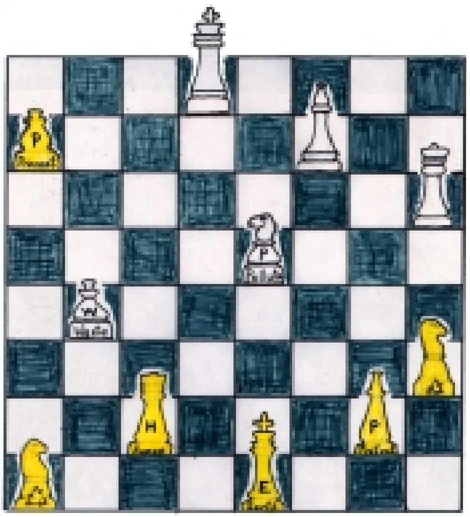
BROOKHAVEN
NATIONAL
LABORATORY

SITE ENVIRONMENTAL REPORT 2000



Chapter 9

Quality Assurance

Quality assurance is an integral part of every function at BNL. A comprehensive program is in place to ensure that all environmental monitoring data meet quality assurance and quality control requirements. Samples are collected and analyzed in accordance with standard operating procedures. These procedures are designed to make certain that samples are representative and data are reliable and defensible. Quality control in the analytical laboratories is maintained through daily instrument calibration, efficiency and background checks, and testing for precision and accuracy. Data is verified and validated before it is used to support decision making.

BNL uses the onsite Analytical Services Laboratory and four offsite contractor laboratories to analyze environmental samples. All analytical laboratories are New York State certified for the tests they perform for BNL, and are subject to oversight that includes state and national performance evaluation testing, review of quality assurance programs, and audits.

The two primary laboratories reporting radiological analytical data scored between 89% and 95% satisfactory results in both state and federal performance evaluation programs. In nonradiological performance evaluation testing, each laboratory received a satisfactory rating of over 92% in the 2000 New York State Environmental Laboratory Approval Program evaluations. The BNL Quality Assurance/Quality Control Program ensures that all analytical data reported for the *Site Environmental Report 2000* are reliable and of high quality.

9.1 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM ELEMENTS

As required by DOE Order 5400.1 (1988), *General Environmental Protection Program*, BNL has established a Quality Assurance/Quality Control (QA/QC) Program to ensure that the accuracy, precision, and reliability of environmental monitoring data are consistent with the requirements of 10 CFR 830 Subpart A, "Quality Assurance Requirements" and DOE Order 414.1 (1998), *Quality Assurance.* Responsibility for quality at BNL starts with the Laboratory Director and extends throughout the entire organization. The BNL quality management system defines quality requirements, establishes an assessment process to evaluate performance, and provides technical assistance from quality professionals.

For environmental monitoring, QA is defined as an integrated system of management activities that includes planning, implementation, control, reporting, assessment, and continual improvement. QC activities measure each process or service against the QA standards. QA/QC practices and procedures are documented in detail in manuals, plans, and a comprehensive set of environmental monitoring standard operating procedures (designated EM-SOPs) (BNL 1999a). Staff who must follow these procedures and plans are required either to sign off on the document or receive training.

The ultimate goal of the environmental monitoring and analysis QA/QC program is ensuring that results are representative and defensible, and that data are of the type and quality needed to verify protection of the environment. To achieve this, monitoring and analytical activities are planned with the end use in mind. Figure 9-1 depicts the flow of the QA/QC elements of BNL's Environmental Monitoring Program, and indicates the section of this chapter that discusses the element in more detail. First, BNL environmental scientists and engineers determine sampling requirements using the U.S. Environmental Protection Agency (EPA) Data Quality Objective (or equivalent) process. During this process, the type, amount and quality of data needed to support decision making, legal requirements, stakeholder concerns, and technical information are considered. Next, an environmental monitoring plan or project-specific sampling plan is prepared that specifies the location, frequency, type of sample, analytical methods to be used, and a schedule. These plans or the standard operating procedures also specify data acceptance criteria. Contracts with offsite analytical laboratories are established as necessary. Detailed standard operating procedures guide sampling technicians on proper sample collection, preservation, and handling requirements. Field quality control samples are prepared as necessary. Samples are analyzed in the field, or subsequently analyzed at certified laboratories, in accordance with established procedures. The results are then validated and/or verified again in accordance with a set of procedures. Finally, data are reviewed and evaluated by environmental professionals and management in the context of expected results, related monitoring results, historical data, and applicable regulatory requirements (e.g., drinking water standards, permit limits, etc.) Data are then used to support decision-making. Data are also reported as required, and summarized in the annual Site Environmental Report. Tables and figures on QA/QC results for calendar year 2000 are presented in this chapter and in Appendix F. Most of the data contained in this report are condensed and summarized from a separate document, *Year 2000 ASL Quality Assurance Report* (Scarpitta and Heotis 2001).

9.2 SAMPLE COLLECTION AND HANDLING

In 2000, environmental monitoring samples were collected as specified by procedures, the *BNL Environmental Monitoring Plan* (BNL 2000), the *Groundwater Monitoring Program QA Project Plan* (BNL 1999b), and/or project-specific work plans, as applicable. For example, the BNL Groundwater Monitoring Program QA Project Plan describes the QA program and QC requirements followed for groundwater monitoring. This plan documents organizational structure, documentation requirements, sampling requirements, field QA/QC sample collection, acceptance criteria, sample custody requirements, data validation procedures, and general data handling/database procedures.

