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Los Alamos
National Laboratory

Environmental Programs Directorate

Waste and Environmental Services

AIRNET - Quality Assurance Project Plan

for the

RADIOLOGICAL AIR SAMPLING NETWORK

Signatures

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REVISION HISTORY

Revision	Date	Description of Changes
1	5/8/87	New document.
2	1/10/90	Revisions to reflect changes in program.
3	12/21/95	Extensively revised following QA/R-5 format to meet new requirements in the FFCA and 40 CFR Part 61.
4	10/2/96	New stations, analytical methods, and group project management.
5	7/7/97	Changes to analytical methods for alpha and beta counts; new location list and station grouping; added consent decree requirements; editorial changes.
6	1/4/99	Revised into Sampling and Analysis Plan format, parts moved to appropriate project plans.
7	6/23/00	New titles, sampler siting criteria, other details.
8	5/3/05	Changed description of sample analyses, added description of siting process, other updates, renamed as Quality Assurance Project Plan. Reflect practice at Jan 2005.
0	03/28/08	Division/Group name change, new procedure number; old procedure number: ENV MAQ AIRNET. Added text on expedited isotopic analysis.
1	03/10/11	Small editorial improvements
2	4/11/2011	Added paragraph on management level classification (ML-4)

1.0 PURPOSE

The emission of radionuclides from the Los Alamos National Laboratory (LANL) is regulated by the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE). Routine measurement and reporting of radionuclide concentrations in the ambient air is required. A system is needed to:

- determine the environmental impact of LANL radioactive air emissions, according to requirements found in DOE Orders 5400.5, "Radiation Protection of the Public and the Environment," and 450.1, "Environmental Protection Program," and the guidance in DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance;" and
- determine the off-site dose contribution from non-point source LANL radioactive air emissions, according to the requirements of 40 CFR Part 61.94(b) (5), "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," as outlined in the Compliance Plan described in Appendix A of the Federal Facilities Compliance Agreement (FFCA) between DOE and EPA dated June 1996.

The Radiological Air Sampling Network (AIRNET) system does not measure the short-lived gaseous activated air product emissions. Such measurements are performed under ENV-EAQ-RN, Quality Assurance Project Plan for the Rad-NESHAP Compliance Team.

This quality assurance project plan (QAPP) and its implementing procedures describe how environmental air monitoring for radioactive air contaminants is conducted at LANL by the Waste and Environmental Services (WES) Division.

This procedure and its implementing procedures meet the requirements of WES Quality Management Plan (WES-QMP), and along with ENV-EAQ-RN and its implementing procedures meet the requirements of the WES Integrated Management Plan (WES-IMP), DOE Orders 5400.5 and 450.1, and the guidance of DOE/EH-0173T.

Applicable quality criteria include 40 CFR Part 61, Appendix B, Method 114, Section 4; DOE Order 414.1B, "Quality Assurance;" and LANL LPR 308 00 00.2, Integrating Quality Management. This plan was written according to EPA QA/R-5, "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations." However, some items of this standard are located in other project plan documents.

2.0 ORGANIZATION

The Environmental Air Monitoring Task Leader manages the operation of the AIRNET. The task leader reports to the WES Environmental Data & Analysis (EDA) Group Leader. An analytical chemist supports the task leader in interfacing with analytical laboratories, uploads electronic data deliverables, and reviews chemistry data packages. A database administrator maintains and updates the AIRNET database. Others are deployed to work for the task leader to collect samples, process collected samples, maintain samplers, manage databases, and provide data evaluation. Other groups in LANL and subcontracting organizations provide support to AIRNET. ALS Laboratory of Fort Collins, Colorado, currently provides analytical services for the filters and the silica gel. Final products from AIRNET are approved by the Environmental Air Monitoring Task Leader and reported to the WES-EDA group leader.

3.0 SYSTEM DESCRIPTION

3.1 Measurements

The AIRNET at LANL is designed to continuously sample environmental levels of airborne particulate radionuclides and tritium emitted from LANL through the collection and measurement of airborne particles and tritiated water at locations around LANL, and the calculation of the dose from those measurements.

Continuous sampling of the air determines the concentration of radionuclides in the air. Analytes and their detection limits are chosen based on whether the analytes are emitted, or have the potential to be emitted, at a level sufficient to contribute more than 10% to an offsite dose greater than 0.1 millirem (mrem) (i.e., each analyte contributes more than 0.01 mrem annually). Filters are used to collect particulate matter, and silica gel is used to collect water vapor.

Gamma spectroscopy is performed within 21 days (SOP-5141, AIRNET-Analytical Chemistry Data Management and Review) after biweekly filter collection to detect unexpected quantities of radionuclide releases and to allow determination of any adverse trends in the ambient concentrations of radionuclides. Biweekly water vapor samples are analyzed for tritium (as oxide). Composited AIRNET filters are analyzed for uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239/240, and americium-241. Analyses for other radionuclides can be performed for an unplanned release or other emergency situation, or if LANL operations warrant.

3.2 Equipment Requirements

Parts needed for AIRNET are off the shelf items and are in no way specifically designed for AIRNET. Therefore all parts mentioned in any AIRNET standard operating procedure are classified ML-4 and may be ordered under the ML-4 classification as described in Section 3.1.1 of the Engineering Processes Manual P341,

The AIRNET relies upon continuously operating vacuum pumps that pull air through a polypropylene fiber filter and, separately, through silica gel, both at known rates.

The analysis laboratory must have equipment for analyzing low levels of radioactive elements by

- direct alpha counting (to determine the gross alpha decay activity),
- direct beta counting (to determine the gross beta decay activity),
- gamma spectroscopy (to detect radionuclides that decay by gamma emission),
- liquid scintillation counting (to detect beta decay from tritium), and
- alpha spectroscopy following radio-chemical separation (to detect low levels of uranium, plutonium, and americium isotopes).

3.3 Assessments and Reviews

Audits and management assessments are performed according to each project that uses AIRNET data. Analytical laboratories participate in inter-laboratory comparison programs.

4.0 DATA QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Data quality objectives (DQOs) are statements of the uncertainty level deemed acceptable. DQOs must strike a balance between time, money, and data quality.

A false high measurement of radionuclides could limit LANL operations unnecessarily. A false low measurement of radionuclides might result in noncompliance with the 10-mrem dose standard. The action levels chosen (SOP-5142, AIRNET—Establishing and Using Action Levels) avoid these problems.

Comparability is a measure of the confidence with which one data set can be compared to another. Comparability of the sampler data is ensured by the use of the same equipment, processes, and analytical methods at all sampler locations.

Representativeness is a measure of the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Air samplers are operated continuously (defined by the FFCA), completely sampling temporal variations. Air samplers are located near sites occupied by the public, at the perimeter of LANL, and in background locations. [Samplers may also be placed near locations of probable or actual release to help understand other measurements.] Locations are to be representative of concentration measurements and are evaluated against siting criteria (see section 7.10).

