BASELINE AIR MONITORING FOR LLW DISPOSAL SITES

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ABSTRACT

Environmental Science Associates, Inc., is conducting the air monitoring portion of US Ecology's site characterization studies for the California Low-Level Radioactive Waste Disposal Facility, which are now in progress. The current air monitoring program is reflective of existing agency guidance and the state of the art in meteorological, air quality, and radiological monitoring and sampling technology. This paper describes the air monitoring program and its regulatory basis. The current program is briefly evaluated for compliance with existing guidance documents, and recommendations are presented for implementation of future air monitoring for site characterization studies.

INTRODUCTION

Environmental Science Associates, Inc., a San Francisco-based firm providing comprehensive services in the environmental sciences is currently participating in the site characterization studies required by the state Department of Health Services (DHS) and the Nuclear Regulatory Commission (NRC) for the siting of a Low-Level Radioactive Waste Disposal Facility (LLRWDF) in California's southeastern desert, to be operated by US Ecology. Two alternative sites, one about 17 miles north of Baker, California and the other about 22 miles west of Needles, California, are being studied for a one-year period. ESA's responsibilities for characterization include meteorology, air quality, and airborne radionuclides. The specific requirements for these portions of the monitoring program are drawn primarily from the NRC's Draft Branch Technical Position (1), with some additions needed to meet the requirements of state and local agencies.

This paper describes the approved air monitoring program for the siting of California's LLRWDF. First, the regulatory basis and specific requirements are briefly described. The installation of the monitoring stations and the overall scope and operation of the monitoring program are then described, followed by an explanation of how the data are reduced, validated, and reported. Finally, the current program is evaluated and recommendations for future air monitoring programs are offered on the basis of ESA's experiences to date.

REGULATORY BASIS FOR THE AIR MONITORING PROGRAM

The primary regulatory basis for the monitoring effort is NRC's Draft Branch Technical Position (1), a guidance document somewhat less formal than a regulatory guide. The required meteorological parameters are described briefly therein, in Section 2.1.7:

> "Section 2.1.7 should include measurements of the amount, type,and temporal distribution of precipita
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> tion; dates and depth of frost penetration; and dates of snow cover. It should also include continuous recordings of air and soil temperature, wind speed, wind direction surface humidity, dew point, and atmospheric pressure. Air and soil temperatures are typically needed at several levels up to 1 meter above and below the ground surface. Because atmospheric stability is typically estimated from fluctuations in wind speed and wind direction at about two and ten meters, these parameters should be measured continuously at both levels.
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> "The applicant should present monthly and annual water budgets for the site showing the magnitudes of precipitation, transpiration, and evaporation.
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> "The applicant also should provide information on severe weather in the site region, including extreme winds, tornadoes, hurricanes, extreme precipitation, hail, thunderstorms, and lightning. Frequency and probability of occurrence, return intervals, predominant direction, and measured extremes for wind speed and precipitation should be given for these events.
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> "Section 2.1.7 should also include analyses of onsite air quality to allow the staff to estimate facility-generated radiological and nonradiological impacts on air quality and to perform atmospheric transport/dispersion modeling. The measurement of air quality parameters should provide at least a one-year record of site-specific information."

Further guidance is given in Sections 2.3.5.2, High Wind Considerations, and in Section 2.19.1, Environmental Monitoring Requirements, Pre-Operational Monitoring. Section 2.3.5.2 reads, in part:

> "The applicant should describe the design bases event for high wind considerations associated with meteorological events such as hurricanes and tornadoes."

Section 2.19.1 reads in part:

> "For [those] characteristics subject to seasonal change variation the data should cover at least a 12-month period. It should demonstrate that an adequate data base to characterize the disposal site for pre-existing

radiological and nonradiological background levels has been established."

Additional guidance is found in 10 CFR Part 61, which requires a meteorological description of the site (61.12), an analysis of the air pathway for releases of radioactivity (61.13), and 12 months of basic environmental data on the disposal site characteristics (61.53).