BNL has prepared sampling standard operating procedures for all environmental media, including groundwater, surface water, soil, sediment, air, flora and fauna (BNL

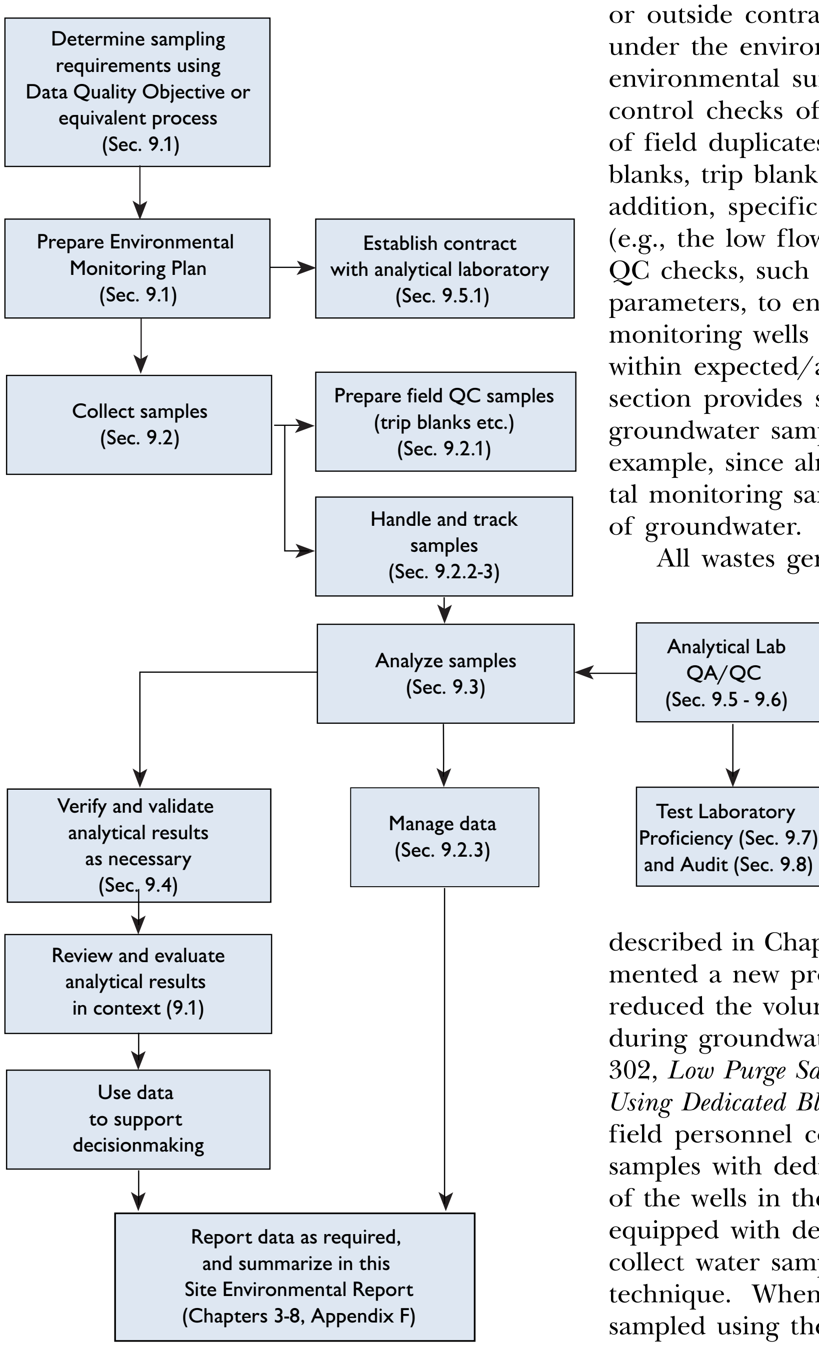


Figure 9-1. Flow of Environmental Monitoring QA/QC Program Elements.

1999a). These procedures contain detailed information on how to prepare for sample collection; what type of field equipment to use and how to calibrate it; how to properly collect, handle, and preserve samples; and how to manage any wastes generated during sampling. The procedures ensure consistency between samples collected by BNL employees or outside contractors, whether collected under the environmental restoration or environmental surveillance programs. Quality control checks of sampling include collection of field duplicates, matrix spike samples, field blanks, trip blanks, and equipment blanks. In addition, specific sampling methodologies (e.g., the low flow sampling technique) include QC checks, such as field analysis of stability parameters, to ensure proper purging of monitoring wells so that all parameters are within expected/acceptable limits. This section provides some specific information on groundwater sampling procedures as an example, since almost half of all environmental monitoring samples collected for BNL are of groundwater.

All wastes generated during sampling (contaminated equipment, purge water from wells, etc.) are managed in accordance with applicable requirements. One factor considered during sample collection is minimizing the amount of waste generated, consistent with the pollution prevention program described in Chapter 2. In 1999, BNL implemented a new procedure that dramatically reduced the volume of wastewater generated during groundwater well sampling. EM-SOP-302, *Low Purge Sampling of Monitoring Wells Using Dedicated Bladder Pumps*, was followed by field personnel collecting groundwater samples with dedicated pumps installed. Most of the wells in the monitoring program are equipped with dedicated pumps designed to collect water samples using the low flow technique. When a well was designated to be sampled using the low flow technique, but a dedicated pump had not been installed, the procedures outlined in EM-SOP-307, *Low Purge Sampling of Monitoring Wells Using Non-dedicated Pumps*, was used. As mentioned in the 1999 Site Environmental Report, the only exception was for the AOC 29 High Flux Beam Reactor Project, where procedures outlined in the *Natural Attenuation Monitoring Work Plan for the HFBR Tritium Plume* (BNL 1998) were followed until April 2000. From April 2000 on, the low flow techniques described in EM-SOP-302 and

307 were used for sample collection. This change to low flow sampling significantly reduced the amount of purge water waste that had to be collected for disposal as radiological waste. An example of the volume reduction achieved is the routine sampling of Well 095-48. Using the sampling technique that involved purging three volumes of the well casing prior to sampling, approximately 200 gallons of tritiated purge wastewater were being collected per month. Using the low flow sampling technique, this was reduced to approximately 5 gallons per month.

