other factors, an abbreviated quality assurance plan will serve as the basis for field quality assurance guidance. This plan is to be completed by program managers as recommended by the corporate quality assurance officer. If the program manager does not comply with this recommendation, it will be the responsibility of the Technical Operations task manager or field supervisor to complete the form, have it reviewed by the quality assurance officer, and distribute copies to all personnel involved with the particular field activity.

10.3 Quality Control Charts

The majority of Versar's analytical work is performed under programs with pre-defined quality control criteria or data quality objectives (i.e., CLP). In the event that control charts are required for a project, control charts will be used as agreed upon by Versar Laboratories and its client.

Quality control charts are used when required to monitor trends in precision and accuracy in the data produced. They are also used to determine sources of error and to refine and improve performance. These charts are based on requirements in the EPA's Handbook for Analytical Quality Control in Water and Wastewater Laboratories. Figure 10-1 is an example control chart.

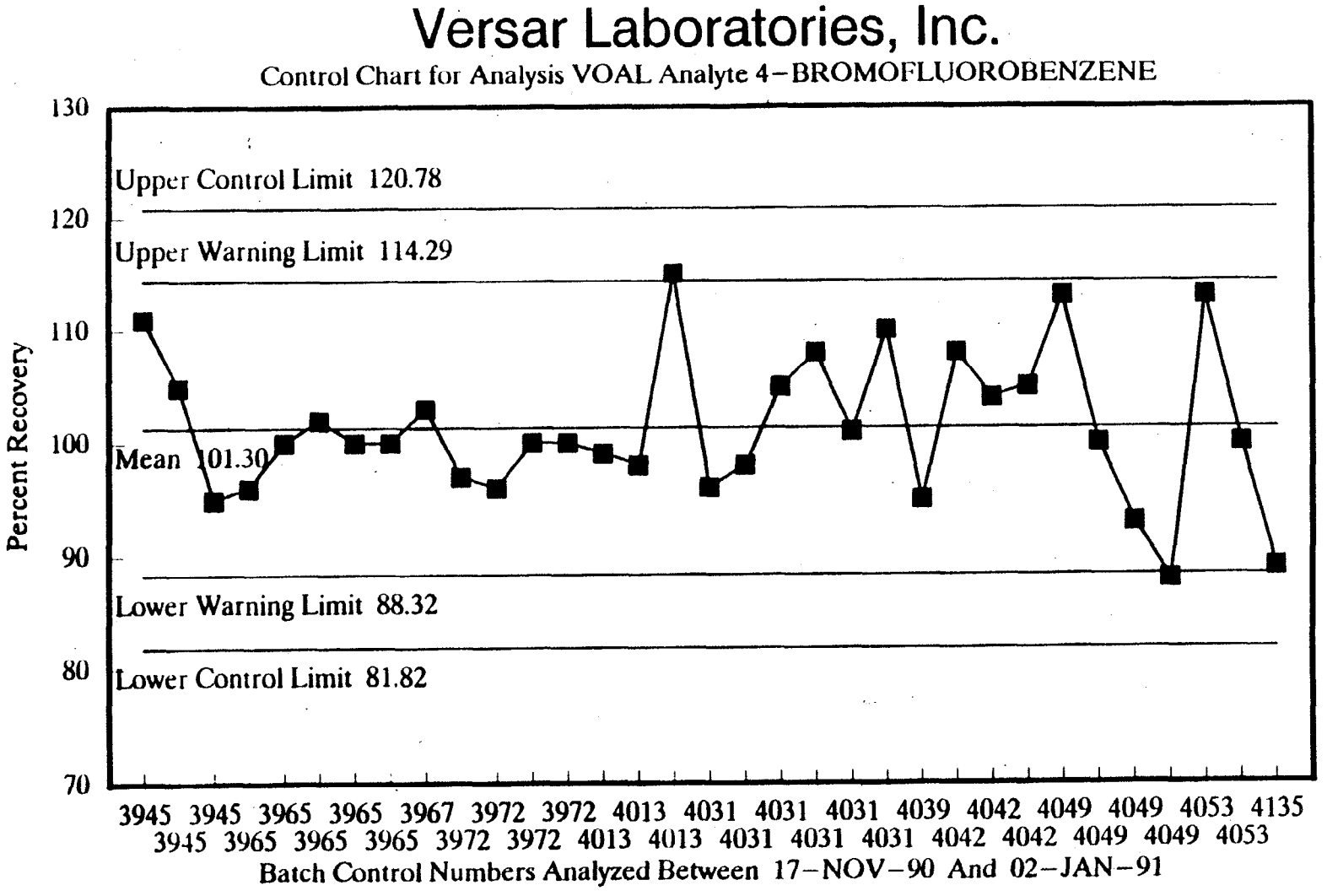

FIGURE 10-1

EXAMPLE CONTROL CHART

Accuracy control charts at Versar can be prepared from percent recovery data from analyses of EPA standard reference materials, spiked samples, laboratory control samples, and spiked blanks. In all cases, a total of 30 data points are collected and plotted, and the upper and lower control limits calculated. Alternatively, control charts can be plotted against fixed control windows such as CLP when program objectives override internally calculated windows.

These completed charts can reflect any noticeable trends in data analysis or differences in analyst technique.

10.4 Document Control System

Document control starts with receipt of samples for analysis. All incoming paperwork is inspected by the sample receiving clerk and by the laboratory project manager. Once all is verified and signed in, clients are contacted if there are mistakes, problems, and/or discrepancies. A log-in information sheet is filled out by the project coordinator/manager and log-in is initiated. The information is then entered into Versar's Laboratory Information Management System. A parameter request sheet is produced which summarizes all tests that are to be performed on a batch of samples. All incoming paperwork and the parameter request sheets are sent to the project manager. The parameter request sheets are reviewed to verify that log-in was properly performed. The parameter request sheets are distributed to the lab sections, and the incoming paperwork is sent to document control and filed by control number.

