

10.0 LABORATORY QUALITY ASSURANCE

It is the policy of U.S. Department of Energy Nevada Operations Office (DOE/NV) that all data produced for its environmental surveillance and effluent monitoring programs be of known quality. Therefore, a quality assurance (QA) program is used for collection and analysis of samples for radiological and nonradiological parameters to ensure that data produced by the laboratory meets customer- and regulatory-defined requirements. Data quality is assured through process-based QA, procedure-specific QA, data quality objectives (DQOs), and performance evaluation programs. The external QA program for radiological data consists of participation in the U.S. Department of Energy (DOE) Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML), and the Environmental Radiological Performance Evaluation Studies Program (PESP) conducted by the U.S. Environmental Protection Agency (EPA) National Exposure Research Laboratory in Las Vegas. The radiological external QA program also consists of participation in the DOE Laboratory Accreditation Program (DOELAP) Radiobioassay In-Vitro study administered by DOE; and the Oak Ridge National Laboratories (ORNL) radiobioassay study conducted by ORNL in Oak Ridge, Tennessee. The QA program for nonradiological data was accomplished by using commercial laboratories with appropriate certification or accreditation by state or government agencies.

The environmental surveillance program off the Nevada Test Site (NTS) was conducted by EPA's Radiation and Indoor Environment National Laboratory-Las Vegas (R&IE-LV). The QA program developed by R&IE-LV for the Offsite Radiological Safety Program (ORSP) meets all requirements of EPA policy, and also includes applicable elements of the DOE/NV QA requirements and regulations. The ORSP QA program defines DQOs, which are statements of the quality of data a decision maker needs to ensure that a decision based on that data is defensible.

10.1 POLICY

Environmental surveillance, conducted onsite by Bechtel Nevada (BN) and offsite by EPA's R&IE-LV, is governed by DOE QA policy as set forth in DOE Order 5700.6C. The Order outlines ten specific elements that must be considered for compliance with the QA policy. These elements are:

1. Program
2. Personnel Training & Qualification
3. Quality Improvement
4. Documents and Records
5. Work Processes

6. Design
7. Procurement
8. Data Acceptance and Review
9. Management Assessment
10. Independent Assessment

In addition, R&IE-LV meets the EPA policy which states that all decisions which are dependent on environmental data must be supported by data of known quality. EPA policy requires participation in a centrally managed QA Program by all EPA elements as well as those monitoring and measurement efforts supported or mandated through contracts, regulations, or other formalized agreements. Further, EPA policy

requires participation in a QA Program by all EPA organizational units involved in environmental data collection. The QA policies and requirements of R&IE-LV are summarized in the "Quality Management Plan" (EPA/ORIA 1996). The QA policies and requirements specific to the ORSP are documented in the "Quality Assurance Program Plan for the Nuclear Radiation Assessment Division Offsite Radiation Safety Program" (EPA 1992 [in revision]). The requirements of these documents establish a framework for consistency in the continuing application of quality assurance standards and implementing procedures in support of the ORSP. Administrative and technical implementing procedures based on these QA requirements are maintained in appropriate manuals or are described in standard operating procedures (SOPs) of the R&IE-LV.

10.2 OVERVIEW OF THE LABORATORY QA PROGRAM

The BN Analytical Services Laboratory (ASL) implements the requirements of DOE Order 5700.6C, "Quality Assurance" through integrated quality procedures. The quality of data and results is ensured through both process-based and procedure-specific QA.

Procedure-specific QA begins with the development and implementation of SOPs which contain the analytical methodologies and required quality control samples for a given analysis. Personnel performing a given analysis are trained and qualified for that analysis, including the successful analysis of a quality control sample. Analysis-specific operational checks and calibration standards traceable to either the National Institute of Standards and Technology (NIST) or the EPA are required. Quality control samples, e.g., spikes, blanks, and replicates, are included for each analytical procedure. Compliance to analytical procedures is measured through procedure-specific assessments or surveillances.