9.2.1 FIELD QUALITY CONTROL SAMPLES

Field QC samples collected for the Environmental Monitoring Program include equipment blanks, trip blanks, field blanks, field duplicate samples, and matrix spike/matrix spike duplicate samples. The rationale for selection of specific field QC samples and minimum requirements for use in the environmental monitoring program are provided in EM-SOP-200, *Collection and Frequency of Field Quality Control Samples*.

Equipment (rinsate) blanks and trip blanks were generally collected for all media except air and flora and fauna. An equipment blank is a volume of solution used to rinse a sampling tool before sample collection. The rinsate is collected to demonstrate that the sampling tool was not contaminated. A trip blank is provided with each shipping container of samples to be analyzed for VOCs. Analytical results from trip blanks are used to determine whether the sample bottle was contaminated during shipment from the manufacturer, bottle storage, shipment to the laboratory, or during analysis at the laboratory. For the Groundwater Monitoring Program, trip blanks consist of an aliquot of distilled water that is sealed in a sample bottle, prepared either by the analytical laboratory prior to shipping the sample bottles to BNL, or by field sampling personnel. Under the groundwater monitoring program, trip blanks were included with all shipments of aqueous samples for volatile organic analyses.

Field blanks were collected to evaluate potential cross-contamination of samples during sample collection. For the Groundwater Monitoring Program, the frequency of collection was one field blank for every twenty samples, or one per sampling round, whichever was more frequent. On any given day, the fields blank were analyzed for the same parameters as the groundwater samples.

Equipment blank samples were collected, as needed, to verify the effectiveness of the decontamination procedures on nondedicated or re-usable sampling equipment. For the Groundwater Monitoring Program, equipment blanks were collected from the final rinse water generated during decontamination using laboratory grade water. When equipment blanks were needed, these QC samples were collected in accordance with EM-SOP-200.

9.2.1.1 FIELD QUALITY CONTROL SAMPLE RESULTS

Contaminants in trip, field, and equipment blanks included methylene chloride, acetone, toluene, and phthalate esters. When these compounds were detected, validation and/or verification procedures were used to "qualify" the data, as described in procedures EM-SOP-203 through 211 (see Section 9.4). The results from blank samples collected during 2000 did not indicate any significant impact to the quality of groundwater results. Typically, the only compounds detected in the blanks were toluene, chloroform, methylene chloride, and acetone.

Field duplicate samples were analyzed to check the reproducibility of sampling and analytical results. For the groundwater monitoring program, duplicates were collected for 5% of the total number of samples collected for a project per sampling round. Table F-1 in Appendix F summarizes the number of field duplicate samples collected during 2000 that were acceptable for input into the Environmental Information Management System database. Field duplicate acceptability was based on EPA Region II guidelines (EPA 1996).

The relative percent differences for concentrations above the contract reporting limits was required to be below 20% for the duplicate. (See Section 9.6.2 for more information on the relative percent difference statistic.) While individual compounds did not meet the 20% Relative Percent Difference limit on several occasions, the overall list of parameters analyzed for a given sample did meet the 20% requirement. This indicated that the field sampling personnel and the laboratories were performing the sampling analyses at a consistently high level of quality.

Matrix spike and matrix spike duplicates for organic analyses were performed in order to determine if the sample matrix adversely affected the sample analysis. Matrix spikes are used to evaluate the effect of the sample matrix on the accuracy of a specific analysis. Matrix spike duplicates are used to evaluate the precision of a specific analysis. They were performed at a rate of approximately one per twenty samples collected per project. For groundwater samples no significant interferences were observed.

Several results for media other than groundwater were considered suspect after evaluating field quality control sample results. These instances are discussed in detail in Chapters 3-8.

9.2.2 FIELD SAMPLE HANDLING

In order to ensure the integrity of samples, chain-of-custody was maintained and documented for all samples collected. A sample or evidence file is considered to be in the custody of a person if any of the following rules of custody are met: (a) the person has physical possession of the sample or file, (b) the sample or file is in view of the person after being in possession, (c) the sample or file is placed in a secure location by the custody holder, or (d) the sample or file is in a designated secure area. These procedures are outlined in EM-SOP-109, *Chain-of-Custody Procedure*. All environmental monitoring samples maintained a valid chain-of-custody from the time of sample collection through sample disposal.

9.2.2.1 FIELD SAMPLE CUSTODY AND DOCUMENTATION REQUIREMENTS

The field sampling team leader was responsible for the care and custody of the samples collected until they were transferred to a sample receiving group or an analytical laboratory. Samples requiring refrigeration were placed immediately into a refrigerator or a cooler with cooling media, and kept under custody rules. The sampling team member who maintained custody of the samples signed the chain-of-custody form upon relinquishing custody of the samples. The laboratory or group receiving the samples would then sign the chain-of-custody accepting custody of the samples.

The sampling team was also required to maintain a field logbook. The field logbook is a bound, weatherproof logbook filled out at the time of sample collection. It contains sample designation, sample collection time, sample description, sample collection method, daily weather, field measurements, and other site-specific observations, as appropriate.

9.2.2.2 SAMPLE PRESERVATION AND SHIPMENT

Samples shipped to offsite laboratories were managed as follows. Prior to sample collection, the sampling team prepared all bottle labels and affixed them to the appropriate containers, as defined in the QA Program Plan or applicable standard operating procedures. Appropriate preservatives were added to the containers prior to sample collection or immediately after collection, and/or samples were refrigerated.