As data is generated and completed in the lab it is assembled as a data package. Upon completion, the entire raw data package is delivered to data processing where it is reviewed for completeness and quality control, and a final report is generated. A narrative describing the analytical task is written. The narrative lists the samples analyzed, tests performed, QC results, problems and corrective actions. Once a report is completed, the report and full data package (if required) are copied and sent to the client. The original is placed in the

file by document control number. It is then entered into Versar Laboratories' computerized document control tracking system.

Documents, reports and raw data are maintained on file in archival storage for a period of 3 years from the reporting date.

11.0 SYSTEM AND PERFORMANCE AUDITS

The Quality Assurance Division is responsible for conducting periodic audits of the laboratory. Two basic types of audits are performed. First, the systems audit covers the quality systems, analytical systems, data generation systems, and management systems. Second, the performance audit covers the operation of the analytical measurements through independent quantitative checks.

11.1 Systems Audits

A systems audit is an inspection and review of laboratory operational and quality control systems. Systems audits are performed as needed by the Quality Assurance Division. The audits may be announced or unannounced and may include, but are not limited to, the following:

- Laboratory quality control inspections
- Laboratory systems inspections
- Standard Operating Procedures review
- Quality Assurance Project Plan review
- Document Control Systems inspections
- Support Systems inspections
- Report and data inspections
- Contract compliance inspections
- Computer Systems inspections
- Method audit

The purpose of the systems audit is to provide management with the necessary information to determine that systems are operating as planned, or to provide sufficient information to develop systems and plans that are needed to improve and enhance laboratory operations. It can cover any or all of the operational quality control elements of the quality assurance program such as:

- Sampling handling
- Sample analysis
- Records control
- Preventive maintenance
- Proficiency testing
- Personnel practices
- Training
- Workload
- Manpower needs

Routine systems audits are performed in order to evaluate the routine operational systems. The objectives of the routine systems audits are:

- To establish that proper management systems are being followed
- To verify that the approved Standard Operating Procedures are being followed
- To verify that good laboratory practices are being followed.
- To ensure that the required quality control is being applied.
- To determine that corrective action identified by on-going QC or previous inspections (internal or external) have been implemented.
- To identify deficiencies and problems and take corrective action.
- To establish that personnel are performing their assigned tasks properly.
- To verify that complete and accurate documentation is available.
- To ensure correct procedures are being followed.