Completeness is a measure of the amount of valid data obtained compared to the amount that was expected to be obtained under correct, normal conditions. Data may be lost due to equipment malfunction, power loss, sample destruction, human error, analytical error, failure to collect an adequate volume of air, inability to gain access to the site, or unacceptable data uncertainty.

Samplers are designed to achieve 95% run-time completeness for the compliance samplers (per Compliance Plan in Appendix A of the FFCA) each calendar year. In addition, at least 80% of the total possible samples (during any calendar year) must provide valid data (per Compliance Plan in Appendix A of the FFCA).

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed conditions, expressed generally in terms of the standard deviation. It refers to the variability that occurs if the same analysis were performed again on the same sample with no change in conditions, or the degree to which repeated measurements on the same sample agree. Results of repeated analyses of standard or duplicate samples provide an estimate of laboratory or instrument precision.

The regulation 40 CFR Part 61.93 requires that the system be able to readily detect a dose of 1.0 mrem above background. Following statistical principles and assuming 95% confidence for such a measurement, we require that 95% of all measurements must fall within two standard deviations of the mean. This represents the minimum acceptable precision for decision making.

To confidently detect concentrations that are significantly less than 1.0 mrem and to meet DOE/EH-0173T, a smaller precision is needed. AIRNET uses 0.1 mrem as the target precision for all measurements. For known contaminants released by LANL, we aim to detect significant contributions offsite (e.g., those that contribute at least 10% to offsite doses greater than 0.1 mrem effective dose equivalent from emissions in a year).

Estimates of total uncertainty at 10 mrem concentrations are discussed later, but precision has been calculated from paired AIRNET stations based on the 1996 and 1997 data. The isotopic analyses were grouped together because the sample size was too small to evaluate each radionuclide individually. The table below shows that the ratio of the standard deviation to the concentration decreases with increasing concentration.

Table 4.6-1
Precision Estimates from Paired AIRNET Stations

Radionuclide	Concentration per Sample	Millirem Equivalent	Precision for Annual Concentration (1 std. dev.)	Percent of Annual Concentration
Pu, U, and Am	100 aCi/m^3	0.5 (max)	11 aCi/m^3	11

Pu, U, and Am	500 aCi/m^3	2.6 (max)	35 aCi/m^3	7
Pu, U, and Am	1000 aCi/m^3	5.3 (max)	50 aCi/m^3	5
Tritium	10 pCi/m^3	0.07	0.38 pCi/m^3	3.8
Tritium	50 pCi/m^3	0.33	0.43 pCi/m^3	0.86
Tritium	100 pCi/m^3	0.67	0.71 pCi/m^3	0.71

Accuracy is the degree of agreement of a measured value with the true or expected value. It is not possible to determine the accuracy of measurements in AIRNET, but an estimate of overall uncertainty (accuracy plus precision) is presented below. Any bias (known inaccuracy) is corrected for if it is known, or estimated. Examples of bias for which corrections are made include blank corrections and corrections for bound water in gels. Unknown bias is presumed zero, the most likely value. To reduce bias, all measurements are traceable to nationally recognized standards such as those provided by NIST.

Uncertainty analysis is driven by the Compliance Agreement in Appendix A of the FFCA requires that the overall uncertainty of all measurements be no greater than 20% at the concentrations in 40 CFR 61, Appendix E, Table 2 (these are values equivalent to an annual dose of 10 mrem).

An analysis was performed on sources of measurement uncertainty in AIRNET. They were calculated for quarterly composite plutonium-239 and biweekly tritium measurements. Plutonium-239 was chosen for this analysis because of its more restrictive dose conversion factor (see memo ESH-17:95-759). Tritium uncertainty was calculated because it is measured and analyzed using a different process. Uncertainties were estimated at air concentrations equivalent to 10 mrem/year. The uncertainty (%) of the sample is higher at the lower concentrations normally found by AIRNET due to the poorer counting statistics at low levels of activity. The sources, sizes, and totals of the uncertainties are shown in Table 4.8-1.

Table 4.8-1
Sources of Uncertainties of Plutonium-239 and Tritium Analyses (%)

Source of Uncertainty	Plutonium-239[a]	Tritium (oxide)
Counting statistics	1	2
Other analytical lab processes	10	5
Aliquoting	NA[b]	0.2
Flow meter reading	10	NA
Flow meter calibration	5	NA
Timer	0.1	NA
Collection efficiency of filter	1	NA
Collection efficiency variation of silica gel	NA	10
Absolute humidity	NA	5[c]
Temperature	NA	0.1[c]
Other	5	5
Propagated total	16	13

[a] Summarized from memo ESH-17:95-759.

[b] = Not analyzed.

[c] Calculated from instrument specifications and estimated 99th percentile worst-case meteorological conditions.

5.0 TRAINING AND EDUCATION

All personnel performing AIRNET-related work obtain appropriate training prior to performing work governed by a procedure. Training is performed and documented according to EP-DIR-SOP-2011, R3, Personnel Training and Qualification.

Contractor analytical laboratories must have a quality management system that complies with requirements of DOE Order 414.1B, Criterion 2.

Personnel working for the AIRNET must understand the basics of radiation measurement and air sampling, and understand the general operation of the system. Individuals performing data review and interpretation must have additional education and/or experience as health physicists or radio-analytical chemists. Documentation of education qualification is maintained by the LANL personnel division.

6.0 DOCUMENTATION AND RECORDS

Retained records will provide sufficient information to allow an individual with equivalent education and training to verify or reconstruct the results. Implementing procedures specify the records, forms, logbook entries, or other information to be kept as documentation of the performance of the procedure.

The following records are kept:

- logbook entries and/or field forms to record sample collection and chain of custody,
- equipment and instrument calibration and maintenance records,
- laboratory analytical results,
- air concentration calculation results,
- dose assessments and assumptions,
- station siting evaluations,
- general correspondence that affects the system, and
- regulatory correspondence.

The following records are kept by sub-contracted laboratories:

- equipment and instrument calibration and maintenance records,
- laboratory quality control results, and
- laboratory instrument calibration and maintenance records.

Subcontractor analytical laboratories retain and manage all documentation related to analyses. These records include statements of work, laboratory data, corrective action reports, logbooks, bench worksheets, training documents, and similar documents.

Work scope documents specify that electronic data packages be returned from the analytical laboratories to the analytical chemist within 30 days for biweekly gamma and tritium, and 45 days for quarterly composites after sample submittal. Accelerated analysis may be requested at times.

The LANL Issue Management Tracking System (LIMTS) system documents quality-affecting problems encountered in the field and laboratory.

Final results are a simple summary of the resultant air concentrations (for the Environmental Surveillance Report (ESR), see ENV-MAQ-232, R3, Preparation of the Annual Environmental Surveillance Report) and a summary of concentrations converted to dose using the levels in 40 CFR Part 61, Appendix E, Table 2.

All records are maintained and available for at least five years for inspection at the facility (as in 40 CFR Part 61.95) and up to 200 years (DOE/HQ DRAFT document, "DOE Records Schedule for Environmental Records," Nov.1996).