After sample collection by BNL or contractor personnel, sample preservation was maintained as required throughout shipping. If samples were sent via commercial carrier, a bill-of-lading was used. Chain-of-custody seals placed on the shipping containers prevented the container from being opened without breaking the seal, ensuring that custody was maintained during shipment.

9.2.3 SAMPLE TRACKING AND DATA MANAGEMENT

9.2.3.1 SAMPLE TRACKING

The majority of Environmental Monitoring Program samples and analytical results were tracked in the Environmental Information Management System. Tracking was initiated when a sample was recorded on a chain-of-custody form. Copies of the chain-of-custody and supplemental forms were provided to the project manager or the sample coordinator and forwarded to the data coordinator for entry into the Environmental Information Management System. Each analytical laboratory also maintains its own internal sampling tracking system.

9.2.3.2 DATA MANAGEMENT PROCEDURES

Data management procedures have been developed and implemented to govern tracking, validation, verification, and distribution of the analytical data. When samples were shipped to an analytical laboratory, chain-of-custody information was entered into the Environmental Information Management System. Following sample analysis, the laboratory provided the results to the project manager or their designee, and, when applicable, the validation subcontractor in accordance with its contract with BNL.

9.2.3.3 DISTRIBUTION OF ANALYTICAL DATA

Once data was entered into the Environmental Information Management System, reports were generated by one of two means. Project personnel and DOE-Brookhaven Area Office staff had a data query tool that allows access to all analytical sample results and print reports. If a project required a special format for the report, the data management group was contacted and a special report was designed and printed.

9.3 SAMPLE ANALYSIS

Environmental samples were analyzed either by the onsite laboratory (the BNL Analytical Services Lab [ASL]), or by one of four contractor laboratories. BNL procured and maintained contracts with the following offsite laboratories:

- General Engineering Lab (GEL) in Charleston, South Carolina, for radiological and nonradiological analytes;
- H2M Lab in Melville, New York, for nonradiological analytes;
- Severn-Trent Lab (STL), in Monroe, Connecticut and St Louis, Missouri, for radiological and nonradiological analytes; and
- Chemtex Lab in Port Arthur, Texas, for select nonradiological analytes.

All samples were analyzed according to EPA-approved methods, if such methods exist. If no EPA-approved methods exist, standard industry methods were used if BNL personnel had approved them.

In addition, sampling technicians performed field analyses of certain wastewaters for residual chlorine and pH.

9.4 VERIFICATION AND VALIDATION OF ANALYTICAL RESULTS

Environmental monitoring data underwent data verification and/or validation, in accordance with established procedures. For example, the procedures used for verification and validation of analytical results in the Groundwater Monitoring Program are contained in EM-SOP-203 through 211. Data packages not subject to validation were verified by environmental program staff, as per BNL procedures.

The following criteria cause data to be rejected during the data verification/validation process:

- *Holding time missed.* The analysis was not initiated or the sample was not extracted within the time frame required by EPA or by the contract.
- *Incorrect test method.* The analysis was not performed according to a method required by the contract.
- *Poor recovery*. The compounds or radioisotopes added to the sample prior to laboratory processing were not recovered at the recovery ratio required by the contract.
- *Insufficient QA/QC data.* Supporting data received from the analytical laboratory were insufficient to allow validation of results.
- *Incorrect MDL.* The laboratory reported extremely low levels of analytes as "less than minimum detectable," but the contractually required limit was not used.
- *Invalid chain-of-custody.* There was a failure to maintain proper custody of samples, as documented on chain-of-custody forms.
- *Instrument failure.* The instrument did not perform correctly or was broken.
- *Preservation requirements*. The requirements identified by the specific analytical method were not met and properly documented.

The data verifier is responsible for checking for the most common errors associated with analytical data. These include holding time violations, unacceptable chemical recovery of internal standards or tracers, use of an improper analytical method, contamination of samples from outside sources (e.g., trip blanks analyzed with samples according to the correct method and no analytes detected), matrix interferences, and completeness of the data package and reports. The data validator is responsible for the same things as a verifier, as well as checking for less common errors, such as calibration not conducted in accordance with method requirements, internal standard errors, transcription errors, and calculation errors.

For samples analyzed by the onsite ASL, the QA officer was responsible for verifying that all analytical batches fulfilled internal QA/QC acceptance criteria. The criteria include: (a) precision, (b) accuracy, (c) recovery, (d) instrument background checks, and (e) stable instrument efficiency performance. All QA/QC data were reviewed before ASL results were reported. These criteria are fully described in ASL's *QA Program Plan* issued in May 1999

(BNL 1999c). The data verifier or validator ensured that data complied with the contract specifications before the data was accepted and reported.

When a set of analytical results was received from an *offsite* laboratory, a certain percentage of results were given to either a data verifier or a data validator who was a subject matter expert in either radiological analyses or analytical chemistry. Nonradiological data analyzed offsite were verified and validated using EPA Contract Laboratory Program guidelines (EPA 1992, 1996). Radiological packages were verified and validated using BNL and DOE guidance documents (BNL 1997, DOE 1994).

The amount of data that underwent either the verification or validation processes was dependent on the Data Quality Objectives for each specific project and environmental media. Data from some projects, such as long term groundwater monitoring, may have undergone only verification, while data from projects such as initial investigations underwent validation ranging from 20% of the results up to 100% of the results. Results of verifications (including data qualifiers discussed in Section 9.2.1.1) were added to the Environmental Information Management System.