Nonroutine systems audits may be initiated and conducted for a variety of reasons which may include, but are not limited to:

- Problems brought to the attention of the Quality Assurance Officer.
- Follow-up of corrective action.
- At the request of corporate or laboratory management.

- At the request of clients.
- Management plans for laboratory systems development.
- Program requirements.
- Results of a performance audit indicating deficiencies.

Following the systems audit, the audit findings are summarized in a report. If deficiencies are observed during the systems audit, they are delineated in the report and corrective action requirements are provided.

11.2 Performance Audits

The performance audit is an independent quantitative check of the analytical measurement. Performance audits are performed internally, through quarterly (or more frequently) submission of EPA QC vials to the laboratory, and externally through Quality Assurance Proficiency Testing Programs. (The programs that VLI participates in are listed in Section 12.0.) The performance audit consists of analyzing standard reference samples or materials which are of known quality, and have been tested and certified to a known concentration.

The analytical results of the internal QC sets are reported to the Quality Assurance Officer. The findings are then compiled and reported to laboratory management. Unacceptable results require investigation by the Quality Assurance Division, the Section Manager, and the Quality Control Specialists. Documentation of corrective action by the section and follow-up review by the QA Division is then provided to management.

12.0 CERTIFICATIONS, ACCREDITATIONS, APPROVALS AND EXTERNAL PROFICIENCY TESTING

External laboratory quality assurance programs provide the laboratory and its clients with an evaluation of the laboratory QA/QC procedures and policies based on established scientific principles and good laboratory practice. Participation in certification, accreditation and approval programs in some cases is voluntary but approval programs may be required in order to conduct laboratory testing legally and/or contractually. Table 12-1 is a complete listing of VLI certifications and approvals. Laboratory acceptance into the programs requires demonstration of acceptable performance through the Quality Assurance/Quality Control Program, on-site laboratory evaluation, and proficiency analytical testing of performance evaluation samples.

Versar Laboratories, Inc. participates in a number of laboratory QA programs in order to maintain the required level of approval to test samples in the following categories:

- Inorganic and organic chemistry
- Hazardous waste chemistry
- Environmental chemistry of water, wastewater and soils
- Drinking water chemistry
- Air (solvents, metals)
- Asbestos (bulk, air)

On a quarterly basis, external proficiency test samples are analyzed under the following programs:

- USEPA Water Supply
- USEPA Water Pollution
- NYSDOH Potable Water
- NYSDOH Nonpotable Water
- NIOSH Proficiency Analytical Testing for Air
- USEPA OSW Interlaboratory Studies
- USEPA Inorganics CLP

On an annual or biannual basis, or the program-specified frequency, performance samples are tested for:

- NIST NVLAP Bulk Asbestos
- HAZWRAP
- US Air Force
- Corps of Engineers

The certifications and approvals maintained at VLI provide a valuable continuing assessment of the high quality of analytical performance that is delivered by VLI and is required to provide analytical support for environmental programs.

TABLE 12-1

VERSAR LABORATORIES, INC.

CERTIFICATIONS, ACCREDITATIONS, APPROVALS

AGENCY	STATUS
American Industrial Hygiene Assoc.	Accredited Laboratory No. 265
National Institute of Standards and Technology (formerly NBS) NVLAP Program	Asbestos Bulk Accreditation NVLAP No. 1122
New York State Dept. of Environmental Conservation	Approved Laboratory
State of New York Dept. of Health	Certified Laboratory No. 10401
State of Virginia	Certified Laboratory No. 395
State of Illinois	Certified Laboratory No. 100222
New Jersey Dept. of Environmental Protection Agency	Approved Contract Laboratory
State of New Jersey Department of Environmental Protection	Certified Laboratory No. 84419
State of California, Department of Health Services	Certified Laboratory No. 330
State of Tennessee	Drinking Water Certification No. 02925
Martin Marietta Energy Systems HAZWRAP, NEESA Programs	Approved Program Laboratory
U.S. Army - COE Missouri River Division	Approved Program Laboratory
U.S. Air Force AFOEHL Brook Air Force Base	Approved Program Laboratory
U.S. EPA Office of Solid Waste	Approved Program Laboratory

13.0 INSTRUMENT MAINTENANCE

All laboratory instrumentation is maintained following procedures outlined by the instrument manufacturers. Instrument maintenance logbooks are kept with each instrument and updated by the operator whenever either routine or nonroutine maintenance procedures are performed.