An essential component of process-based QA is data review and verification to assess data usability. Data review requires a systematic, independent review against pre-established criteria to verify that the data are valid for their intended use. Initial data processing is performed by the analyst or health physicist generating the data. An independent review is then performed by another analyst or health physicist to ensure that data processing has been correctly performed and that the reported analytical results correspond to the data acquired and processed. Data checks are made for internal consistency, proper identification, transmittal errors, calculation errors, and transcription errors. Supervisory review of data is required prior to release of the data to sample management personnel for data verification. Data verification ensures that the reported results correctly represent the sampling and/or analyses performed, and includes assessment of quality control sample results. Data processing by sample management personnel ensures that analytical results meet project requirements. Data discrepancies identified during the data review and verification process are documented on data discrepancy reports (DDRs). DDRs are reviewed and compiled quarterly to discern systematic problems.

Process-based QA programs also include periodic operational checks of analytical parameters such as reagent water quality and storage temperatures. Periodic calibration is required for all measuring equipment such as analytical balances, analytical weights, and thermometers. The overall effectiveness of the QA program is determined through systematic assessments of analytical activities. Systematic problems are documented and corrective actions tracked through System Deficiency Reports.

Similar procedures and methodologies are used by R&IE-LV to ensure the quality of environmental radiological data collected off the NTS.

10.3 DATA AND MEASUREMENT QUALITY OBJECTIVES

DATA QUALITY OBJECTIVES

DQOs delineate the circumstances under which measurements are made, and define the acceptable variability in the measured data. DQOs are based on the decision(s) to be made, the range of sampling possibilities, what measurements will be made, where the samples will be taken, how the measurements will be used, and what calculations will be performed on the measurement data to arrive at the final desired result(s). Associated measurement quality objectives (MQO), which define acceptable variability in the measured data, are established to ensure the quality of the measurements.

DECISIONS TO BE MADE

The primary decisions to be made, based on radiological environmental surveillance measurements, are whether, due to NTS activities: (1) any member of the general public, outside the site boundaries, receives an effective dose equivalent (EDE) that exceeds regulatory limits; (2) there is detectable contamination of the environment; or (3) there is a biological effect. A potential EDE to a member of the public from NTS activities is much more likely to be due to inhalation or ingestion of radionuclides which have reached the person through one or more pathways, such as transport through the air (inhalation exposure), or through water and/or foodstuffs (ingestion exposure), than to be due to external exposure. A pathway may be quite complex; e.g., the food pathway could include airborne radioactivity falling on soil and plants, also being absorbed by plants, which are eaten by an animal, which is then eaten by a member of the public. At

the NTS because of the depth of aquifers, negligible horizontal or vertical transport, lack of surface water flows and little rain, very sparse vegetation and animal populations, lack of food grown for human consumption, and large distances to the nearest member of the public, the airborne pathway is by far the most important for a possible EDE to a member of the public.

Decisions made based on nonradiological data are related to waste characterization, extent and characterization of spills, compliance with regulatory limits for environmental contaminants, and possible worker exposure(s).

RANGE OF SAMPLING POSSIBILITIES

Determination of the numbers, types and locations of radiological sampling stations is based on factors such as the location of possible sources, isotopes of concern, wind and weather patterns, the geographical distribution of human populations, the levels of risk involved, the desired sensitivity of the measurements, physical accessibility to sampling locations, and financial constraints. The numbers, types, and location of nonradiological samples are typically defined by regulatory actions on the NTS and are determined by environmental compliance or waste operations activities. Workplace and personnel monitoring to determine possible worker exposures is conducted by Industrial Hygienists and Health Physicists from the Environmental, Safety, Security and Health (ESS&H) Department.

MEASUREMENTS TO BE MADE

Radioanalyses are made of air, water, or other media samples to determine the types and amounts of radioactivity in them. These measurements are then converted to radioactivity concentrations by dividing by the sample volume or weight, which is measured separately. Nonradiological inorganic or organic constituents in air,

water, soil, and sludge samples are analyzed and reported by commercial laboratories under contract to BN. Methods and procedures used to measure possible worker exposures to nonradiological hazards are defined by Occupational Safety and Health Administration or National Institute of Occupational Safety and Health protocols. Typical contaminants for which ESS&H personnel collect samples and request analyses are asbestos, solvents, and welding metals. Sample media which are analyzed include urine, blood, air filters, charcoal tubes, and bulk asbestos.