9.5 ANALYTICAL LABORATORY QA/QC

9.5.1 CONTRACTOR LABORATORY SELECTION

The process of selecting contractor laboratories involves evaluating past performance evaluation testing results, pre-selection bidding, post selection auditing, and adherence to their own QA/QC programs. Once the contract has been awarded, the laboratory must follow the quality assurance requirements, and analytical and quality control requirements in the BNL statement of work. Routine QC procedures followed by laboratories include daily instrument calibrations, efficiency and background checks, and standard tests for precision and accuracy, as discussed in Sections 9.6.1.2. All analytical laboratories used by BNL are New York State Department of Health (NYSDOH) certified for the analytes they test for BNL. They are also subject to performance evaluation testing (Section 9.7) and audits (Section 9.8).

Sample analyses for environmental restoration samples were performed by GEL and STL. Environmental surveillance data were analyzed by either ASL or H2M Labs, Inc.

The onsite BNL analytical laboratory, ASL, performs approximately 5,000 radiological and nonradiological (chemical) analyses per year on environmental samples in support of both environmental monitoring and facility operations. The ASL is certified by NYSDOH for tritium, gross alpha/beta, and gamma in potable and nonpotable water analyses in several matrices, all of which are approved EPA methods.

Samples sent offsite for radiological analyses were those requiring either EPA methods or DOE standard methods that ASL did not perform. Examples are strontium-90 and actinide analyses in soil, vegetation, animal tissue, and water. As discussed in Chapter 3, samples used to verify compliance to permitting requirements were generally analyzed by an offsite laboratory.

Samples requiring semivolatile organic analyses and toxicity characteristic leachate procedure (TCLP) samples were sent offsite. In addition, when demand exceeded ASL capacity, some strontium-90, metals, and polychlorinated biphenyls (PCBs) were sent to a contractor laboratory. The contracts specified analytes, methods, required detection limits, and deliverables, which include standard batch QA/QC performance checks. Successful bidders were also required to provide BNL with a copy of their QA/QC manual as well as their QA Program Plan.

A contract for nonradiological sample analyses was established with H2M Laboratories, Inc. A second contract for nonradiological sample analyses was established with Chemtex Laboratory in order to provide special analytical services required to meet BNL discharge permit requirements for four analytes in wastewater samples collected from various recharge basins and one cooling tower. Contracts for radiological and nonradiological analyses were also established with GEL and STL.

9.5.2 QUALITY ASSURANCE PROGRAM FOR ANALYTICAL ACTIVITIES

For ASL analyses, procedures have been established to calibrate instruments, analyze samples, and assess QC. These procedures are consistent with EPA methodology and are described in Appendix D. QC checks were performed and include analysis of blanks and instrument background; use of Amersham Radiopharmaceutical Company or National Institute for Standards and Technology (NIST) traceable standards; and analysis of reference standards, spiked samples, and duplicate samples. The ASL supervisor, QA officer, or group leader reviewed all ASL analytical and QA results before data were reported. Offsite contractor laboratories that perform radiological and chemical analyses for BNL are also required to maintain stringent QA programs.

A nonconformance report was generated when discrepancies were found in field sampling designs, documented procedures, chain-of-custody, calibration/standardization programs, acceptance criteria, statistical data analyses, QA software or data processing systems, or when failures in performance evaluation testing occurred. Corrective actions were then made following an investigation into the root cause.

9.6 ASL INTERNAL QUALITY ASSURANCE PROGRAM

This section further describes the QA requirements for analytical activities conducted as part of the 2000 BNL Environmental Monitoring Program, and the results of QA checks. ASL's nonradiological chemical group is certified by the NYSDOH ELAP to perform analyses utilizing EPA Methods 524 and 624 for volatile organic analytes, in potable and wastewaters, respectively. Thirty-seven VOCs are currently provided for analysis with Method 624 (for ground and wastewaters), an addition of 26 new analytes since 1998. EPA Method 524 (for potable water) includes 63 organic analytes and was a new addition to ASL's capabilities. Metals are analyzed utilizing both atomic absorption spectroscopy and inductively coupled plasma/mass spectroscopy by EPA Methods. ASL is now certified for analyses of 17 metals (the entire ELAP list) in potable water, as well as 21 metals in wastewater. Certification for three anions has been established for potable and wastewaters, using EPA Method 300.

In May 1999, ASL issued its own *QA Program Plan* (BNL 1999c) following EPA Region II guidelines (EPA 1998). Twenty-five internal operating procedures maintained by ASL were also revised in 2000. The QA procedures followed at ASL include daily instrument calibrations, efficiency and background checks, and routine tests for precision and accuracy. A detailed description of these activities can be found in the document titled *Year 2000 Quality Assurance Report of the Analytical Services Laboratory* (Scarpitta and Heotis 2001). A brief summary of ASL's QA Report follows.

9.6.1 RADIOLOGICAL INSTRUMENT CALIBRATIONS

ASL operates eight high-purity germanium gamma detectors. Each detector was calibrated daily for energy and instrument efficiency using a NIST traceable cesium-137 standard. Geometry efficiency calibrations are performed quarterly. Efficiency is the measure by which radiological decaying events are converted into observable counts (counts per minute). All eight gamma detectors performed well within the EPA acceptance limit of 1 keV during 2000.

ASL operates two gross alpha/beta (GAB) detectors and two liquid scintillation spectrometers for tritium. Instrument background and count-time are used to determine the MDL of a radiological analyte. In 2000, there was no unusual drift and/or variability in instrument background for alpha, beta, and tritium, based on the mean background count-rates (and one standard deviation) values of 0.062 ± 0.006, 1.612 ± 0.068, and 3.000 ± 0.168, respectively. Instrument efficiencies were determined daily, using a calibration standard, and averaged for the calendar year. All analyzers exhibited stable behavior and there were no unusual occurrences with existing instrumentation. The annual average efficiencies for alpha, beta, and tritium were 0.310 ± 0.001, 0.463 ± 0.001, and 0.241 ± 0.010, respectively.