Versar has a full time on-site service engineer who has electronic technology qualifications. The responsibilities of the service engineer include the coordination of routine maintenance procedures and to ensure the thorough documentation of all repairs. Instrumentation files have been established in a centralized location where a complete service history is maintained; the files include all service records in addition to service and repair manuals and documentation.

The service engineer has completed a number of specialized technical training courses offered by the analytical instrument manufacturers which emphasize troubleshooting and repair. The efforts of the service engineer include repair of laboratory instrumentation; routine maintenance is performed by experienced instrumental analysts.

Laboratory personnel are responsible for the daily recording and/or calibration of a variety of equipment including but not limited to refrigerator and freezer temperatures, pH meters, and balances. Scheduled periodic measurement and documentation is performed for ovens and incubator temperatures, mercury thermometers and electronic thermocouples, and air flow rates in fume hoods. Expendable materials are replaced at recommended intervals. Some of these items include vacuum pump oil and air filters on instrumentation cooled by forced air supplies. Cleaning and lubrication of serviceable parts are also performed following specific guidelines established by the instrument manufacturers.

For some laboratory instrumentation, service contracts are maintained with the manufacturer or with another qualified repair facility. Rapid response time is provided by these vendors who are located in the Washington, DC metropolitan area.

Continuing education for all laboratory personnel is provided by both the laboratory service engineer and through on-site seminars conducted by some of the local repair facilities.

14.0 CORRECTIVE ACTION

When established quality control criteria are violated, the analytical system being used for measurement is "out of control." When this occurs, corrective action must be taken immediately to remedy the situation. The following are examples of situations which require corrective action.

- Established analytical control limits are violated.
- Results of audit samples are unacceptable.
- Project specific QA plan is not adhered to.

The corrective actions can take a variety of forms. They could be as simple as notifying the client and qualifying the data, or as extensive as resampling and complete reanalysis. In any situation where the ultimate quality of the data could be compromised, the client will be informed of the situation and the options.

Within the laboratory there are several mechanisms to deal with QC problems. Should QC problems be noted in analysis requiring reextraction. A rework sheet is filled out and submitted. A review comment sheet is filled out at review, and if problems are noted, the work is resubmitted to the lab. Should major problems be encountered, a corrective action memo for the project should be written, and a copy sent to all required personnel. Copies of all corrective action memos should be sent to the Quality Assurance Officer. Corrective action memos are kept on file in the QA branch.

A nonconformance is any event that is beyond the required control limits established for laboratory operation. Non-conformances can be due to data that are outside accepted bounds for accuracy and precision, to improper equipment calibration or maintenance, or to improper data validation. Any activity in the laboratory that affects data quality can result in a nonconformance requiring corrective action.

The first level of responsibility for monitoring laboratory nonconformance lies with the analyst. On a routine basis after the analysis or calibration is performed, the analyst will

review the quality control results for blanks, EPA check standards, duplicates, matrix spikes, internal standards, and surrogates.

The second level of responsibility lies with the section supervisors. The supervisors are to inspect the data as it is being produced to verify that the analysts are performing the analysis and the QC checks correctly. It is important that this be an on-going activity as results are being generated and not after the fact. The supervisor is responsible for deciding when corrective action is required, and thus approve and initiate the appropriate corrective action. Corrective actions may include, but are not necessarily limited to:

- Examination of data calculations.
- Verifying proper procedures.
- Rerunning samples.
- Recalibrating instruments.
- Replacing reagents and solvents that give unacceptable blank values.
- Implementation of additional training.
- Reassignment of personnel.

Another aspect of corrective actions addresses the long-term monitoring of laboratory operations. Long term corrective action involves the identification and elimination of the causes of nonconformance. The Quality Assurance Staff are responsible for this assessment by reviewing QC sample information, reviewing QC charts, and performing statistical analysis. If data are outside accepted criteria, the QAO will establish a positive feedback loop to assure that the appropriate corrective actions have been taken. As appropriate, the QAO will ensure that each of the following steps will be followed:

- The problem will be identified.
- Responsibility for investigation of the problem will be assigned.
- The cause for the problem will be investigated and determined.