SAMPLING LOCATIONS

The locations of routine radiological environmental surveillance sampling both on and off the NTS are described in Chapters 4 and 5 of this report. Onsite sampling methodologies are described in BN's Environmental Management SOPs, and offsite methodologies by similar R&IE-LV procedures. The locations of nonradiological environmental sampling and monitoring are determined through site remediation and characterization activities and by permit requirements.

USE OF THE MEASUREMENTS

There are several techniques to estimate the EDE to a member of the public. One technique is to measure the radionuclide concentrations at the location(s) of interest and use established methodologies to estimate the EDE a person at that location could receive. Another technique is to measure radionuclide concentrations at specific points within the site and to use established models to calculate concentrations at other, offsite locations of interest. The potential EDE to a person at such a location could then be estimated. This second technique is the one used for most of the environmental surveillance data measured at the NTS.

CALCULATIONS TO BE PERFORMED

The EDE of greatest interest is the EDE to the maximally exposed individual (MEI). The MEI is located where, based on measured radioactivity concentrations and distances from all contributing NTS sources, the calculational model gives the greatest potential EDE for any member of the public. The assumptions used in the calculational model are conservative; i.e., the calculated EDE to the MEI most certainly exceeds the EDE any member of the public would actually receive. The model used at the NTS is EPA's CAP88-PC, a wind dispersion model approved for this purpose.

MEASUREMENT QUALITY OBJECTIVES

MQOs are commonly described in terms of representativeness, comparability, completeness, precision, and accuracy. Although the assessment of the first two characteristics must be essentially qualitative, definite numerical goals may be set and quantitative assessments performed for the latter three.

REPRESENTATIVENESS

Representativeness is the degree to which a sample is truly representative of the sampled medium, i.e., the degree to which measured analytical concentrations represent the concentrations in the medium being sampled (Stanley and Verner 1985).

Representativeness also refers to whether the locations and frequency of sampling are such that calculational models will lead to a correct estimate of potential EDE to a member of the public when measured radioactivity concentrations are put into the model. An environmental monitoring plan for the NTS, DOE/NV/10630-28, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities" has been established to achieve representativeness for

environmental data. Factors which were considered in designing this monitoring plan include locations of known and potential sources, historical and operational knowledge of isotopes and pathways of concern, hydrological, and topographical data, and locations of human populations.

COMPARABILITY

Comparability refers to the degree of confidence and consistency we have in our analytical results, or defined as "the confidence with which one data set can be compared to another" (Stanley and Verner 1985). To achieve comparability in measurement data, sample collection and handling, laboratory analyses, and data analysis and validation are performed in accordance with established SOPs. Standard reporting units and a consistent number of significant digits are used. Instruments are calibrated using NIST-traceable sources. Each batch of field samples is accompanied by a spiked sample with a known quantity of the compound(s) of interest. Extensive QA measures are used for all analytical processes. In addition, comparability is attained through comparison of external performance audit results to those achieved by other laboratories participating in the EPA PESP.

COMPLETENESS

Completeness is defined as the percentage of samples collected versus those which had been scheduled to be collected, or the percentage of valid analysis results versus the results which would have been obtained if all samples had been obtained and correctly analyzed. Realistically, samples can be lost during shipping, handling, preparation, and analysis, or not collected as scheduled. Also data entry or transcription errors can be made. The BN completeness objectives for all radiological samples and analyses have been set at 90 percent for sample collection and 85 percent for analyses, or 75 percent overall. R&IE-LV's completeness objective for the Long-

Term Hydrological Monitoring Program is 80 percent and for the other networks is 90 percent.

Completeness for inorganic and organic analyses is based on the number of valid results received versus the number requested.