Records are archived in compliance with LANL and DOE requirements for records retention, storage, and management, including protection from fire, flood, or rodents. Access to records is monitored.

7.0 SAMPLING PROCESS DESIGN

7.1 Compliance Sampler Design

Locations for the compliance air samplers (listed in Appendix A) were evaluated using a sampler network analysis. The primary consideration of this network analysis was the placement of samplers in all sectors that contain a potential maximally exposed individual (MEI). Assumptions and criteria for this analysis (see Compliance Plan Appendix A, FFCA) include:

- A standard 16-sector radial array (22.5º sector angle) from potential release sites was used to evaluate potential MEIs.
- Maximum off-site concentrations for non-point source emissions occur at the site boundary since all such emissions are considered real or effective ground-level releases.
- Residence or business "islands" within LANL's boundary are monitored.

From this network analysis, a number of MEI locations are currently identified. All of the sectors with a potential MEI contain a sampler. These locations provide a sampler on or near the LANL boundary between or near the release point and the potential MEI for any given non-point source within LANL. This arrangement effectively provides a "fence" of samplers along the LANL boundary and all adjacent populated areas around or enclosed by LANL(see section 7.10).

7.2 Additional Sampler Locations

Temporary stations may be installed to monitor site restoration work and are removed when actual or potential emissions are assessed to be no longer a cause for concern. Other AIRNET stations may also be installed periodically. Appendix A has a list of all the current long-term sampling stations.

7.3 Future Compliance Station Siting Criteria

A special case for compliance monitoring siting occurs when there is a diffuse source of emissions located on the boundary of LANL, close to a business, office, or residence. Existing compliance criteria could require many samplers to cover each wind direction sector containing a receptor. ESH-17-238, Evaluating New Diffuse Sources and New Receptors for AIRNET Coverage, addresses this case.

7.4 Environmental Surveillance Report Station Selection

The locations used for reporting (see ENV-MAQ-232, R3, Preparation of the Annual Environmental Surveillance Report) in the ESR meet DOE Order 450.1. Primary objectives include demonstrating compliance with public dose limits, measuring accidental releases of radionuclides, identifying and quantifying new or existing air quality problems, and characterizing air emission trends.

7.5 Background Station Design

DOE suggests background stations be over 15 kilometers (km) from the site boundary. Regional background AIRNET samplers located in Española, El Rancho (less than 15 km from boundary but over 15 km from sources), and Santa Fe are used to establish background concentrations for all radionuclides

except uranium. The natural uranium background is based on stations in Los Alamos County. The background for non-natural uranium is assumed zero.

7.6 Other Samplers Design

Other samplers are located on site to satisfy DOE requirements or to meet programmatic needs. The following are used in siting such samplers:

- annual average wind speed and direction;
- areas of on-site predicted maximum concentrations;
- topographic and other features that could influence dispersion;
- availability, safety, security, and accessibility of sampler locations;
- availability of power; and
- customer's specific programmatic needs for monitoring.

The number and locations of onsite samplers are subject to change. A current list of samplers is kept by the Environmental Air Monitoring Task Leader.

7.7 Sampling Frequencies

A continuous sample of air is collected during the sampling period. The samples are collected from the air sampling stations usually every two weeks. To detect unplanned releases DOE/EH-0173T recommends that the sampling interval not exceed two half-lives of the shortest-lived radionuclide being monitored (arsenic-74 with a half life of 18 days). Samples may be collected at a shorter interval for emergency response or in unplanned release situations.

7.8 Sample Matrices

Atmospheric particle diameters range from about 0.01 to tens of microns (μm). The optimum size for deposition in the upper respiratory tract and the deep lung is 0.01–3 μm, with 1 μm often used for dose assessment (ANSI N13.1 Table). The filter paper retains a minimum of 99% of dioctylphthalate with an aerodynamic mean diameter of 0.3 μm, at the operational air face velocity and pressure drop. Filter material has a low uranium content to assist in uranium background concentration determination. Polypropylene air filtration media have been used since 1996. SOP-5143, AIRNET— Environmental Sampling of Airborne Particulate Radionuclides describes filter preparation.

Silica gel is used to collect water vapor from the sampled air. As part of the water vapor, tritium is absorbed as T_2O or HTO. Water vapor concentrations in the ambient air are measured by the meteorology program (EP-ERSS-QAPP-05,R0 Quality Assurance Project Plan for Meteorological Monitoring). Silica gel is discarded after use. The silica gel used has an absorption capacity of 0.26 grams (g) of water per gram of gel at 50% relative humidity. Approximately 135 g of gel are used, giving a collection capacity of 35 g of water per collection period. Normally 10–20 g are collected. The volume of bound water in the gel is determined according to SOP-5178, AIRNET - Determining Water Content of Silica Gel using the Lindberg Furnace, whereas SOP-5144, AIRNET - Sampling of Ambient Airborne Tritium, describes silica gel cartridge preparation.

7.9 Measurement Parameters

The following parameters are measured or calculated:

- sample collection time,
- air flow rates through filter media and through silica gel,
- absolute humidity,
- tritium concentration in water absorbed by the silica gel,

- gamma-emitting nuclide concentrations on filter clumps, and
- plutonium-238, plutonium-239/240, uranium-234, uranium-235, uranium-238, and americium-241 concentrations on composited filters.

7.10 Sampler Siting Evaluation Criteria

Siting criteria (from DOE/EH-0173T and 40 CFR Part 58, "Ambient Air Quality Surveillance") for new sampler sites are found in SOP-5147, AIRNET-Evaluation of Sampler Sites against Siting Criteria.

Uniform application of these criteria is important. However, not all sites can meet all these criteria. Good scientific judgment is used to select the optimal location based on the site and on specific sampling needs. Siting evaluations are retained.

7.11 Field Decontamination

No special field decontamination steps are required because of the low levels of activity, although every effort is taken to avoid cross contamination and ensure representative measurements. Sampling procedures specify handling and packaging requirements to prevent cross contamination. Filter heads are dedicated for use at only one station and are cleaned before each period in the field. Filter caps are used before and after filters are deployed in the field.

Operational changes at TA-54-1001, where samples are processed, are reviewed prior to implementation. Analytical laboratories maintain controls for prevention of cross contamination.

7.12 Analysis Frequency

Approximately every two weeks, samples are collected and sent for the analyses described in Section 10 of this document. Over LANL closures samples may be collected after three weeks. Some analysis is done quarterly.

8.0 SAMPLING METHODS REQUIREMENTS

8.1 Air Sampling Equipment

Each AIRNET sampler consists of a particulate filter assembly, a silica gel water vapor absorber, two flow metering units, and an oil-free, constant flow vacuum pump, all enclosed in a lockable weather-tight housing. In the housing are connecting and exhaust hoses and a 120 volt (V) electrical supply.

The air sampling pump runs continuously without overheating when the filter becomes plugged. Pumps must maintain constant flow (preferably not drop below 90% of initial flow).

The particulate filter assembly consists of a 47-millimeter (mm) particulate filter supported on wire mesh in a commercially available holder that can be disconnected by a quick-disconnect fitting. The aluminum three-part holders can be screwed apart and have an O-ring seal at the joints.