- A corrective action to eliminate the problem will be determined.
- Responsibility for implementing the corrective action will be assigned and accepted.
- The effectiveness of the corrective action will be established and the corrective action implemented.
- The fact that corrective action has eliminated the problem will be verified.
- The complete process of establishing and implementing corrective action will be documented.

A formal system of reporting and recording actions is established for the resolution of major problems.

15.0 CHEMICALS AND REAGENTS

15.1 General Purity Requirements

Most chemical compounds used in the laboratory are ACS certified; especially if used as primary standards. The analyst is responsible for choosing the compounds with the appropriate purity to meet method requirements (i.e., technical grade if specified, otherwise the lowest cost compound to meet method standards). ACS certified reagents and compounds meet ACS specifications of purity, and usually a certificate of analysis for each batch number can be obtained, if any unusual contaminants interfere in analysis.

15.2 Storage

15.2.1 Flammable Chemicals

Any chemicals that ignite on contact with air are stored under a noncombustible atmosphere (gas or liquid). Flammable solvents are kept in vented safety cabinets.

15.2.2 Other Chemicals

Other chemicals and reagents are stored in metal cabinets, refrigerators, and freezers, as appropriate. All units are kept closed and latched when not in use. Oxidizers and poisonous/toxic chemicals are marked with brightly colored dots on lids for extra awareness/identification and stored separately in their own cabinets. Materials safety data sheets are being provided for each chemical.

Bulk acids and bases are kept in a storeroom, and individual bottles are brought into the laboratory using a rubber acid carrier. Acids are stored in the acid cabinet, except for acetic acid which is kept separately (to avoid contact with nitric acid). Ammonium hydroxide is the only common liquid base and is stored separately in a sturdy nalgene tub. No bulk chemicals are stored on laboratory benches. The analyst should dispense the required amount, then return the bulk container to the appropriate cabinet.

15.3 Working Standards and Solutions

Standards and solutions are prepared as needed, usually from chemical compounds that are ACS certified and weighed on the Mettler balance (for which the calibration is checked daily). The label on the storage bottle includes the name and concentration (if valid) of the standard/solution, the chemicals and proportions used in preparation, or a method number (e.g., MCAWW 350.1 or Standard Methods, etc.), if appropriate, date prepared (expiration date, if known), special storage requirements (refrigerate, keep in dark), and initials of person who prepared it. For some standards, code numbers relating to the documentation log for the information is used.

Commonly used solutions (different acid and base normalities, stock standards) are kept in the reagent cabinet, next to the instrument they are used for, or in a special section of the refrigerator. EPA vials are stored in a special constant temperature refrigerator. All autoanalyzer standards and solutions are kept on shelves next to the Technicon system.

15.4 Distilled Water (DI)

The laboratory is supplied with Reagent Grade Water from a Millipore reverse osmosis system. A sand filter removes large particulate matter from tap water which is then passed through a softener to remove Ca^{+2}, Mg^{+2}, and iron ions. The R/O membrane itself removes anions, monovalent cations, and most organics. The water is then fed through the polishers to remove any left over ions that passed through the R/O membranes and through the final filters (less than .2 microns) to remove bacterial contamination and tiny particulate matter. Two to three gallons of tap water are used for each gallon of DI produced.

The system is thoroughly checked daily. The salt level in the brine tank (where multivalent cations are exchanged for Na^{+} and K^{+}) is checked and refilled, if necessary. The pressure differential is checked across the intermediate and final filters (pressure gauges are at each stage of the system) and it should be 5 psi to 10 psi. If it exceeds the upper limit, the filter that is clogged is replaced. The resistivity between the two sets of the polishers is checked, and if it is less than 15 megohms, the polishers need to be replaced by

Millipore (inform the Versar systems manager). The resistivity is checked again after the final filter, and if it is less than 15 megohms, the system manager is informed; if less than 10 megohms all Laboratory Managers and Shift Supervisors are immediately informed.