PRECISION

Precision refers to "the degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions" (Taylor 1987). Practically, precision is determined by comparing the results obtained from performing the same analysis on split samples, or on duplicate samples taken at the same time from the same location, maintaining sampling and analytical conditions as nearly identical as possible. Precision for samples is determined by comparing results for duplicate samples of particulates in air, tritiated water vapor, noble gases, and some types of water samples. For thermoluminescent dosimeters (TLDs), precision is assessed from variations in the three CaSO_4 elements of each TLD. Precision is expressed quantitatively as the percent relative standard deviation (%RSD), i.e., the ratio of the standard deviation of the measurements being compared to their mean converted to percent. The smaller the value of the %RSD, the greater is the precision of the measurement. The precision objectives are shown in Table 10.1. They are a function of the concentration of radioactivity in the samples; i.e., the analysis of samples with concentrations near zero will have low precision while samples with higher concentrations will have proportionately higher precision.

ACCURACY

Accuracy refers to how well we can measure the true value of a given quantity and can be defined as "the degree of agreement of a

measured value with the true or expected value of the quantity of concern" (Taylor 1987). For practical purposes, assessments of accuracy for ASL are done by performing measurements on special quality assurance samples prepared, using stringent quality control, by laboratories which specialize in preparing such samples. The values of the activities of these samples are not known by the staff of the ASL until several months after the measurements are made and the results sent back to the quality assurance laboratory. These sample values are unknown to the analysts and serve to measure the accuracy of the analytical procedures. The accuracy of these measurements, which is assumed to extend to other similar measurements performed by the laboratory, may be defined as the ratio of the measured value divided by the true value, expressed as a percent. Percent bias is the complement of percent accuracy, i.e., %Bias = 100 - % accuracy. The smaller the percent bias, the more accurate are the measurements. Table 10.2 shows the accuracy objectives of the ASL and of the R&IE-LV.

Measurements of sample volumes should be accurate to ± 5 percent for aqueous samples (water and milk) and to ± 10 percent for air and soil samples. The sensitivity of radiochemical and gamma spectrometric analyses must allow no more than a 5 percent risk of either a false negative or false positive value. Control limits for accuracy, monitored with matrix spike samples, are required to be no greater than ± 20 percent for all gross alpha and gross beta analyses and for gamma spectrometric analyses.

Both the R&IE-LV and ASL participate in several interlaboratory performance evaluation (PE) programs such as EPA's PESP and EML's QAP and the DOELAP for TLDs. The ASL also participates in two bioassay programs, DOELAP and ORNL.

The accuracy of the TLDs is tested every two or three years by DOELAP. This

involves a three-part, single blind, performance testing program followed by an independent onsite assessment of the overall program. Both BN and R&IE-LV participate in this program.

Once the data have been finalized, they are compared to the MQOs. Completeness, accuracy, and precision statistics are calculated. If data fail to meet one or more of the established MQOs, they may still be used in data analysis; however, the data and any interpretive results must be qualified. Current and historical data are maintained in an access-controlled database.

All sample results exceeding the traditional natural background activity range are investigated. If data are found to be associated with a non-environmental condition, e.g., a check of the instrument using a calibration source, the data are flagged and are not included in calculations of averages, etc. Only data verified to be associated with a non-environmental condition are flagged; all other data are used in calculation of averages and other statistics, even if the condition is traced to a source other than the NTS.

10.4 RESULTS FOR COMPLETENESS, PRECISION, AND ACCURACY

Summary data for completeness, precision, and accuracy are provided in Tables 10.3 to 10.6. Complete data used in these MQO's for 1995 may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

COMPLETENESS

The analysis completeness data for calendar year 1996 are shown in Table 10.3. These percentages represent all analyses which were carried to completion, and include some analyses for which the results were

found to be invalid for other reasons. Had objectives not been met for some analyses, other factors would be used to assess acceptability, e.g., fit of the data to a trend or consistency with results from samples collected before and after.