AIR MONITORING PROGRAM

Station Installation and Instrumentation

Each of the candidate sites of one square mile was surveyed to determine the most representative location for the meteorological stations. Although stations should be near the center of the study areas to provide representative data, topographic and vegetative conditions near the center of some sites may be unsuitable. In any event, stations should be located so as to provide the most representative meteorological data possible. Table I lists the general siting criteria ESA used in site selection, and their relative levels of importance as an aid in selecting the sites.

Each monitoring station consists of a ten-meter lattice tower, supporting the monitoring instrumentation and probes; dual high-volume (Hi-Vol) particulate samplers; and a secure equipment shelter housing data collection equipment, calibration equipment, power supply, and supplies. The tower is a lattice-type structure secured to the ground by concrete footings and guy lines. The tower is equipped with lightning protection and is designed to withstand high winds. Each monitoring station is fenced for security.

The equipment shelter contains instrumentation that reduces to hard copy, converts to magnetic tape, and inputs to a telemetry system, all of the meteorological parameters being continuously monitored. Additionally, the instrumentation includes a digital readout of meteorological parameters to assist in station checks and calibrations. Power for the station is provided by batteries charged by a solar panel and a gasoline-powered generator. Air conditioning and heating of the instrument shelter is provided.

Meteorological and Air Quality Data Collection

Meteorological data collected by the instruments on the tower is continuously recorded by an electronic data collection system, which includes a cassette recorded (for collection of data on tape), a printer (for a hard copy of the

TABLE I

General Meteorological Station Siting Criteria

Station Siting Criteria	Rank /a/
1. Not in a flash flood area	1
2. Representative of basin-wide conditions	1
3. Not in a sensitive biological area	1
4. Not in rough terrain (boulders, washes, ravines, rock outcrops)	2
5. Near the center of the site	2
6. Not in areas of substantial vegetation (creosote)	3
7. Not immediately downwind of development	3
8. Accessible via a public road	4
9. Reasonably level	4
10. Not highly visible from public roads	5

/a/ High (1) to Low (5)

SOURCE: Environmental Science Associates, Inc.

data), a battery power supply charged by a solar panel, and low-battery detection equipment. The system incorporates a microprocessor to permit on-site computation of various meteorological parameters, including the standard deviation of wind direction (sigma theta), and indication of atmospheric stability. The continuous sensor outputs are read every ten seconds by the microprocessor. The 10-second readings are averaged over 10 and 60 minutes; the 10- and 60-minute averages are recorded in a digital format.

The primary data collection system consists of an electronic meteorological data collection system and two high-volume (Hi-Vol) air samplers. The electronic system includes two anemometers (at two and ten meters), two wind vanes mounted at the same height as the anemometers, a solar pyranometer mounted at ten meters, three temperature probes (at ten meters, two meters, and within one meter of the surface) and two soil temperature probes. Table II lists the meteorological and air quality parameters measured and the corresponding instrumentation. Table III provides detail on the measurement specifications for each parameter. The meterological monitoring equipment is mounted according to standard specifications and procedures to avoid data bias from the tower. The data recorded by the system is sent to an on-line printer to provide a real-time hard copy of data.

A data logger at each installation constantly telemeters data to a base station in a nearby town. From the base station, the Station Caretaker monitors data acquisition and identifies any malfunctions. This system also permits direct data transmission from the two base stations to the project office for analysis.

The secondary data collection system consists of mechanical meteorological monitoring instruments, mounted on the tower or housed on the instrument shelter, that record meteorological data on strip-charts or collect samples for manual measurements. These data provide a backup to the electronically recorded data in the event that the electronic system fails for any reason. The strip-chart recordings also are used to validate the data and to audit the data collection system.

Collection of TSP data is by duplicate Hi-Vol samplers mounted at a height of approximately three meters (sampling height). The use of two units at each site is standard to avoid the possible loss of data should one unit malfunction. Particulate concentrations are measured over 24 hours every six days.