At most of the DI faucets in the laboratories there is a resistivity indicator light. If it goes out, the System Manager is informed and the DI system is thoroughly checked to locate the problem.

15.5 Gases

The most commonly used gases in the laboratory are nitrogen, helium, CO_2, air, hydrogen, acetylene, argon, and oxygen. All are purchased in ultra-high purity (UHP) grade. Specially mixed gases are purchased as needed with a certificate of their contents, if required.

Gas cylinders are kept until needed in a storage bay secured by chains. This applies to empty as well as full cylinders. They are transported to the laboratory on a special cart secured by chains and attached securely to the laboratory bench. Appropriate regulators are provided for use with each gas.

16.0 TRAINING

The Versar Laboratories, Inc. training program is a comprehensive training program which provides the employee with the required formal instruction and guidance to properly and safely perform their job. The areas in which formal training is to be provided are:

- Company Policies
- Health and Safety
- Chemical Hygiene Plan
- Good Laboratory Practice
- Quality Assurance/Quality Control
- Laboratory Procedures and Techniques
- Method and Analytical Procedures
- Instrument Operation
- Instrument Maintenance
- Supervision
- Management

Training records are maintained on file for each laboratory staff member. The records are to include diplomas, verification of degrees, certificates from external training courses, records of internal training courses, and all other records of job-related training.

The Versar Laboratories, Inc. training program includes essentially three levels of training. The program begins with orientation, moves on to laboratory procedures, and then continues to provide professional development through advanced training.

From a personnel standpoint, the laboratory is staffed primarily with degreed chemists and scientists. At all levels, the training begins with an orientation process in which the new hire is informed of the corporate and laboratory operational procedures. This level includes company personnel policies, benefits, working conditions, and daily routine. It also includes some introduction to laboratory specific matters as safety, waste disposal, quality assurance/quality control, right to know, and spill cleanup.

routine. It also includes some introduction to laboratory specific matters as safety, waste disposal, quality assurance/quality control, right to know, and spill cleanup.

The second level of training begins with general lab technique. Usually, the training begins as an "apprenticeship." The responsibility of the training for a specific individual is assigned to a fully trained analyst. The training is accomplished through written standard operating procedures, audio visual courses, hands on instruction and testing. As the employee develops a basic level of operation in the laboratory and takes on more responsibility, more specific technical training is accomplished through instrument manufacturer courses and other external training courses. Throughout the training process, the elements of good laboratory practice are taught. A thorough understanding of quality control procedures is developed. The analyst learns to incorporate the required levels of QC into the daily analytical routine, and how to interpret the results in order to maintain data that meets program objectives.

The corporation provides in-house technical and management development seminars and training courses on site. In-house experts and outside training consultants teach a variety of professional courses on site. Financial assistance is provided for elective studies, graduate, and undergraduate programs for interested employees, providing incentive and means to continuing education and personnel development.

17.0 SAFETY

17.1 General

Versar Laboratories, Inc. recognizes safety as essential for the achievement of quality work, efficient operation, and worker satisfaction. Safety begins with a responsible safety program, and a good safety program can only be effectively initiated by responsible management. Responsibility for safety within the laboratory sections exists at four different levels: individual, safety chemist, safety committee, and top management. Management at all levels has prime responsibility for the safety of all employees working under its supervision, and will conduct operations in a safe manner at all times.

As required by the Occupational Safety and Health Administration (OSHA) under the Occupational Exposure to Hazardous Chemicals in Laboratories Standard, 29 CFR 1910.1450 (Appendix 1A), Versar Laboratories has developed and is implementing a Chemical Hygiene Plan in order to provide assurance that hazards of all chemicals handled and used in the laboratory are evaluated and information concerning the hazards is communicated to employees.

An accident-free environment is of importance to everyone concerned. Every employee will be expected to obey safety rules and work to the best of his or her ability to prevent accidents and injuries, both to oneself and ones fellow employees.

A sound safety organization that is respected by all employees is essential. A good laboratory safety program must always be based on active participation of both the laboratory administration and all employees.

