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Los Alamos
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Environmental Safety and Health Directorate

Environmental Protection (ENV) Division

Technical Project Plan

for

Meteorological Monitoring

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1	9/14	Revised to include specific regulatory drivers for the meteorology program, user performed calibration plan, updated tower/instrument locations.

1.0 PROGRAM STRUCTURE AND RESPONSIBILITIES

The purpose of the meteorology monitoring program is to provide all routine meteorology measurements required by LANL to meet DOE Orders and State and Federal Regulations.

This Technical Project Plan (TPP) specifies how the LANL meteorology monitoring program implements the quality and technical activities defined by DOE Orders and State and Federal Regulations. The quality and technical requirements for meteorological monitoring are specified by DOE Order 414.1d Quality Assurance, EPA Guidance for Quality Assurance Project Plans (EPA 2002), and ANSI Standard 3.11 Determining Meteorological Information at Nuclear Facilities. The TPP will be reviewed annually and revised as necessary.

1.1 DOE Orders and Regulatory Requirements

The following DOE Orders and regulatory requirements describe the rationale and requirements for meteorological monitoring programs at LANL.

On-site meteorological data are required for use in atmospheric dispersion modeling applications. Specific regulations requiring LANL to perform atmospheric dispersion modeling include:

- the federal Clean Air Act for radioactive air emissions (40 CFR 61 Subpart H, National Emissions Standards for Hazardous Air Pollutants – Radionuclides) for pre-construction approval for sources of air emissions and annual documentation of off-site radiological doses
- the New Mexico regulations for non-radioactive air emissions (20.2.70 NMAC Title V Operating Permit for LANL non-radionuclide air emissions) for pre-construction approval for sources of air emissions,
- the federal Nuclear Safety Management (10 CFR 830) for determining worst case meteorology conditions for accidental releases from nuclear facilities,
- the New Mexico regulations for the LANL Hazardous Waste Facility Permit (RCRA) for determining downwind air concentrations of specific waste treatment units,
- the DOE Order for Comprehensive Emergency Management System (DOE Order 151.1C) for performing real time impact assessments of potential LANL unplanned releases of toxic or radioactive materials, and
- the DOE Order on Radiation Protection of the Public and the Environment (DOE Order 458.1) for calculating radiation doses to members of the public.

A wide variety of meteorological measurements, such as temperature, pressure, relative humidity, and rainfall, are required to support other regulatory compliance programs and LANL operational requirements. These programs include:

- The Laboratory effluent discharge permits (National Pollutant Discharge Elimination System permits for stormwater, construction sites, and general sources) require routine on-site rainfall and temperature monitoring.
- DOE/NMED Consent Order uses meteorology data as part of site characterization projects
- LANL SWEIS and environmental assessments require meteorology data for facility assessments

- LANL engineering design standards require meteorology data (rainfall, snowfall, temperature, dewpoint temperature, etc.) for building and road designs
- OSHA safety requirements (wind speed, temperature, rainfall) for identifying safe working conditions and required personal protective equipment

A wide variety of meteorological measurements are also used in the analysis of LANL research and experiments. These data include pressure, temperature, solar radiation, and relative humidity.

Guidance documents providing the technical requirements on instrumentation, sampling, siting, data processing, and quality assurance include:

- ANSI/ANS-3.11-2010 "Determining Meteorological Information at Nuclear Facilities,"
- EPA-454-99-005 "Meteorological Monitoring Guidance for Regulatory Modeling Applications," and
- DOE/EH-0173t “Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance”

1.2 Organizational Structure

The LANL Meteorology Program is part of the Environmental Protection (ENV) Division. ENV Division provides environmental expertise to the Laboratory. The primary customers of ENV are the LANL operating facilities, LANL Utilities and Infrastructure Division, Environmental Programs (EP) Directorate, the Environment, Safety, and Health (ESH) Directorate, and LANL research programs.

The ENV Meteorology Program is responsible for

- maintaining calibrated instrumentation and quality assured data to support regulatory compliance, DOE Order compliance, and operational needs
- providing data analysis and weather forecasting support to LANL operations, and
- providing emergency response dispersion modeling and weather forecasting.