9.6.2 PRECISION AND ACCURACY

Precision is the percent difference between two measured values, whereas accuracy is the percent difference between a measured value and its known (expected) value. The relative percent difference statistic is the measure of batch precision. It is defined as the absolute difference between two results, divided by the average of both results, multiplied by 100. Typically, a radioactive tracer solution (i.e., spike) is added to either a routine sample or tap water sample as a means of determining both precision and accuracy. In the case of nonradiological analyses, a known amount of a given analyte is added to a sample, and the percent recovery is the measure of accuracy.

The percent recovery is the ratio of the measured amount, divided by the known (spiked) amount, multiplied by 100.

For gross alpha/beta, the relative percent difference was determined for each batch of analyses performed. Tap water was spiked with known amounts of americium-241 (for alpha) and strontium/yttrium-90 (for beta) in order to determine batch precision. The acceptance criteria for batch precision are a relative percent difference less than 20% (for activity concentrations that are five times greater than the method MDL). During 2000, gross alpha/beta batch precision was consistently within the acceptable range 100% of the time. There were no rejected batches for gross alpha/beta analyses performed in 2000.

Tritium precision was determined for 429 batches processed in 2000. ASL utilizes three sampling protocols for differing sample volumes (i.e., 7 mL distilled, 7 mL undistilled, and 1 mL undistilled). In total, there were three rejected batches of tritium in 2000, representing a rejection rate of 0.7%. Each rejected batch was reprocessed and then passed QC with no loss of data. For seven batches of strontium-90 processed in 2000, there were no rejected batches.

Gross alpha/beta accuracy results for 268 batches processed showed no failures based on the EPA's acceptance criteria of ± 25% for recovery.

9.6.3 NONRADIOLOGICAL: ORGANIC AND INORGANIC ANALYSES

Method precision was determined for 11 organic compounds, 3 anions and 20 metals processed by ASL in 2000. All analytes had relative percent differences within ASL's internal acceptance limit of ± 20%. The three standard deviation uncertainties were also within the EPA acceptance criteria of ±20%.

ASL has an internal QC program for the ion chromatography and atomic absorption methods used for inorganic analyses. One hundred and four batch checks were performed in 2000 for metals and anions. For the 21 certified metals analyzed by ASL, only beryllium and aluminum exceeded the three standard deviation EPA acceptance criteria for recovery. For aluminum, this was attributable to two reference check recovery values of 160% and 300% in March and December, respectively, that resulted in an overall three sigma standard deviation value that was higher than acceptable. For beryllium, three recovery values (130%, 122% and 110%) in the month of June resulted in an overall three sigma standard deviation value that was higher than acceptable. For this reason, analytical data for both aluminum and beryllium from the months in question were "qualified" but still usable.

The ASL has an internal QC program for the gas chromatography/mass spectroscopy method used for 14 primary VOCs. Recoveries and 99% confidence intervals were determined for 39 independent VOC measurements. Average recoveries for all of the 14 analytes were within their target ranges of ± 25%.

The 99% confidence intervals for surrogate recoveries were also determined for three additional analytes in 2000. The recovery range for 4-bromofluorobenzene was 75 - 125%. The recovery ranges for toluene and dibromofluoromethane were 80 - 120% and 80 - 115%, respectively. All surrogate recoveries were within EPA acceptance limits.

9.7 PERFORMANCE EVALUATION TESTING

As in prior years, ASL and three contractor laboratories participated in several national and state performance evaluation testing programs. Results of those performance evaluation tests provide information on the quality of a laboratory's analytical capabilities. As noted above, performance evaluation testing data are not presented in this report for the fourth contractor, Chemtex Laboratory, because no ERA or NYSDOH performance evaluation testing program includes the specific analytes analyzed by this laboratory. Chemtex only performed four chemical analyses for BNL on the following analytes: dibromo-nitrilo-propionamide, tolytriazole, polypropylene-glycol-monobutyl-ether, and 1,1-hydroxyethylidene-diphosphonic acid.

Effective December 21, 1998, EPA's performance evaluation programs for both radiological and nonradiological analytes were terminated. Environmental Resources Associates (ERA), a private independent performance evaluation program, was chosen by ASL to replace EPA's radiological and nonradiological performance evaluation program. During 2000, ASL, GEL, STL, and H2M participated in either the NYSDOH Environmental Laboratory Approval Program (ELAP) (for radiological and nonradiological proficiency evaluation testing) or the DOE Environment Measurements Laboratory (EML) Quality Assessment Program (radiological only). These laboratories participated in at least one performance evaluation program, although in several cases these labs participated in several programs. The results from these blind, independent tests are provided below.

9.7.1 SUMMARY OF PERFORMANCE EVALUATION TEST RESULTS

During 2000, BNL's overall satisfactory *radiological* scores in the NYSDOH ELAP and DOE Program were equivalent to its offsite contractor laboratory (GEL), with an 89% rate of satisfactory results, whereas in the ERA radiological program, both BNL and GEL achieved 94% and 95% rates of satisfactory scores, respectively. For *nonradiological* results, the overall rate of satisfactory results ranged from 92 to 99% for BNL, H2M, GEL and STL in both ERA and NYSDOH testing programs.

Figures 9-2 and 9-3 summarize the 2000 scores of ASL and the three contractor laboratories that participated in the mandatory U.S. DOE EML QA Program (for radiological analytes only) and the NYSDOH ELAP, as well as the voluntary ERA program. The bar graphs of Figures 9-2 and 9-3 summarize all tabulated radiological and nonradiological results (as percentage scores) that were acceptable, within warning limits, or unacceptable, for each analytical laboratory, and by performance evaluation testing program. A "warning" is considered satisfactory, being within two and three standard deviations of the target value, and an "unacceptable" result is greater than three standard deviations of the target value. An "overall satisfactory" score is the sum of results rated as acceptable and those rated as "warning," divided by the total number of results reported. Tabulated results are presented in Appendix F and are described in detail in Sections 9.7.2 and 9.7.3, below.