The completeness of MQOs for the onsite networks were met or exceeded in all cases. For the offsite networks, the MQOs were met or exceeded except for the high volume and pressurized ion chamber networks, where field equipment malfunction prevented complete collections.

PRECISION

From replicate samples collected and analyzed throughout the year, the %RSD was calculated for various types of analyses and sampling media. The results of these calculations are shown in Table 10.4 for both the onsite and offsite networks. In addition to examination of %RSDs for individual duplicate pairs, an overall precision estimate was determined by calculating the pooled standard deviation, based on the algorithm given in Taylor (1987). To convert to a unitless value, the pooled standard deviation was divided by the grand mean and multiplied by 100 to yield a %RSD. The table presents the pooled data and estimates of overall precision. The pooled standard deviations and %RSD indicate the estimated achieved precision for samples.

For the R&IE-LV, the samples not meeting the precision MQO were low activity, air particulate samples in which ^7Be was detected. The precision data for all other analyses were well within their respective MQOs. The R&IE-LV data presented in Table 10.4 include only those duplicate pairs that exceeded the minimum detectable concentration (MDC).

For the ASL, there was one analysis that failed to meet the MQO, namely, gross alpha in air. Subsequent investigation of the

analytical procedure revealed equipment and procedure problems for part of the year that have since been corrected. A reason for the low precision in some of the analyses was the low activity in these environmental samples, e.g., for tritium in air, the few that were useful for calculation of precision barely exceeded the MDC.

ACCURACY

The ASL and R&IE-LV accuracy objectives were measured through participation in the interlaboratory comparison and quality assessment programs discussed below.

RADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external radiological PESP consisted of participation in the QAP conducted by DOE/EML and the PESP conducted by EPA. These programs serve to evaluate the performance of the radiological laboratory and to identify problems requiring corrective actions.

Summaries of the 1996 results of the interlaboratory performance evaluation and quality assessment programs conducted by the EPA and DOE/EML are provided in Tables 10.5 and 10.6. The last column in each table (percent Bias) is the accuracy of analysis and may be compared to the objectives listed in Table 10.2. The individual radionuclide recoveries are listed in tables which are being published separately in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

Accuracy, as percent difference or percent bias is calculated by:

$$\%BIAS = \left(\frac{C_m - C_a}{C_a} \right) 100$$

where:

%BIAS = percent bias
 C_m = measured sample activity
 C_a = known sample activity

The R&IE-LV failed the accuracy MQO in only 1 of the 24 analyses attempted in the EPA PE Study. In the EML QAP, 14 of the 42 analyses performed exceeded the DQO of ± 20 percent. In 1996, R&IE-LV maintained accreditation by DOELAP for the personnel TLD program. Quality Assurance checks are routinely performed to ensure compliance with applicable performance standards. Software and hardware changes have been implemented that will increase the Panasonic TLD systems report capability and reader sensitivity to lower energy radiation. When final performance testing and accreditation is completed, the new hard- and software will then be used for dose of record.

BN's ASL results exceeded the three normalized deviation limits in 7 of the 58 analyses attempted. The MQOs for accuracy in analysis of DOE/EML samples were not met in only 2 of the 25 samples supplied.

CORRECTIVE ACTIONS IMPLEMENTED IN RESPONSE TO PERFORMANCE EVALUATION PROGRAMS

BN results were generally within the control limits determined by the program sponsors. Results which were not within acceptable performance limits were investigated, and corrective actions taken to prevent reoccurrence. Corrective actions included a new process for preparing and including quality control samples, training of analysts, and an improved tracking system for PE samples.

In the R&IE-LV, the 1996 results that did not meet analysis criteria were investigated to determine the cause of the reported error. Corrective actions were implemented, including the addition of personnel to perform reviews on data entry and counting system output to detect and correct potential operator error.

COMPARABILITY

The EPA PESP and the EML/QAP provide results to each laboratory participating in each study that include a grand average for all values, excluding outliers. A normalized deviation statistic compares each laboratory's result (mean of three replicates) to the known value and to the grand average. If the value of this statistic (in multiples of standard normal deviate, unitless) lies between control limits of -3 and +3, the accuracy (deviation from known value) or comparability (deviation from grand average) is within normal statistical variation.