The water vapor absorber cartridge is a vertically mounted plastic column holding about 135 g of silica gel. Air flows upward through the gel. The vertical orientation prevents the gel from settling to one side, providing maximum surface area contact with the air flow. The cartridge has a quick-disconnect fitting. The cartridges are installed in a PVC pipe mounted outside the sampler housing to keep the gel cooler to increase the vapor collection efficiency. The cartridge has a shield around it, preventing rain from striking the sides of the cartridge.

The silica gel cartridges are cylindrical, clear Plexiglas about 5 centimeters (cm) in diameter and 20 cm tall. The cartridge has screens at each end to hold in the gel. The top screws off for filling and is sealed with an O-ring. The quick-disconnect fitting seals when disconnected.

The flow control assembly allows adjustable air flow by regulator valves connected to the sample holders and to the vacuum pump.

A Rotameter-type (floating ball) flow meter indicates the flow through the silica gel. A magnahelic gauge measures flow through filters.

A vacuum-activated digital timer records the actual run time of the pump. The timer measurement is used to calculate the true sampled air volume if a pump does not operate for the full sampling period. It contains a battery back up for continuous operation in case of loss of 120 V power.

Compliance AIRNET stations are equipped with electronic dataloggers and either a radio-frequency or cell phone communication system. The datalogger calls a central computer at TA-54-1001 if the battery voltage is too low or if the pressure switch on the pump line closes due to loss of vacuum. The operational status of these stations is checked every working day.

Samplers meet the intent of the sampling requirements in ANSI N13.1 (1969, and 1999). See memo ESH-17:97-216 on how 1969 requirements are met.

8.2 Meteorology Parameters

Absolute humidity is used to calculate tritium concentrations and is supplied by the Meteorology Monitoring Project (EP ERSS QAPP 05, Quality Assurance Project Plan for Meteorological Monitoring) and EP-ERSS-SOP-5131, R0, Calibration and Maintenance of Instruments for the Meteorology Monitoring Project. The average of two week-long averages from a network of stations is used. Each station measurement has an accuracy of ± 0.5 grams per cubic meter (g/m^3).

8.3 Sample Collection

Sample collection generally occurs every two weeks, replacing the filter holder and the gel cartridge with a pre-loaded replacements. The flow rates and the digital timer reading are recorded. Procedures SOP 5143, AIRNET— Environmental Sampling of Airborne Particulate Radionuclides, SOP 5144, AIRNET – Sampling of Ambient Airborne Tritium and SOP 5149, AIRNET—Management of Field Data, AIRNET Database Users Guide, provide instructions for the collection of samples.

8.4 Corrective Actions on Sampling Equipment

Responsibility for the operation and maintenance of the field sampling equipment is assigned by the Environmental Air Monitoring Task Leader. The sample pumps are checked for proper operation and flow each time samples are collected. If the pump or flow rate are defective, the sample collector notifies the pump maintenance technician. A record of the defect and the pump's condition is made and for trending.

Filter holders and cartridges are inspected at each use and replaced as needed. Silica gel cartridges are leak-checked (see SOP-5153, AIRNET – Leak Checking Silica Gel Cartridges).

8.5 Preparation of Sampling Equipment

Air pumps are cleaned (SOP-5146, AIRNET – Maintenance of Air Sampling Pumps) at each six-month rebuild. Flow control panels are cleaned and adjusted (SOP-5151, AIRNET – Maintenance of Flow Control Panels) . SOP 5143, AIRNET— Environmental Sampling of Airborne Particulate Radionuclides, and SOP 5144, AIRNET – Sampling of Ambient Airborne Tritium cover the preparation of filters and silica gel cartridges.

8.6 Sample Volume

Though high-volume samplers are recommended by EPA (Appendix A, "Guidance on Implementing the Radionuclide NESHAPS"), they cannot operate for the two-week sampling period without plugging the filter materials and are too noisy for use near homes or businesses. LANL has chosen to use "medium volume" samplers. The pump pulls air through both the particulate filter and the silica gel cartridge at different flow-rates through separate trains. The particulate filter branch is calibrated to 4.0 ± 0.4 cubic feet per minute (ft^3/min) (roughly 0.1 m^3/min). The total volume sampled is calculated from start and stop readings of the timer and the magnahelic gauge. The water vapor sampling branch has an initial flow rate of 200 ±20 cm^3/minute (0.0002 m^3/minute).

The amount of water vapor collected is determined both after sample collection and at the time of distillation of the water from the silica gel. The minimum water volume needed for analysis is 5 milliliters (mL) (to achieve a detection limit of at least 500 pCi/L of water). A smaller amount can be analyzed using longer count times or with a higher detection limit. Most volumes distilled are 5 to 20 mL. Corrections are made for the volume of bound water in the gel.

9.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

9.1 Sample Holding Times

The water in the silica gel is recovered by distillation within 21 days of collection. The distillate is counted within 14 days of distillation.

Gamma analyses are performed on clumps of filters as soon as possible, and no later than 75 days after collection. DOE/EH-0173T recommends that the holding time not exceed four half-lives of the shortest-lived radionuclide being monitored (arsenic-74 with a half-life of 18 days).

Composited filter samples collected during the previous calendar quarter are analyzed within 90 days of the end of the quarter.

At times a filter sample will undergo an isotopic analysis within a few days of shipment to the analytical laboratory rather than waiting for the end of the quarter.

Gross alpha or gross beta analysis may be done as part of an investigation after the quarterly isotopic analysis.

9.2 Sample Handling

Preventing damage or compromise to samples after retrieval is essential. [Samples not retrieved by AIRNET personnel should get into AIRNET personnel control as soon as possible, preferably within hours, and the chain-of-custody (see Section 9.3) should be maintained.

Plastic covers are installed on the filter holders before and after collection to prevent cross-contamination. Particulate filters are handled only with tweezers during installation in and removal from the filter holders. Filters are shipped in individual glassine envelopes.

Shipping of all samples occurs as soon as possible after collection.

Gel samples are analyzed promptly after distillation to minimize the chances for moisture loss or contamination.

9.3 Sample Custody

A documented chain-of-custody is maintained for all samples collected. The possession, handling, and transfer of custody of samples are documented. A sample is in custody if it is in one's physical possession, in one's view, locked up so no one can tamper with it, or in a secure area where access is restricted to authorized personnel only.

A secured area is locked or under custody seal, and may be a room, cooler, cabinet, vehicle, or refrigerator. Actual or suspected broken chain-of-custody must be recorded and all associated results qualified or rejected.

9.4 Sample Tracking

A pre-printed form (Attachment 2, SOP-5143, AIRNET— Environmental Sampling of Airborne Particulate Radionuclides) or direct electronic entry is used to document the sample collection and the required information regarding location, sampler status, air flow, timer reading, and initial chain-of-custody. SOP-5143 describes chain-of-custody requirements for collection.

Samples received by analytical laboratories are considered physical evidence and handled according to procedures meeting EPA chain-of-custody requirements. Sample tracking requirements are described in the respective laboratories' quality management plans.