9.7.2 RADIOLOGICAL ASSESSMENTS

Both ASL and GEL participated in the DOE EML Quality Assessment Program and the NYSDOH ELAP. Overall, ASL's performance in the DOE EML performance evaluation program was satisfactory in 90.7% of the analyses performed on four matrices (air, vegetation, water, and soil), as shown in Table F-2. Twenty-seven of 43 analyses (62.8%) were within established DOE EML limits, showing acceptable agreement with the known value. Twelve results (27.9%) were within warning limits, demonstrating satisfactory agreement. Four analyses (9.3%) fell outside the acceptance limits. The four results that were not acceptable (H3, Sr-90, alpha and beta) occurred in the March round of testing, but were acceptable in the September round of EML testing.

GEL's performance for radiological analyses in DOE's EML performance evaluation program is also presented in Table F-2. GEL's performance in the DOE EML intercomparison study was acceptable or within warning limits in 97% of the analyses performed on the four matrices (air, vegetation, water, and soil). Seventy-one of 96 analyses (74%) were within EML's acceptance limit; 22 of 96 analyses (23%) were within upper and lower warning limits, demonstrating satisfactory agreement; 3 analyses (3%) fell outside the acceptance limits.

ASL's radiological results for the NYSDOH ELAP performance evaluation program were in 75% agreement for the four analyses, as shown in Table F-3. The one result that was unacceptable for beta in the April 2000 round was acceptable in the November 2000 round. For the same performance evaluation program, GEL had an overall satisfactory score of 90% on the ten analytes shown in Table F-3.

Both ASL and GEL participated in several voluntary ERA radiological performance evaluation studies shown in Table F-4. The overall ASL score on the thirty results reported in 2000 was 93.3% with two unacceptable tritium results. A review of internal QC checks showed a 15% to 20% negative bias in tritium measurements during the year that resulted in unacceptable tritium results in the ERA performance evaluation testing program. ASL had performed successfully in the September round of tritium testing in the DOE EML intercomparison, as shown in Table F-2, but not in the March round. The negative bias issue has since been resolved after the root cause of the problem was identified.

The actual negative bias in tritium was within the EPA acceptance limit of ± 25%, so

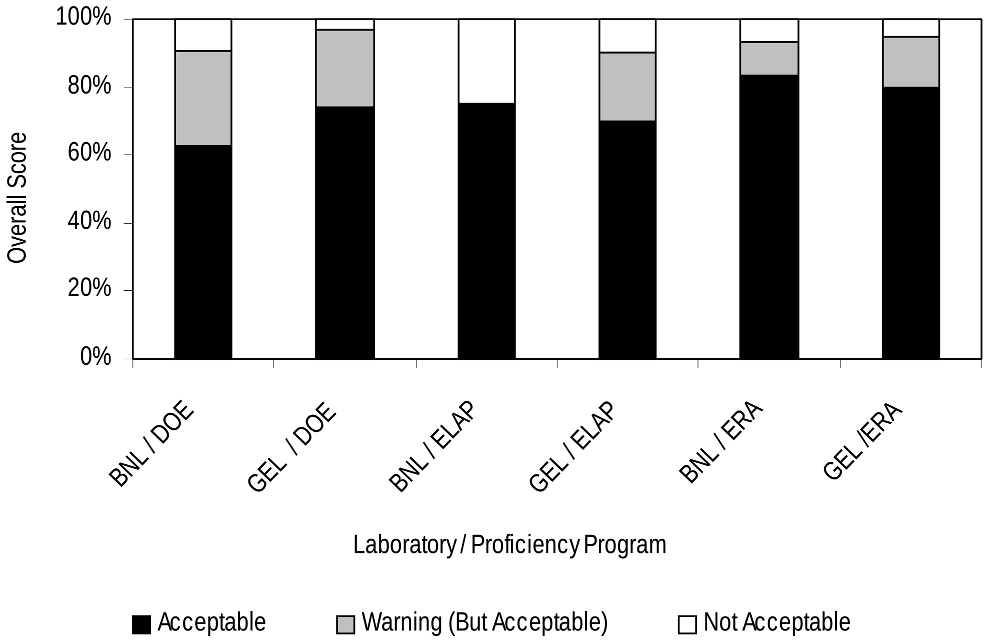


Figure 9-2. Summary of 2000 Performance Evaluation Scores in DOE, NYSDOH ELAP, and ERA Radiological Programs.