Data from the 1996 intercomparison studies for all variables measured were compared with the grand average to calculate a normalized deviation for the R&IE-LV results. With the exception of one gamma spectroscopy sample, all analyses were within three standard normal deviate units of the grand mean, and most were within two normalized deviate units. This indicates acceptable comparability of the R&IE-LV results with the 98 to 186 laboratories participating in the EPA PESP.

One of the two EML studies for 1996 was reported outside of acceptable limits for gamma spectroscopy in both air and water matrices. Follow up investigation established a volume data entry error in both cases. Corrective actions were implemented.

R&IE-LV began participating in the DOE Mixed Analyte Performance Evaluation Program (MAPEP) during 1996. Analysis of water and soil matrix samples was performed with all analytical results within the acceptable bias limit of ± 20 percent.

The onsite ASL's results in the EML QAP were acceptable. There were only two instances in which the ASL results were greater than the MQO. The EPA PESP includes a grand average (average result from all participating laboratories, less

outliers) in its report to participants. Using the formula for percent bias described above, the percent bias of the ASL results as compared to the grand average was calculated for each analysis. The outcome for this calculation did not differ from the accuracy results reported above. Thus comparability of the ASL results is the same as its accuracy on PE samples as reported above.

SPIKE AND REAGENT BLANK DATA

Reagent blanks prepared by ASL were analyzed for the same radionuclides as the

samples. All 242 reagent blank results were less than the MDC of the analysis for which the blanks were designed.

A similar number of spike samples were prepared by ASL. The accuracy (as percent recovery) varied from 67 to 117 percent for the eight different analyses. The standard deviations of these percent recoveries is a measure of precision. These ranged from 3.5 to 14.6 percent for seven of the analyses. The uranium analysis procedure had a standard deviation of 58 percent, because of three spikes that were just barely above the MDC.

Table 10.1 Precision Objectives Expressed as Percents

<u>Analysis</u>	<u>ASL</u>	
	<u>Conc. > 10 MDC</u>	<u>4 MDC ≤ Conc. ≤ 10 MDC</u>
Gross Alpha	±30	±60
Gross Beta	±30	±60
Gamma Spectrometry	±30	±60
Scintillation Counting	±30	±60
Alpha Spectrometry	±20	±50
Noble Gas Analysis	±30	±40

Note: The precision objective for TLDs at environmental levels is 10 percent.

<u>R&IE-LV</u>		
Conventional Tritium	±10	±30
Strontium (in milk)	±10	±30
Thorium	±10	±30
Uranium	±10	±30
Enriched Tritium	±20	±30
Strontium (in other media)	±20	±30
Plutonium	±20	±30

Table 10.2 Accuracy Objectives Expressed as Percent Bias

<u>Analysis</u>	<u>ASL</u>	
	<u>Conc. > 10 MDC</u>	<u>4 MDC ≤ Conc. ≤ 10 MDC</u>
Gross Alpha	±20	±50
Gross Beta	±20	±50
Gamma Spectrometry	±20	±50
Scintillation Counting	±20	±50
Alpha-Spectrometry	±20	±50
Noble Gas Analysis	±30	±60

Note: The objective for TLDs is 20 percent for exposures <10 mR and 10 percent for ≥10 mR.

<u>R&IE-LV</u>		
Tritium, Conventional	±10	±30%
Strontium (Milk)	±10	±30%
Thorium	±10	±30%
Uranium	±10	±30%
Tritium, Enriched	±20	±30%
Strontium (other media)	±20	±30%
Plutonium	±20	±30%
TLDs	Meet DOELAP Criteria	