10.0 ANALYTICAL METHODS REQUIREMENTS

10.1 Sample Analyses

Gamma-ray spectrometry is used to determine specific gamma-ray emitting nuclides on groups of filters.

On a quarterly basis, a composite sample of biweekly particulate filters is prepared. All composites are analyzed for selected radionuclides, including plutonium-238, plutonium-239/240, uranium-234, uranium-235, uranium-238, and americium-241 by dissolution followed by alpha spectrometry.

When a filter sample requires an isotopic analysis within a few days of collection these samples will be split to allow an expedited analysis on one half and the normal chain of analyses on the other.

The biweekly silica gel samples are distilled by the analytical laboratory and the distillate analyzed for tritium by liquid scintillation counting.

10.2 Target Minimum Detectable Activity

The DOE does not specify a minimum detectable activity (MDA) for any radionuclide. The MDA varies by sample. Setting a maximum MDA raises costs significantly, so AIRNET chooses to specify "target" MDAs to meet DOE requirements. A target MDA may not always be met.

The chosen MDA in AIRNET is two standard deviations above the average analytical background. The MDAs for each analyte are presented in Table 10.2-1.

Conformance to the target MDAs is determined by the average laboratory MDA over any 6-month period.

The MDA for alpha and beta are 1 and 2 pCi/filter, respectively, complying with 40 CFR Part 61, Appendix B, Method 114 (A-4 and B-4).

Gamma-ray spectroscopy provides identification and quantitative analysis of gamma-ray emitting radionuclides. These measurements are conducted using high-resolution germanium detectors and comply with 40 CFR Part 61, Appendix B, Method 114 (G-1).

For some of the gamma emitting radioisotopes shown in the table below, it is not possible to consistently achieve a detection limit that meets the target MDA equivalent to 0.1 mrem; however, all measurements should meet the MDA equivalent to 0.5 mrem.

To obtain lower detection limits and reduce analytical costs, multiple sample filters (up to 10) are grouped ("clumped") together for counting. If a high count is detected in the clumped filters, the filters can be counted individually. Filters may also be composited for a site over time to improve the detection for a specific location (see the analytical laboratory's quality management plans).

Table 10.2-1
MDA Levels to Meet DOE Requirements for Gamma Spectroscopy

Radionuclide	MDA (pCi/m^3) for 0.5 mrem dose	Target MDA(pCi/m^3) for 0.1 mrem dose
Arsenic-73	0.55	0.11
Arsenic-74	0.11	0.022
Beryllium-7	1.15	0.23
Cadmium-109	0.0295	0.0059
Cobalt-57	0.065	0.013
Cobalt-60	0.00085	0.00017
Cesium-134	0.00135	0.00027
Cesium-137	0.00095	0.00019
Manganese-54	0.014	0.0028
Sodium-22	0.0013	0.00026
Lead-210	0.000028	0.00014
Rubidium-83	0.017	0.0034
Rubidium-86	0.028	0.0056
Ruthenium-103	0.13	0.026
Selenium-75	0.0085	0.0017
Zinc-65	0.00455	0.00091

The tritium analysis complies with 40 CFR Part 61, Appendix B, Method 114 (B-5). The maximum MDA to meet EPA requirements and the target MDA to satisfy DOE requirements are provided in Table 10.2-2.

Table 10.2-2
MDA for Tritium Analyses

Radionuclide	0.1 mrem Dose Concentration (Ci/m^3 air)*	Maximum MDA for 0.1 mrem Dose (pCi/mL Distillate)	Target MDA to Meet DOE Requirements (pCi/mL Distillate)
Tritium	1.5×10^{-11}	6	0.5

*From 40 CFR Part 61, Appendix E, Table 2.

Table 10.2-3
MDA Levels for Alpha Spectroscopy

Radionuclide	0.1 mrem Dose Concentration (Ci/m^3)*	Maximum MDA for 0.1 mrem Dose (pCi/half filter composite)	Target MDA to Meet DOE Requirements (pCi/half filter composite)
Uranium-234	7.7×10^{-17}	0.53	0.04

Uranium-235	7.1×10^{-17}	0.49	0.04
Uranium-238	8.3×10^{-17}	0.57	0.04
Plutonium-238	2.1×10^{-17}	0.14	0.05
Plutonium-239	2.0×10^{-17}	0.14	0.04
Americium-241	1.9×10^{-17}	0.13	0.05

*From 40 CFR Part 61, Appendix E, Table 2.

Composite filter samples for a calendar quarter are analyzed for uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239/240, and americium-241 by dissolving one-half of the composited filters in an acid solution, separating, and concentrating (e.g., electroplating or co-precipitating) the radionuclides onto sample planchettes. Alpha spectrometry methods which comply with 40 CFR Part 61, Appendix B, Method 114 (A-1) are applied to the planchettes. For each radionuclide, the maximum MDAs to meet EPA requirements, and the target MDAs to satisfy DOE requirements, are provided in Table 10.2-3. Target MDAs are based on historic MDAs. Radioanalytical procedures pertinent to this analytical method are in the analytical laboratory's procedures.

10.3 Sample Disposition

After the analyses are complete, the analytical laboratory stores the covered planchettes (with the dissolved composite filters) and the remaining half filters in a clean protected area until notified by AIRNET staff at which time the remaining half filters are returned to the AIRNET staff. In the case of expedited isotopic analysis there is no remaining half filter.

In case of sample loss or analytical problems, it may be necessary to use the remaining half filters for a new composite sample so AIRNET staff store the remaining half filters at the task leader's discretion. The task leader must approve any additional analyses that would destroy the remaining half filters.

11.0 QUALITY CONTROL REQUIREMENTS

11.1 Duplicate Sampling

Duplicate stations exist at a minimum of one location in AIRNET. They serve as process duplicates to validate the overall sample collection and analysis process and methodology. Data from these duplicate stations are analyzed by evaluating the measurement differences between the stations.

11.2 Trip and Matrix Blanks

As part of the regular sample submission every two weeks, trip and matrix blanks are submitted with each filter and tritium set.

11.3 Laboratory Sample Duplicates

Duplicate field samples serve as the primary check for laboratory duplicate analyses. AIRNET staff may submit additional duplicate samples, such as previously-analyzed filters (for recounting), or a split of the silica gel distillate.

Tritium spikes are submitted with each biweekly tritium set. Analytical laboratories perform sample duplicate or spike analyses on their equipment according to internal procedures. These laboratories have procedures that call for the analysis of blanks and spikes, which are carried through all chemistry steps. For composites, these may consist of a preparation blank and/or a filter blank plus one preparation spike and/or filter spike with every set of 20 samples.

11.4 Analytical Laboratory Checks and Calibration

Analytical laboratories perform appropriate quality control checks on their equipment, to meet the accuracy and precision requirements in this procedure. Each laboratory is responsible for maintaining appropriate records of checks and supplying quality control information, as required by the contract. Each analytical laboratory is responsible for corrective actions for their equipment.