Radiological Data Collection

The goal of the radiological component of the program is to establish reliable total background atmospheric radiation levels at each site and to identify, to the extent possible, the contribution from local sources such as mining activities, natural geologic materials, or past nuclear testing in the region, and the global component due to sources such as nuclear tests and nuclear accidents. To establish these background levels, it is necessary to measure gross alpha, gross beta, and total gamma emissions from particulate matter samples taken at the project sites to indicate the total burden of radioactive species present. It is also necessary to monitor background concentrations of specific radionuclides that may be components of the low-level waste.

These radionuclides include:

- Radon-222
- Strontium-90
- Thorium-Series
- Tritium (airborne)
- Uranium Series

The primary focus of the radiological monitoring program is on particulate sampling. The radionuclides listed above were selected for characterization of baseline activity levels from among the numerous radionuclides that will be disposed of at a future facility on the basis of consultations with responsible state and federal agencies. The sample collection apparatus is shown in Fig. 1. Methods of analysis adhere to standard guidelines such as those established by the Intersociety Committee on Methods of Air Sampling and Analysis. The aforementioned agencies were consulted during development of the program to assure that agency personnel concurred with the methods to be used. Sampling periods range from daily to monthly.

Data Analysis

Data from field measurements include:

- Magnetic tape from the primary (electronic) data collection system
- Hard copy printout from the printer
- Strip-charts from the secondary (mechanical) data collection system
- Hi-Vol filters for TSP and radionuclide analysis
- Membrane filters for radiological particulate analysis
- Gas and water vapor samples for radionuclide analysis
- Instrument maintenance logs
- Calibration reports
- Periodic inspection forms
- Audit reports

Numeric field data are reduced to a standard format and summarized monthly. A quarterly data summary is submitted to the client. Data reported in the monthly

TABLE II

Primary Meteorological/Air Quality Data Collection Parameters

Symbol	Measurement	Units	Height of sensor (m)	Instrument
WS	Wind Speed	m/s	2, 10	Anemometer
PWG	Peak Wind Gust	m/s	2, 10	Anemometer
WD	Wind Direction and Variation	A (azimuth)	2, 10	Wind Vane
P	Precipitation (total)	inches	1	Tipping Bucket Rain Gauge
E	Evaporation	inches	0.5	Evaporation Pan
AT	Air Temperature	°C	0.5, 2, 10	Temperature Probe
ST	Soil Temperature	°C	-1, -.5	Temperature Probe
SR	Solar radiation	mw/cm^2	10	Pyranometer
BP	Barometric Pressure	millibars	1	Pressure Sensor
RH	Relative Humidity	percent	2, 10	RH probe
TSP	Total Suspended Particulate	ug/m^3	3	Hi-Vol Sampler

SOURCE: Environmental Science Associates, Inc.

TABLE III

Meteorological/Air Quality Data Collection System Specifications

Measurement	Sample Frequency	Range Min	Range Max	Units	Resolution	Accuracy
Wind Speed	second	0.5	91	m/s	0.1%	1-3%
Wind Direction	second	1	360	degrees	1.0°	5°
Sigma Theta	second	0	99.9	degrees	0.1°	1.8°
Precipitation	continuous	na	na	inches	0.01%	0.5%
Evaporation	continuous	na	na	inches	0.03	1.0%
Air Temperature	10 sec	-35	70	°C	0.1°	0.35°
Soil Temperature	10 sec	-30	50	°C	0.1°	0.5°
Solar Radiation	minute	na	na	W/m^2	1.0%	5%
Atm. Pressure	10 sec	945	1,045	millibar	0.3%	0.2%
Relative Humidity	10 sec	0	100	percent	0.5%	1.5%
TSP	6 days	na	na	ug/m^3	na	na

na = not applicable

NOTE: System power is also recorded at five-minute intervals in volts DC, but is not considered a field measurement.

SOURCE: Environmental Science Associates, Inc.