The overall meteorology data management system is under the direction of the Operations Integration Office of the ESH Directorate. OIO provides (or coordinates with other Divisions to provide):

- project management for initiatives modifying software programs, database operations and design, and network processes operating on LANL's network
- computer system administration
- data management server
- meteorology tower dial-up PC security
- database management system and documentation
- routine meteorology data processing and graphic display programs and documentation
- routine automated meteorology data delivery to emergency response and National Weather Service customers
- web server providing meteorology data to internal LANL customers
- web server providing meteorology data to external LANL customers

The OIO works closely with meteorology program staff to ensure data delivery to customers. OIO and ENV-DO set priorities for funding, staffing, and implementing the meteorology data management system.

The Maintenance and Site Services (MSS) Division is responsible for administering the subcontract for tower maintenance and repair and providing hoist inspections.

The LANL Standards and Calibration Laboratory (QPA-SCL) is responsible for the calibration of

- meteorology calibration standards,
- humidity, pressure, and solar radiation instruments, and
- review/approval of the meteorology program Users Calibration Plan (Appendix B of this document).

QPA-SCL either calibrates meteorology standards and instruments or sends them to vendors who are qualified to do so. QPA-SCL maintains the records for equipment they calibrate or send out.

The Meteorology Program is responsible for operational meteorological monitoring at LANL and is supported mainly by LANL General and Administrative (G&A) funding. Day-to-day management of the Meteorology Program is the responsibility of the Meteorologist, who reports to ENV-Compliance Programs Group (ENV-CP) line management.

1.3 Base Responsibilities

The Meteorology Program's work can be divided into four broad components: measurements, data management, analysis, and support of emergency management. Work in these four components can be considered either "base work" or "quality improvement work." "Base work" is continuous, routine work essential to providing customers with basic services.

"Quality improvement work" consists of short-term projects designed to fix or improve some aspect of the Program. Work assignments include base work plus quality improvement projects as time allows. The base work responsibilities of Meteorology Program members are given in the table below.

Job Title	Base Program Responsibilities
Meteorologists (1 FTE)	Plan, coordinate, and participate in programmatic work; oversee quality assurance; ensure goals are achieved in a cost-effective manner; submit budget performance data to upper management; handle data requests and conduct meteorological analyses; make data quality decisions; maintain plume modeling skills; support the Emergency Operations Center; forecast weather. Assure that the subcontract for tower inspection, maintenance, and repair is implemented.
Instrument Technician (1 FTE)	Maintain the measurement network including procurement, acceptance testing, installation, calibrations, inspections, data logger programming, and documentation; assist with data quality control activities.
Meteorology Data Steward (0.5 FTE)	Overall responsibility for routine data processing. Assure that up-to-date meteorology measurements are delivered to the web and to customers. Perform data quality updates; maintain software support contracts; perform data processing and backups; provide PC support. Responsible for meteorology tower datalogger programming aspects related to data transfer to met tower dial PC. Responsible for datalogger communications software installed on the met tower dial PC. Provide subject matter expertise in meteorology data processing to OIO staff.

2.0 PERSONNEL TRAINING AND QUALIFICATION

Meteorology Program personnel are selected through an extensive process aimed at ensuring sufficient training and qualification. Training is on-going, as personnel annually review Laboratory and ENV Division-wide training requirements and all program-specific procedures applicable to their job assignments.

Staff is encouraged to continue their training and education in their individual areas of expertise; formal training and self-study in meteorology, instrumentation, and computer science are especially relevant to programmatic work. In addition to on-site training offered through LANL, attendance at professional meetings is encouraged to the extent the budget and time allow.

2.1 Personnel Qualifications

The table below summarizes necessary qualifications and mix of skills and level of proficiency required by programmatic work.

Meteorologist	Should have a graduate degree in meteorology. A substantial research background is also necessary to be fully effective in assisting LANL personnel with a wide variety of analyses. Should also have electromechanical and computer programming experience in order to effectively oversee all aspects of the Program. LANL R&D electrical worker and first aid/CPR training are required to fulfill work responsibilities. Other specific training is designated in procedures or Integrated Work Documents (IWDs).
Instrument Technician	Must be an accomplished electromechanical technician with formal training in electronics and several years of experience. Good understanding of meteorological sensors, data loggers, and general principles of engineering and measurement science is also necessary. Should be an independent worker with strong problem-solving skills. LANL R&D electrical worker and first aid/CPR training are required to fulfill work responsibilities. Serve as Person-In-Charge for meteorology instrument calibrations and tower instrument change-out/maintenance. Other specific training is designated in procedures or Integrated Work Documents (IWDs).
Meteorology Data Steward	Should have experience in system administration tools and processes plus a good working knowledge of UNIX and Windows commands and utilities. Should be proficient with datalogger protocols for transferring data to the met tower dial PC. Should be proficient at data processing. Specific training is designated in procedures or Integrated Work Documents (IWDs).