For gross alpha, gross beta, gamma spectroscopy, alpha spectroscopy and liquid scintillation counting, calibration is performed at least as often as the manufacturer's recommended interval. Background and efficiency data are maintained. Check sources are run periodically on the counting instrument to check for proper operation and response.

The distillation of water from silica gel is covered by the analytical laboratory procedure which describes the distillation process and specifies cleanliness steps.

12.0 INSTRUMENTATION AND EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Every six months, the pumps are replaced with maintenance refurbishment. This ensures high overall reliability. Pump vanes and certain gaskets, filters, O-rings, and seals are changed and the pump tested before sampling use. A database is used to track the pump replacement schedule (SOP-5146, AIRNET – Maintenance of Air Sampling Pumps).

Periodic cleaning and adjustment of the flow control panels includes cleaning of the control valve and all lines, and lubrication of the sealing O-ring (SOP-5151, AIRNET – Maintenance of Flow Control Panels).

Compliance samplers (see Appendix A) are checked for normal operation every working day using the automated telemetry. See SOP-5152, AIRNET – Station Telemetry.

13.0 INSTRUMENT CALIBRATION

13.1 AIRNET Calibration

Upon installation of the pump in the sampler enclosure, the air flows through the filter, and separately through the gel cartridge, are measured with a calibrated air flow measuring device and adjusted. Calibration is performed about every six months and upon change of any major permanent component of the system. Calibration records are maintained (SOP-5145, AIRNET – Calibration of Air Sampling Stations). Calibration follows the ENV Division Rad-NESHAP calibration protocol "Calibration of Measurement and Test Equipment" cooperating with the LANL Standards and Calibration Laboratory.

13.2 Analytical Laboratory Instrument Calibrations

Analytical laboratory instrument calibration meets the accuracy and precision requirements given in this document. Each laboratory is responsible for maintaining appropriate records of calibration and supplying calibration information in the data packages.

13.3 Meteorology Instrument Calibration

The instruments for measuring atmospheric relative humidity and temperature are maintained as specified in the QA project plan for meteorology (EP ERSS QAPP 05) and SOP-5131, Calibration and Maintenance of Instruments for the Meteorology Monitoring Program.

14.0 INSPECTION AND ACCEPTANCE OF EQUIPMENT AND SUPPLIES

Responsibility for inspection and maintenance of the field sampling equipment and supplies is assigned by the Environmental Air Monitoring Task Leader. A visual inspection of most consumables is sufficient to detect problems that may cause loss of data.

Filters are semi-automatically cut by AIRNET personnel allowing detection of defectives. Filters are inspected again when installed in the filter holders.

Silica gel acceptance is based on information included in shipped quality certification documents. Before use the gel is dried in an oven (see SOP-5144, AIRNET – Sampling of Ambient Airborne Tritium) and inspected visually when loaded into cartridges.

Pumps receive initial preparation and testing prior to use (run for at least five minutes, pull a minimum vacuum of 21 inches of mercury), as in SOP-5146, AIRNET – Maintenance of Air Sampling Pumps.

Inspection and maintenance of analytical laboratory supplies is the responsibility of the analytical laboratory. Supplies are accepted based on information included in quality certification documents shipped with the materials. Laboratories inspect and accept supplies based on the risk to the analytical results.

15.0 DATA MANAGEMENT

15.1 Data Integrity

Long-term data integrity is expected through the use of a limited access database (an off-site system not operated by AIRNET staff) that holds the quality assured verified and validated field and chemical analysis data on all samples collected from 1958 to present. The AIRNET task leader specifies who may be on the list of archivists. The AIRNET Database Administrator has full write-access to these assets but is only authorized to move data into the archive tables or make documented changes to archived data if he/she has trained to procedures SOP-5141, AIRNET – Analytical Chemistry Data Management and Review, and SOP-5149, AIRNET – Management of Field Data and does so with the knowledge of an archivist.

15.2 Data Transfer and Management

Field data are entered into the AIRNET database within two weeks of sample collection (SOP-5149, AIRNET – Management of Field Data). To avoid transcription, field data are entered directly into small computers and later electronically uploaded to the AIRNET database (SOP-5149, AIRNET – Management of Field Data). Data undergo validation and verification by the field team leader and are transferred to the Field Data Archive in the AIRNET_ARCHIVE database when complete by an authorized archivist.

Most analytical data are transferred electronically from the analytical laboratories to AIRNET personnel via an Electronic Data Deliverable (EDD) specified in the Statements of Work (SOW) governing these analytical chemistry procurements. Some data may be manually entered into a database. Data will be electronically managed and stored according to SOP-5141, AIRNET – Analytical Chemistry Data Management and Review, and SOP-5149, AIRNET – Management of Field Data. AIRNET personnel have been assigned responsibility for the establishment and management of the databases and electronic transfer network. These data undergo validation and verification by a chemist and are transferred to the Chem Data Archive in the AIRNET_ARCHIVE database when completed by an authorized archivist.

16.0 ASSESSMENTS AND RESPONSE ACTIONS

16.1 Corrective Actions

Corrective actions are addressed with Performance Feedback and Improvement Tracking System.

16.2 Inter-laboratory Comparisons

Besides regular instrument calibration procedures, the analysis laboratory participates in appropriate inter-laboratory comparison programs, meeting acceptable performance standards on each analyte. Failure to meet these standards may result in disqualification of the laboratory until corrective actions are implemented. The analytical laboratory participates in at least one appropriate comparison program evaluate its performance.

The analytical laboratory analyzes filter and tritium evaluation samples at least annually. The laboratory's results are satisfactory if they meet the system's acceptance criteria. The DOE-EML inter-laboratory comparison program supplies file spectra to test gamma identification. The analytical laboratory participates in this program at least annually.

16.3 Action Levels

After data evaluation all data from the AIRNET samples are reviewed. SOP-5142, AIRNET – Establishing and Using Action Levels, describes how the action levels are developed and the actions to be taken to verify a high reading, notify appropriate personnel and managers, and document the actions. The procedure describes the two different action levels ("investigation" and "alert").

16.4 Emergency Response Actions

AIRNET personnel may be asked to respond to a suspected release of radioactive materials. In such cases, air filters and silica gel samples may be collected as soon as possible and may be analyzed on a priority basis. Analytical chemistry requirements are presented in SOP-5173, AIRNET – Sample Analyses for Unplanned Releases. See also SOP-5222, Analytical Chemistry Analysis of Air Filters during an Emergency Event. Results are forwarded to the responsible LANL management for decision making. Dose may be calculated as described in ESH-17-503, Calculation of Doses from Unplanned Airborne Releases.

17.0 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

17.1 Criteria to Accept, Reject, or Qualify Data

All data will be evaluated for one of three outcomes: accept, qualify, or reject. Data evaluation criteria include being within expected range of values, using proper laboratory methods, and having an acceptable analytical uncertainty. Acceptability limits and methods used are covered elsewhere in this document.