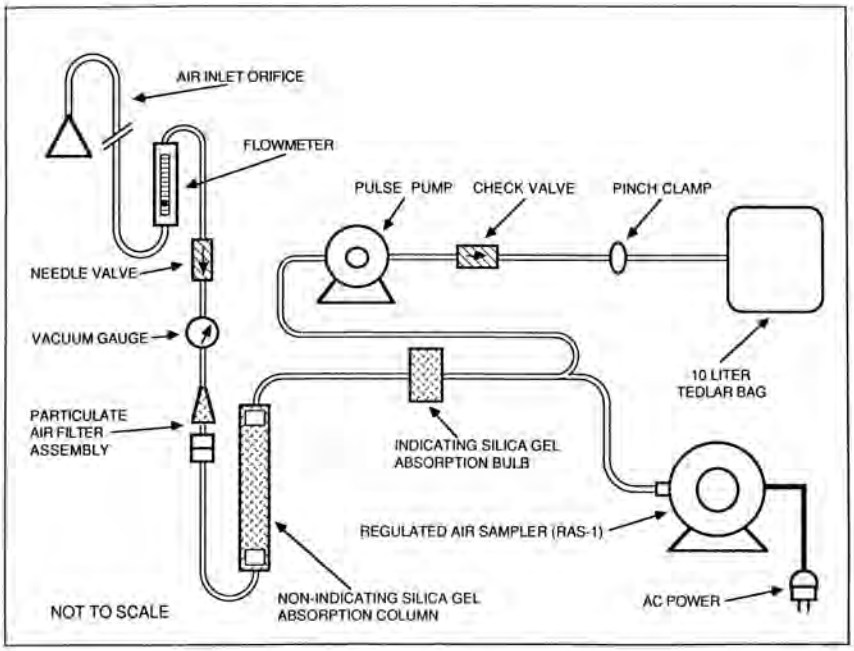

Fig. 1. Radiological Monitoring Equipment Assembly.

summaries are taken from magnetic tape, hard printout, and strip-charts. Normally, data from the backup sources (i.e., printer, strip-charts, etc.) are not reported in the data summaries. Such data are redundant and are intended only for backup and for operational checks of the instruments. The data summary sheets present the data as hourly average readings for each day of the month.

Hi-Vol filters are pre-weighed by the vendor. Used filters are post-weighed in the laboratory to determine the amount of particulate collected on the filters during the monitoring periods. These laboratory procedures are carried out in accordance with standard methods.

Particulate, moisture, and air samples are analyzed for radionuclide activity levels. The constituents to be analyzed are listed above.

Site-specific air monitoring data are compared to regional meteorological, air quality, and airborne radionuclide data as one step in screening for local anomalies. Data are analyzed concurrently with sampling to provide quality assurance and control.

Station Operations and Maintenance

Periodic inspections (approximately three times per week) of each monitoring station by the Station Caretaker (a local employee) is an integral component of the air monitoring program, ensuring a reliable data collection effort. Periodic inspection logs and checklists are completed during each site inspection. Guidelines are provided in the Procedures Manual to assist the Station Caretaker with replacement of mechanical components of the data collection system. Procedures and forms contained in the Procedures Manual include procurement and calibration logs, data collection and data discrepancy forms, control charts, calibration curves,and calculation sheets.

In addition to frequent inspections by Station Caretakers and monthly calibrations by ESA project personnel, beginning and ending performance audits are conducted by a qualified independent consulting firm.

Agency Liaison

Meteorological, radiological, and air quality sampling data are used in conjunction with environmental analyses and permit applications required in subsequent phases of site characterization and selection. The monitoring program is designed to be consistent with the recommendations of various agencies, primarily the U.S. EPA, California Air Resources Board, the California Department of Health Services, the Nuclear Regulatory Commission and local Air Pollution Control or Air Quality Management Districts. These agencies will be concerned with the comprehensiveness, accuracy, reliability, and representativeness of the data collected. To the extent necessary to ensure their acceptance of the meteorological and air quality data collected, these agencies have been consulted on station location and data collection requirements. ESA has maintained contact with these agencies throughout the monitoring period.