Table 10.3 Analysis Completeness Data for Calendar Year - 1996

<u>Analysis</u>	<u>Medium</u>	<u>Completeness Percent</u>	
		<u>BN</u>	<u>R&IE-LV</u>
Gross Alpha/Beta	Low Volume Particulate Air Filter	97.3	95.5
Plutonium	High Volume Particulate Air Filter	--	85.3
Plutonium	Low Volume Particulate Air Filter	97.8	--
Gamma Spectrometry	Low Volume Particulate Air Filter	98.0	95.5
Gamma Spectrometry	Low Volume Charcoal Air Filter	(a)	95.5
Gamma Spectrometry	High Volume Particulate Air Filter	(a)	85.3
Tritiated Water	Air	90.6	(a)
Krypton-85	Air	81.4	(a)
Gross Alpha	Potable Water Taps	100	
Gross Beta	Potable Water Taps	100	(a)
Gamma Spectrometry	Potable Water Taps	100	(a)
Tritiated Water	Potable Water Taps	100	(a)
Plutonium	Potable Water Taps	100	(a)
Gross Beta	Wells, Reservoirs, Springs, Ponds	95.3	(a)
Plutonium	Wells, Reservoirs, Springs, Ponds	95.3	(a)
Gamma Spectrometry	Wells, Reservoirs, Springs, Ponds	98.5	98.0
Tritiated Water	Wells, Reservoirs, Springs, Ponds	95.3	97.8
Strontium-90	Wells, Reservoirs, Springs, Ponds	98.5	(a)
Gross Alpha	Potable Wells and Taps	96.9	(a)
Tritium	Milk	(a)	93.5
Strontium	Milk	(a)	93.5
Pressurized Ion Chamber	Ambient Radiation	(a)	73.9
TLDs, Environmental	Ambient Radiation	90.2	93.9
TLDs, Personnel	Ambient Radiation	(a)	86.3

(a) Analyses not performed.

Table 10.4 Precision Estimates from Replicate Sampling - 1996

<u>Analysis</u>	<u>ASL</u>	
	<u>Number of Replicate Analyses</u>	<u>Precision Estimate % RSD</u>
Gross Beta in Air	50	7.0
Gamma in Air	48	1.6
Gross Alpha in Air	28	50.7
Gross Alpha in Potable Water	28	5.1
Gross Beta in Potable Water	35	15.1
HTO in Tunnel Effluent	7	6.4
Pu in Tunnel Effluent	14	1.5
	<u>R&IE-LV</u>	
Gross Alpha in Air	84	28.5
Gross Beta in Air	145	18.0
Gamma Spectrometry (Low-Vol ⁷ Be)	14	36.2
Gamma Spectrometry (Hi-Vol ⁷ Be)	11	46.8
Tritium in Water (enriched)	12	7.9
Tritium in Water (unenriched)	2	26.2

Table 10.5 Accuracy of R&IE-LV Radioanalyses (EML QAP and PESP) - 1996

Water Samples Range of Results - pCi/L

<u>Analysis</u>	<u>No.</u>	<u>PESP</u>	<u>R&IE-LV</u>	<u>% Bias</u>
Gross Alpha	5	10 - 75	12 - 71	-4.2 - 20
Gross Beta	5	7 - 167	13 - 162	-3.2 - 13
Gamma Spec. ^(a)	5	10 - 745	12 - 6300	-9 - 790
Strontium	2	10 - 25	12 - 24	-4 - 23
Alpha Spec.	5	5 - 58	5 - 55	-6 - 3
Tritium	2	10880 - 22000	10800 - 21300	3.1 - -0.4

(a) One group of samples submitted for gamma spectrometric evaluation included an incorrect dilution factor, thus a reporting error. Positive % Bias for the remaining samples was a maximum of 12 for the 1996 reporting period.

% Bias Range for Analysis of EML QAP Samples

<u>Analysis</u>	<u>No.</u>	<u>Air</u>	<u>Soil</u>	<u>Vegetation</u>	<u>Water</u>
Plutonium	13	-3.1 - 6.5	-30 - 1.9	-11 - 13	0.5 - 1.3
Uranium	4	(a)	(a)	(a)	0.8 - 20
Strontium	5	(a)	-100	-100 - -91	-11 - 15
Tritium	2	(a)	(a)	(a)	-16 - -11
Gamma Spec.	19	-5.2 - 18	(a)	(a)	25 - 28

(a) No sample.