17.2 Individual Responsibility

Each individual who works in the laboratory has a responsibility to learn the health and safety hazards of the chemicals being used or produced, and the hazards which may occur from the equipment and techniques being employed. For this purpose Material Safety Data Sheets (MSDS) are provided by suppliers for each chemical used within the laboratory.

These MSDS's outline toxicity, handling, storage, and disposal characteristics for the chemical. Each individual should consult the appropriate MSDS for any uncertainty when working with a particular chemical.

Instruction manuals are available for all laboratory instruments. Analytical personnel should become familiar with safe operating practices prior to using any instrument. Staff members are also expected and required to familiarize themselves with the safety aspects of any new procedure prior to beginning work.

The individual employee should also report any unsafe practice or condition that exists in the laboratory to the safety chemist immediately. The individual, along with the safety chemist, will investigate any accident which occurs, and record and report the apparent causes, and institute any preventive measures necessary to prevent similar accidents.

17.3 Section Safety Chemist

The section safety chemist is responsible for giving all the necessary directions, including the safety measures to be used, and responsible for seeing that employees carry out their individual responsibilities. The duties of the safety chemist include the following:

1. Promote safety awareness among section personnel.
2. Report to the Section Chief, on a regular basis, the status/condition of safety supplies and equipment.
3. Ensure the working order of safety equipment.
4. Conduct laboratory safety training within the section.
5. Serve as the Section Representative on the Laboratory Safety Committee.

17.4 Laboratory Safety Committee

The Laboratory Safety Committee is composed of safety chemists from each laboratory section. The Committee meets on a regular basis once each month, or more frequently

should the need arise. A chairperson is appointed to head the Committee and also to report directly to upper management.

The objectives of the Laboratory Safety Committee are to protect those working in the laboratory from injury, to protect others who may be exposed from the hazards of the laboratory, and to ensure safety of the environment. These objectives are addressed by:

1. A safety chemist in each laboratory, providing the ability to identify and communicate safety defects to the Committee for corrective action.
2. Promoting an active safety program involving all laboratory operations.
3. Educating personnel in safety awareness and good laboratory practice.
4. Developing safety policies for guidance.

The Laboratory Safety Committee is also responsible for preparing and distributing safety policy memorandums. These memorandums outline procedures and practices necessary for an effective safety program.

17.5 Safety Equipment

An effective safety program also incorporates safety equipment for the prevention of accidents and the promotion of a safe working environment. It is the organization's fundamental responsibility to provide the facilities and safety equipment to ensure a safe working environment. The section safety chemist will then ensure the working order of the safety equipment.

General Chemistry Section safety equipment includes the following:

1. Fire extinguishers - located in convenient locations, and can be used for all classes of fires.
2. Safety showers - located at both ends of the laboratory to be used in accidents involving acids, caustic, or other harmful liquids, and clothing fires.

3. Eye washes - located on the safety showers which provide fountain-type flushing.

4. Safety shields - use of shields is recommended when working with pressurized systems and reactive or explosive conditions.

5. Personal protection equipment and materials - this equipment and material includes such items as lab coats, gloves, safety glasses, and respirators.

   a. Lab coats and gloves - should be worn when working with chemicals or samples.

   b. Safety glasses - all laboratory personnel are required to wear safety glasses.

   c. Respirators - available for emergency situations in which dangerous gases, fumes, or aerosols are formed.

6. Chemical storage cabinets - provided for chemical storage of flammables, acids, caustics, and oxidizers.

7. Fume hoods - used to contain hazardous materials and operations. Fume hoods are not to be used for storage.

8. Chemical spill kits - available for chemical spill clean up from acids, alkalies, and mercury.

17.6 Accidents

Accidents have causes, and most can be prevented. In the event of an accident, it is imperative that good records be kept, and that corrective action be taken to prevent future occurrences.

1. Accident Reports

   A standard accident report form is provided to each section safety chemist. Regardless of the severity of the accident, this report is filled out as soon as possible after the accident. The safety chemist is responsible for ascertaining and filling out all the information. The report should contain sufficient information to enable the safety chemist,

Laboratory Safety Committee, and Division Director to determine who was involved, what happened, when and where it happened, and what injuries, if any, resulted. These accident reports also provide useful information as to the effectiveness of the safety program.