Quality Control/Quality Assurance Plan

A Quality Assurance/Quality Control (QC/QA) Plan has been prepared for the air monitoring program. The QC/QA Plan covers all phases of station installation, calibration, operation, and maintenance and all data collection, handling, analysis, and reporting. The content of the QC/QA Plan includes: Document Control and Revisions, Program Preparation, Installation Control, Instrument Calibration, Data Collection and Handling, Data Validation, Data Analysis, Data Reporting, Preventive Maintenance, Repair, Audits, and Reports.

EVALUATION OF THE CALIFORNIA AIR MONITORING PROGRAM

The air monitoring program for site selection of the California facility can be evaluated against several criteria, but space limitations dictate that this evaluation be brief. The most important question is whether it satisfies the regulatory requirements described earlier. The regulatory guidance is clear on the meteorological parameters to be monitored (i.e., precipitation, evaporation, etc.), and the current program meets this requirement. Guidance documents are less clear, however, concerning other data collection parameters such as height(s) of measurement(s), number of measurements, averaging period, acceptable measurement methods and instrumentation, quality control, quality assurance, and reporting formats and units. The California program follows EPA and California Air Resources Board protocols, where appropriate, and standard practices in meteorological and air quality monitoring. Our evaluation is that the current program meets the requirements in all respects, and may be more comprehensive and rigorous than necessary in some area.

RECOMMENDATIONS FOR FUTURE AIR MONITORING PROGRAMS

On the basis of ESA's experiences to date with the air monitoring program for the California facility, a few recommendations can be made for future work.

One recommendation concerns the rationale for requiring collection of meteorological and radiological data. The basis for each of the meteorological and radiological monitoring requirements should be described in detail by the responsible agency so that the responsiveness of the resulting monitoring program can be easily evaluated. Applications for the data generated by the program should be specified to ensure that the content and format of the data collected is consistent with the intended applications.

In 1982, on the basis of the 1982 version of NRC's Draft Branch Technical Position, Thomas J. Lockhart of Meteorological Research, Inc. addressed the fundamental question of whether the meteorological data required for characterization under the guidelines was, in fact, necessary for the intended purposes, or whether the requirements were excessive (2). After a review of guidance documents then in effect, he recommended a greatly reduced monitoring program (a total of 12 sensors rather than the 20 necessary to strictly comply with the Draft Branch Technical Position) (1). He identified pressure, soil moisture, frost depth, and precipitation penetration rate and depth as parameters of little importance in addressing characterization concerns. The questions he raised have not been fully addressed in recent revisions of the regulatory guidelines.

A second recommendation is that critical data be distinguished from non-critical data at the outset of the monitoring program. Site characterization studies are subject to a thorough quality assurance program. In the absence of agency guidance concerning those types of data deemed critical to the program, quality assurance procedures are applied equally to all data collection streams. This may have the result of expanding the program beyond that needed to adequately respond to agency needs.

A third recommendation is that monitoring periods be sensitive to the parameter being monitored. For example, annual snow depth data may consist of only one or two measurements for southwestern desert areas; this number of observations cannot be considered statistically valid. On the other hand, annual temperature data will consist of thousands of observations. To require the same monitoring period for all meteorological, air quality, and airborne radionuclide data may result in excessive data collection for some parameters and insufficient characterization of other parameters.

REFERENCES

1. Nuclear Regulatory Commission, "Draft Branch Technical Position on Standard Format and Content of License Applications for Near-Surface Disposal of Radioactive Waste," (1986).

2. Thomas J. Lockhart, "On-Site Meteorological Measurements for Low-Level Radioactive Waste Disposal," Proceedings of the Symposium on Low-Level Waste Disposal, Arlington, Virginia, June 16-17, 1982.