17.2 Data Evaluation

Data are evaluated according to SOP-5141, AIRNET – Analytical Chemistry Data Management and Review, 5148, AIRNET – Technical Evaluation of Data and Air Concentrations, and SOP 5149, AIRNET – Management of Field Data. Many of the checks described here are performed by database queries.

The data needed for determining air concentrations are categorized into three areas: field, analytical chemistry, and meteorological data. Field data include: collection date and time, sampler number, timer reading, filter flow rate at installation, filter flow rate at removal, silica gel flow rate at installation, silica gel

flow rate at removal, silica gel mass at installation, silica gel mass at removal, moisture distillation volume and comments.

Analytical chemistry data packages are generated by the analytical laboratory. Data packages are reviewed for conformance to contract specifications and for data usability which includes the presence of narrative letter and a summary data table, properly completed chain-of-custody forms, analytical completeness, proper holding times and analytical time sequences, required detection limits on analytical methods, expected blank sample values, evidence of cross-contamination, numbers that appear inconsistent, and complete calibration documentation traceability of standards. The radiochemical analytical data extracted from the packages include the analyte, date of analysis, result, uncertainty, units and MDA.

Missing analytical data can be reconstructed or estimated based on a professional evaluation of the reasons for the missing or incomplete data if clearly documented. In some cases, an appropriate estimated value may be used. Such data is flagged as “qualified.”

Absolute humidity is calculated on a weekly basis starting Tuesday midnight (Mountain Standard Time). The two weekly values are averaged to estimate the average absolute humidity for the biweekly sampling period. Absolute humidity is determined as the average of all LANL tower locations not used for site-specific monitoring. These averaging periods were evaluated in memo ESH 17:98 283.

Air concentration records are generated for each radionuclide at each sampler using field, meteorological, and analytical laboratory data. Air concentration records are reviewed for acceptance, rejection, or qualification. The air concentration record is evaluated within 30 days of the completion of the field data record and radiochemistry record. The data used to calculate air concentrations consist of air volume through filter during sample period, sum of air volumes for quarterly composited filters, average absolute humidity during the sampling period, radiochemical analyses, analyte concentration in the sample, analyte concentration uncertainty in the sample, and analyte concentration units for the sample.

17.3 Outliers

During data evaluation, various statistical techniques are used to identify concentrations that are considered outliers. At times, it is not appropriate to include known outliers in the calculation of the summary statistics. Professional judgment is exercised in these decisions (SOP-5148, AIRNET – Technical Evaluation of Data and Calculated Air Concentrations).

17.4 Summary Statistics

Each year summary statistics for each sampler are published in the annual ESR. The summary includes values for the annual mean radionuclide concentration at each station, standard deviation or confidence interval of the annual concentration calculated from the individual measurements at each station, and uncertainty of analytical results or comparisons to the MDAs. The environmental variability is characterized by the sample standard deviation of either the biweekly or quarterly analyte. The variation due to the radio-analytical process is included in the sample standard deviation.

17.5 Negative Values and Data Less than MDA

Environmental data with negative or “less than” values are used in calculations to obtain the best estimate of the true value (DOE/EH-0173T). The true value, which is always unknown for a continuous variable, cannot be negative, but arbitrarily discarding negative values improperly biases the estimate of the true value (see memo ESH 17:95 384).

When data are reported as being “below minimum detectable activity level” (when an actual value is not presented), the concentration is not assumed to be zero, but is calculated using a methodology

suggested in EPA QA/G-9, "Guidance for Data Quality Assessment" (pages 4-54 to 4-61). The method depends on the percentage of results reported as "non-detects."

Radio-analytical values are reported even if the result is below the published laboratory MDA level, since the background count is usually some positive value. Reported values of less than the detection limit require professional evaluation to interpret. Statistically, these results have a low level of confidence associated with them (50% or less), and actions and decisions based on such data may not be warranted.

18.0 VALIDATION AND VERIFICATION METHODS

18.1 Field Data Evaluation

Most of the checks described in this section are automated in a computer database program. Each of the field data types listed in the previous section are evaluated for completeness and expected range.

For completeness each field element should have a value. If a value is missing, an explanation is provided. If a datum is missing without an acceptable explanation, the record is considered "qualified" or "rejected" depending on the missing information. The more frequent explanations for missing data points include power outage, timer or vacuum switch malfunction, timer not reset or pump failure.

Each element has a nominal value with a range of possible values. If the element is outside its range of normal values, the record is qualified. Nominal values and normal ranges for data elements are in SOP-5149, AIRNET – Management of Field Data.

If the field record is not qualified or rejected, it is accepted. If the field record is qualified, further validation and verification may be performed. Best professional judgment is applied to qualified data. Amended field records are considered acceptable but are flagged as "qualified." Amendments are documented.

18.2 Analytical Data Evaluation

The analytical data packages are evaluated by the analytical chemist for acceptability. Data are then evaluated for completeness and expected range. If a value is missing, the record is rejected with an explanation.

The analytical data should be within an expected range. If a value is outside its normal range, it is investigated (SOP-5142, AIRNET – Establishing and Using Action Levels).

If the analytical data are not qualified, they are accepted. If the data are qualified, further validation and verification may be performed. Amended field records are considered acceptable but flagged as "qualified." Data is rejected if it is believed to be incorrect or non-representative.

18.3 Calculation of Air Concentrations

Air concentrations are calculated (SOP-5148, AIRNET – Technical Evaluation of Data and Calculated Air Concentrations) using total sampler run time for sample period, sampler air flow rate for sample period, reported total concentration of radionuclide on the filter or in the water vapor sample, and absolute humidity and bound water volume (for tritium concentrations).

The nominal values and their normal ranges for air volume per sample period are specified in the database. If the volume is out of range, it may be flagged as "qualified." If any source datum used to calculate an air concentration value is qualified, then the air concentration is qualified. Air concentrations that are not qualified are considered accepted, having satisfied all the data review, validation, and verification requirements.

A professional evaluation will be performed to estimate or otherwise complete data labeled as "qualified." After this evaluation, the data are either rejected or accepted for use in calculating air concentration values. If the value remains qualified, it is used in concentration calculations.

To demonstrate compliance with the 10 mrem EPA standard, doses are calculated from AIRNET mean concentration data using 40 CFR Part 61, Appendix E, Table 2. The doses for the FFCA compliance stations (Appendix A) are used, in conjunction with other data, to demonstrate compliance with the 10 mrem EPA standard. Doses from all AIRNET stations are evaluated to calculate the dose to the public from all pathways. The all pathway dose is compared to the DOE annual public dose limit of 100 mrem. See ESH-17-502,R1, Air Pathway Dose Assessment, for details.

For an unplanned release or an emergency response, dose can be calculated as described in ESH-17-503, Calculation of Doses from Unplanned Airborne Releases.

Air concentrations are reviewed to see if any exceed the "investigation" or the "alert" action levels as covered in SOP–5142, Establishing and Using AIRNET Action Levels.

19.0 RECONCILIATION WITH DQO FOR PRECISION AND COMPLETENESS

Periodically, the precision of the analytical results are evaluated by a method similar to that in the estimation of overall uncertainty presented in the DQOs of the appropriate project quality plan (see ESH-17:95-759). The precision is compared to the required overall precision of 20% at the levels in 40 CFR Part 61, Appendix E, Table 2 (equivalent to an annual dose of 10 mrem).