2. Workers' Compensation

All laboratory employees are covered for work-related illnesses or injuries under the Versar's Workers' Compensation insurance policy. In the event of a job-related injury, an employee can only qualify for Workers' Compensation after 7 days of disability. Disability in which one is completely unable to work must be determined by a physician. Two forms, one filled out by the employer, the other filled out by the attending physician, are required under the provisions of the Workmen's Compensation Act.

18.0 LABORATORY WASTE

18.1 Waste Disposal Program

Versar's laboratory maintains a waste disposal program for all of its wastes which conform to federal and state regulations. Wastes are brought into the lab as samples and are created in the process of performing the required analytical tests on those samples. Nonhazardous and hazardous wastes are generated in this process. A hazardous materials storage facility is maintained on the property to securely store lab wastes that require disposal through strictly regulated hazardous waste disposal laws and regulations. For wastewater leaving the laboratory facility, a wastewater discharge permit is maintained with Fairfax County, and a wastewater treatment system treats the wastewater prior to discharge into the public sewerage system.

18.2 Organization and Responsibility

The waste disposal program is the responsibility of the laboratory Technical Services Manager and the waste disposal committee. The committee meets monthly to manage the waste disposal operation and report the status of the program to the lab manager.

The wastewater treatment system is maintained by the laboratory support services supervisor. The treatment system is monitored continuously and permanent records are kept on the discharge.

18.3 Health and Safety

Handling of hazardous wastes requires special consideration, including health and safety training, medical surveillance and proper equipment. Each Versar employee working in potentially hazardous conditions (i.e., handling hazardous wastes in the waste facility) must successfully complete 40 hours of health and safety training. Additionally, they must pass a physical in order to become certified for respirators and must be on a medical surveillance program to monitor body functions for potential exposure.

18.4 Waste Storage

As wastes are generated, they are segregated into hazardous and nonhazardous wastes. Hazardous wastes are segregated according to content, as specified by EPA waste disposal regulations.

1. Acid waste containing Hg and Ag: pH is adjusted to less than 2, typically from TKN, COD, and Cl^- (titrimetric) analyses.

2. Alkaline waste containing CN^- and sulfide: pH is adjusted to more than 12, typically from sulfide and phenol analyses.

3. Nonflammable solvents.

4. Flammable waste.

5. Chromerge waste containing Chromic acid and concentrated H_2SO_4.

6. Hazardous wastes that do not meet any of the above specifications are kept separate from all other wastes.

7. Occasionally, a waste will have hazardous components from various classifications. Questions concerning storage and disposal of such wastes are directed to supervisors or the section chief.

Hazardous wastes are stored in the laboratory in the following types of containers:

1. Flammable wastes are stored in approved metal containers.

2. All other specified wastes are stored in five-gallon Nalgene carboys.

3. Neutralized waste from laboratory spills are stored in "lab packs." Lab packs are stored in the hazardous materials storage facility to await disposal.

Labels for hazardous waste storage containers must provide the following information:

1. Laboratory-specified waste: type of waste and analyses from which it came.

2. "Lab Packs" are labeled with Hazardous Waste I.D. cards, upon which are listed: type of waste, all contents of package, date and place of generation. This information, along with the date of disposal, are entered in the Waste Log Book, which is maintained by the Waste Committee.

18.5 Disposal

18.5.1 Hazardous Waste

All hazardous laboratory waste is stored in the laboratory until it is taken to the waste facility. Disposal of all waste is performed by a contracted outside disposal company. All disposal procedures meet EPA waste disposal specifications, which dictate which wastes can or cannot be landfilled, and which can or cannot be incinerated.

18.5.2 Nonhazardous Waste

Wastes from standard laboratory procedures which are not listed above are considered nonhazardous and are handled as follows:

1. Acidic, nonhazardous waste is neutralized with Na_2CO_3, and is then poured down the drain. All other nonhazardous waste may also be poured down the drain.

2. Laboratory drains lead to a holding tank in which the pH is continuously monitored. Any waste with pH lower than 5 or higher than 10 is treated with either NaOH or HCl.

3. Any questions concerning waste classification as hazardous or nonhazardous are directed to supervisors or section chiefs.