% Bias Range for Analysis of MAPEP QAP Samples

Plutonium	4	(a)	1.4 - 3.9	(a)	-4.0 - -4.8
Strontium	1	(a)	(a)	(a)	-15
Gamma Spec.	3	(a)	(a)	(a)	-5.6 - 4.6

(a) No sample.

Table 10.6 Accuracy of ASL Radioanalyses (EPA PESP and EML QAP) - 1996

<u>Analysis</u>	<u>No.</u>	<u>BN/ASL</u>	<u>EPA QA Normalized Deviation^(a)</u>	
<u>Water Samples</u>		<u>Average pCi/L</u>	<u>Known</u>	<u>Grand Avg.</u>
⁶⁰ Co	5	15.7 - 109	0.23 - 3.46 ^(b)	0.15 - 3.77 ^(b)
⁶⁵ Zn	2	48.7 - 342	2.41 - 4.73 ^(b)	1.86 - 4.36 ^(b)
¹³⁴ Cs	5	414 - 80.3	-1.50 - 1.02	-0.50 - 2.57

(a) No sample.

(b) Results exceed 3 Normalized Deviations.

Table 10.6 (Accuracy of ASL Radioanalyses [EPA PESP and EML QAP] - 1996, cont.)

<u>Analysis</u> <u>Water Samples</u>	<u>No.</u>	<u>BN/ASL</u> <u>Average pCi/L</u>	<u>EPA QA Normalized Deviation^(a)</u>	
			<u>Known</u>	<u>Grand Avg.</u>
¹³⁷ Cs	5	31.3 - 200	0.46 - 4.62 ^(b)	-0.08 - 4.15 ^(b)
¹³³ Ba	2	70 - 717	-0.65 - 1.73	-0.07 - 2.48
⁸⁹ Sr	5	13.3 - 68	-1.73 - 1.15	-0.89 - 1.03
⁹⁰ Sr	4	10.3 - 18.7	-2.19 - 0.12	-1.74 - 0.05
¹³¹ I	2	40 - 74	1.65 - 3.75 ^(b)	1.27 - 3.58 ^(b)
Tritium	2	10060 - 22800	-1.30 - 0.65	-0.84 - 0.89
²²⁶ Ra	4	6.9 - 27.2	-1.19 - 13.4 ^(b)	-0.85 - 13.3 ^(b)
²²⁸ Ra	5	3.4 - 22.6	-2.22 - 3.26 ^(b)	-2.62 - 3.38 ^(b)
U (nat.)	5	10.0 - 41.2	^(b) -5.13 - -0.04	^(b) -4.27 - 0.29
Gross Alpha	6	10.0 - 85.5	-1.95 - -0.09	-0.33 - 0.41
Gross Beta	6	6.6 - 151	-2.57 - 0.17	-2.61 - -0.06

(a) ± 3 Normalized Deviation is acceptable.

(b) Results exceed 3 Normalized Deviations.

% Bias Range for Analysis of EML QAP Samples

<u>Analysis</u>	<u>No.</u>	<u>Air</u>	<u>Soil</u>	<u>Vegetation</u>	<u>Water</u>
Americium	2	-26 - -14	(a)	-10 - 28	-2.1 - 7
Plutonium	4	-23 - 0	-8 - -2.6	-15 - 0	-12 - 2
Uranium	5	-8 - 7.5	-3 - -10	(a)	1 - 10
Strontium	2	-11 - -5.1	-16 - -3	-9 - -5	0 - 1.4
Tritium	2	(a)	(a)	(a)	-17 - -14
Gamma Spec.	6	-51 - 8.4	-20 - 4	1 - 79	-20 - 9
Gross Alpha	2	-19 - 63	(a)	(a)	3 - 5.4
Gross Beta	2	4 - 202	(a)	(a)	-17 - 13

(a) No sample.



Cactus in Bloom in Area 5