Two measures of data completeness are calculated annually for each sampling location: run-time fraction is the total operating hours (from timer readings) divided by the hours in the time period being evaluated, and sample completeness is the number of verified and validated sample results divided by the total number of possible samples in a calendar year.

The required completeness for run time fraction is 95% for compliance stations and 90% for other samplers. Sample completeness must be at least 80%. Occasions on which precision and completeness criteria are not met are recorded, their causes investigated, reported to management, and corrected where possible.

20.0 REFERENCES

Eberhart, C., May 19, 1995. "Statistical Analysis of Environmental Data with Negative Values," Los Alamos Scientific Laboratory memorandum ESH-17:95-384 to Distribution, Los Alamos, New Mexico.

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Miller, S., May, 1997. "Comparison of Environmental Sampling for Rad-NESHAP Compliance with the Guidance of ANSI N13.1," Los Alamos Scientific Laboratory memorandum ESH-17:97-216 to file, Los Alamos, New Mexico.

Miller, S., J. Dewart, and D. Kraig, July 16, 1998. "Use of Relative Humidity and Temperature to Calculate Atmospheric Water Vapor and Tritium Concentrations," Los Alamos Scientific Laboratory memorandum ESH-17:98-283 to C. Eberhart, Los Alamos, New Mexico.

APPENDIX A AIRNET SAMPLER LOCATIONS

The following samplers are in place on the date of this procedure. For a current list, contact the Environmental Air Monitoring Team Leader.

Key to groups: R = Regional Pu = Pueblo P = Perimeter W = Waste storage stations
D = Decontamination and Decommissioning O = Onsite stations

Station Number	Group	Station Name	Location
116[b]	R	Española	Northern New Mexico College, SH84, east of Science Bldg
226[b]	R	Santa Fe West	Booster Station #4, Camino la Tierra, Santa Fe
234[b]	R	El Rancho	North of SH502 at private residence in El Rancho
299[b]	R	School for Deaf	New Mexico School for Deaf at Cerrillos Rd/St. Francis Rd
248	Pu	Jemez	Visitor Center, Jemez Pueblo, SR4
294	Pu	San Ildefonso	San Ildefonso Pueblo, waste transfer station
300	Pu	Picuris	Picuris Pueblo, SR75 (60 km northeast of LANL)
112	P	Barranca School	Barranca Elementary, Barranca Rd, south side of school
114[a]	P	L A Airport	100 m west of airport terminal building
119[a]	P	Rocket Park	100 m S of White Rock Post Office, Sherwood Ave
121[a]	P	Pajarito Acres	Piedra Dr, White Rock
124	P	TA-49	TA-49 entrance on SR4
133[a]	P	Bandelier NM	Fire tower Bandelier Natl Mon, 1.5 km from entrance
137[a]	P	Well PM-1	North of SR4/E Jemez Rd, at service bldg
149[a]	P	48th Street	Off 48th St. then Sandia St, inside fence of the water tanks
151[a]	P	Royal Crest	South of Royal Crest Trailer Court, East Jemez Rd
157[a]	P	East Gate	Old guard tower, SR502, near east end of airport runway
166[a]	P	McDonald's	South of McDonald's, Trinity Dr, south of containers
167[a]	P	White Rock Fire Station	Old fire station, Rover Blvd, White Rock
168[a]	P	White Rock Nazarene	Intersection of Pajarito Rd/SR4, White Rock
172[a]	P	LA County Landfill	LA County Disposal Site, East Jemez Rd
173	P	TA-49 QA	TA-49 entrance on SR4
206[a]	P	East Gate QA	Old guard tower, SR502, near east end of airport runway
210[a]	P	Los Alamos Canyon	Los Alamos Canyon, east of Ice Rink
211[a]	P	Los Alamos Hospital	East of LA Medical Center
212[a]	P	Crossroads Church	Intersection of Canyon Rd/East Rd
213[a]	P	Monte Rey South	SR4/Monte Rey South, White Rock
223	P	Urban Park	Intersection of Sycamore St./North Rd
257[a]	P	Los Alamos Inn	South of Los Alamos Inn, Trinity Dr
290[a]	P	Airport Rd	Intersection of Airport Rd/SR502
311	P	LA Airport Runway	East end Los Alamos Airport Runway
159	W	Area G NE	Northeast corner, Area G, TA-54
160	W	Area G South	South boundary, Area G, TA-54
161	W	Area G Pit 38 W	West end Pit 38, Area G, TA-54

APPENDIX A AIRNET SAMPLER LOCATIONS

Station Number	Group	Station Name	Location
170	W	Area G Bldg 375	Northeast of Bldg 375, Area G, TA-54
189	W	Area G East	East end, Area G, TA-54
191	W	Area G Bldg 226	North of Bldg 226, Area G, TA-54
207	W	Area G Bldg 33	North of Bldg 33, Area G, TA-54
208	W	Area G Pit 38 E	East end Pit 38, Area G, TA-54
169[a]	D	TA-21	TA-21, at water tower, DP Rd
291	D	Knights of Columbus	SW corner LA County bus depot, DP Rd.
317[a]	D	A-15 West End	A-15 Parcel, West End, DP Rd
318	D	East Rd Fire Station	East Road Fire station, East Rd
319	D	New Beginnings Church	Intersection of Sombrillo Ct/East Rd
320	D	Hedge Row	East Rd, 200m east of Fire station
326[a]	D	DP Rd Fire Station	Across road from Fire station, DP Rd
327[a]	D	DP Rd Ace Hardware	Across road from Ace Hardware, DP Rd
328[a]	D	DP Rd LA Monitor	Across road from Los Alamos Monitor, DP Rd
329[a]	D	A-15 Center West	A-15 Parcel, 100 m east of West End station, DP Rd
330[a]	D	A-15 Center East	A-15 Parcel, 200 m east of West End station, DP Rd
331[a]	D	A-15 East End	A-15 Parcel, 300 m east of West End station, DP Rd
337	D	Veterans of Foreign Wars	Cnr 17th St and Trinity Dr
344	D	Hilltop House	Intersection of 4th St and Central Avenue
345	D	Canyon School	East end of Central Avenue
347	D	Airport Hangar	East side of easternhangars at LA Airport
348	D	Midrunway	Midway along runway LA Airport alongside SR502
139	O	Pajarito Booster	Intersection of Rex Rd/Pajarito Rd, TA-54
148	O	TA-5	TA-5, transformer station
196	O	Pajarito Rd	TA-36, 1.5 km east of TA-18, Pajarito Rd
262[a]	O	Research Park	West of Los Alamos Fire Station, West Jemez Rd
297	O	TA-50, MDA C	East of MDA-C, TA-50
302	O	TA-3	West of steam plant, Diamond Dr, TA-3
307[a]	O	TA-16	TA-16 parking lot, West Jemez Rd

[a] Compliance station

[b] Background station