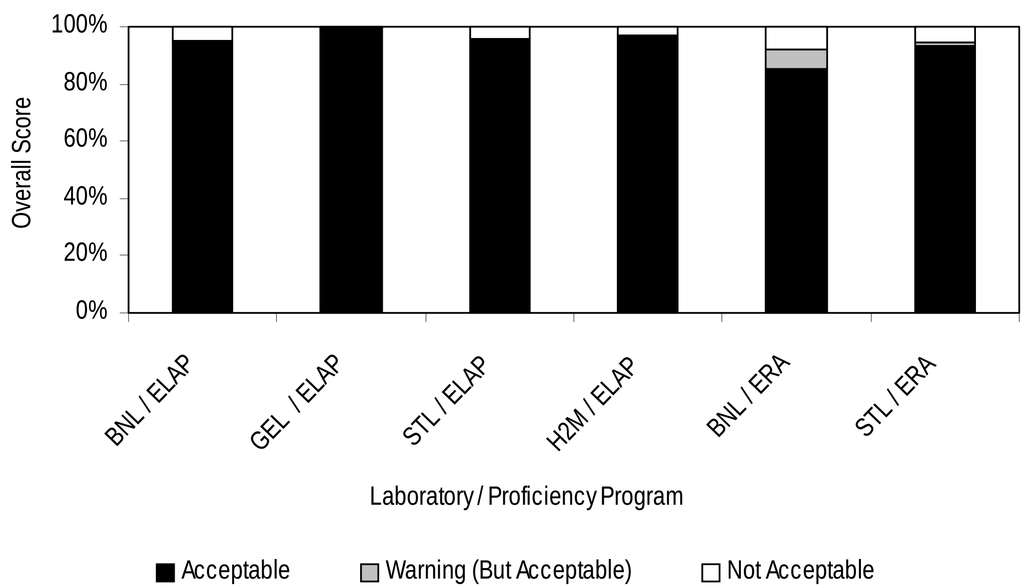


Figure 9-3. Summary of 2000 Performance Evaluation Scores in DOE, NYSDOH ELAP, and ERA Nonradiological Programs.

that no ASL data were qualified or rejected. GEL's overall score in the ERA radiological performance evaluation studies was 94.7% for 19 analytes reported as shown in Table F-4. One unacceptable result was reported for radium-226.

9.7.3 NONRADIOLOGICAL ASSESSMENTS

ASL, GEL, STL, and H2M participated in the NYSDOH ELAP during 2000. The NYSDOH certifies laboratories for nonpotable water, potable water and solid wastes. These results are summarized in Tables F-5 through

F-7 as "satisfactory," "warning," "unsatisfactory" or "not tested," for each of the four laboratories. (Note that STL has two labs: one in Missouri and one in Connecticut.) Although not required for New York State certification, ASL and STL also participated in the ERA water supply and water pollution studies which are presented in Table F-8.

Results for the NYSDOH ELAP for nonpotable water are shown in Tables F-5. There were a total of 85 results reported by ASL with five unacceptable results. In the ELAP nonpotable water category, ASL's overall satisfactory score was 94.1%. GEL reported results for 365 analytes with one unacceptable result, corresponding to an overall satisfactory score of 98.1%. There were 582 results reported by H2M, with 16 unacceptable results corresponding to an overall satisfactory score of 97.3% . STL's performance in the NYSDOH ELAP nonpotable water studies is shown separately for both the Missouri and Connecticut laboratories. The Missouri laboratory reported 182 results with an overall satisfactory score of 96.2%, whereas the Connecticut laboratory reported 585 results for an overall satisfactory score of 96.8%.

Results for the NYSDOH ELAP Solid and Hazardous Waste Chemistry Proficiency Program are shown in Table F-6 for ASL only. For the twenty-three results reported, ASL scored 100% in this category

Table F-7 summarizes results of the potable water category of the NYSDOH ELAP. ASL reported 142 results with 134 acceptable and 8 unacceptable results, corresponding to an overall satisfactory score of 94.4%. GEL reported 161 results with 158 acceptable and 3 unacceptable results, corresponding to an overall satisfactory score of 98.1%.

H2M reported 195 results with 189 acceptable and 6 unacceptable results, corresponding to an overall satisfactory score of 96.9%. STL (Missouri) reported 159 results with 149 acceptable and 10 unacceptable results, corresponding to an overall satisfactory score of 91.2 %.

ASL and STL participated in the voluntary ERA water pollution and water supply performance evaluation studies, as shown in Table F-8. For both water supply and water pollution studies, ASL reported 217 results with 185 acceptable, 15 within warning limits, and 17 unacceptable results. The overall satisfactory score for ASL in ERA's water supply and water pollution studies was 92.1%. STL (Connecticut) reported 381 results with 356 acceptable, 4 warning and 21 unacceptable. The overall satisfactory score for STL in the ERA water supply and water pollution studies was 94.5%.

9.8 LABORATORY AUDITS

In addition to performance evaluation testing, BNL conducts a program of internal and external audits to verify the effectiveness of the environmental sampling, analysis, and database activities. Contractor laboratories were subject to audits by BNL personnel at the time of contract renewal. The contractor laboratories were audited periodically by ASL and/or Environmental Restoration Program staff to verify competence in analytical methodology and implementation of a comprehensive QA program.

During 2000, ASL began contract renewal and bid processes for both GEL and H2M. The audits of these two laboratories occurred in the spring of 2000 and there were no significant findings. An audit of Chemtex is planned for late 2001, when the existing contract expires.

The BNL Quality Management Office, DOE Brookhaven Group, DOE Chicago Operations, regulatory agencies, and other independent parties also periodically audit BNL environmental programs, as discussed in Chapters 2 and 3.

9.9 CONCLUSIONS

Detailed data on quality control results for all analyses conducted at BNL's ASL are presented in ASL's *Year 2000 QA Report* (Scarpitta and Heotis, 2001). The report presents tables and figures depicting instrument calibration, efficiency and background checks, and precision and accuracy testing. Overall, QC checks were consistently within the EPA guidelines of ±20%.

Detailed data on external performance evaluation testing are also presented in the Year 2000 QA Report for the ASL and three offsite contractor laboratories. Overall, the two laboratories (ASL and GEL) reporting radiological analytical data in the *Site Environmental Report 2000* had combined satisfactory results of 89% and 96%, respectively, in both state and federal performance evaluation programs. For nonradiological performance evaluation testing, ASL and the three BNL contractor laboratories (H2M, GEL, and STL) all scored over 92% in the NYSDOH ELAP evaluations.

Based on implementation and evaluation of the QA/QC program, it can be concluded that the analytical data reported in the *Site Environmental Report 2000* are reliable and of high quality.

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