3.0 QUALITY IMPROVEMENT

LANL-wide guidance on quality improvement is provided by the LANL Procedure P322-4 “Laboratory Performance Feedback and Improvement Process”.

Within the Meteorology Program, several processes will be pursued to detect and prevent quality problems;

- Automated data checks: meteorological values that fall outside a prescribed range are reassigned non-values. An email is automatically sent to all program personnel alerting them of the details of each automatic data value change. Other checks include comparing 15 minute rainfall totals with 24 hour summary values.
- Manual data check: the meteorologist reviews the most recent 12 hours of data using the chart summaries feature on the Weather Machine on a daily basis. In addition, the meteorologist will use a PV-Wave software program to graphically review meteorological data every week. The high frequency of manual data checks have proven to be key to quickly identifying malfunctioning instruments. When unrealistic values are encountered, the data values are manually reassigned non-values and all personnel are alerted through the tower log book.
- Automated computer systems data transfer check: An email is automatically sent to all program personnel alerting them of the details of any data transfer issues (e.g. transfer did not occur, transfer occurred late, etc).
- Manual data check: the instrumentation technician performs a daily review of data capture information to identify instrumentation issues. The instrument technician will inspect all instrument sites once per month to identify instrument or safety/security issues.
- Routine calibration and maintenance of instruments: the instrument technician implements the meteorology instrument calibration program outlined in Appendix A. Instruments that do not meet calibration requirements are taken out of service or rebuilt to meet requirements.
- Annual inspection and maintenance of meteorology towers and hoists: a subcontractor specializing in tower inspection and maintenance inspects all towers annually and performs routine maintenance as required. The LANL hoist program conducts the annual instrument boom hoist inspection in conjunction with the tower maintenance subcontractor visit, to assure correct operation and maintenance of the instrument boom hoists.
- Management Updates: the Meteorologist will regularly update line management on data quality issues and administrative topics such as budget and activities. Beginning in CY2014, the meteorologist will write an annual review of data quality; this report will be submitted to management and made available to customers.
- Customer feedback: users of the meteorological data contact Meteorology Program personnel with questions and problems concerning the data and tools provided by the Program at weather@lanl.gov.
- Internal assessments: An internal assessment of the meteorology calibration procedure was conducted in 2013 (OIO-13-001). Beginning in CY2014, the meteorologist will document a review of the meteorology program using the DOE Meteorological Coordinating Council (DMCC) Meteorological Monitoring Program Self-Assessment Tool http://orise.orau.gov/emi/dmcc/files/2011DMCCAssessmentTool.pdf This assessment will be submitted to management with proposed corrective actions.
- Independent assessment: audits provide a fully independent source of quality control. Independent assessment is addressed further in chapter 11.

4.0 DOCUMENTS AND RECORDS

The Meteorology Program will follow ADESH and ENV Division procedures for developing and maintaining procedures, records management, and document control. The Meteorology Program will maintain formal documentation that documents the work and results of the Program. The Program generates records of methods used, work completed, results of its measurement and analysis activities, and data quality. Electronic records are submitted and stored in the ENV domino system and the ADEP Sharepoint system. ADESH is developing a Documentum records management system for consolidating all ESH records during CY2015. Hardcopy records associated with the various program components are stored in the instrument lab (TA-54-1001) and at the meteorologist's office (TA-00-1328).

Record	Description	Location	Responsible Person
Meteorological station workbooks	Station engineering drawing, wiring diagrams, instrumental configuration, and data logger programs	ENV domino record system ADEP Sharepoint record system Notebook by station, instrument lab	Instrument Technician
Calibration activity workbooks	Notes on all instrument calibration and repair activity	ENV domino record system ADEP Sharepoint record system Various notebooks, instrument lab	Instrument Technician
Audit reports	Results of independent performance audits	ENV domino record system ADEP Sharepoint record system	Meteorologist
Meteorological site logbook (tower logbook)	Record of all events at the stations, including instrumentation failure, changes in data acquisition, downtime for audits and repairs, and a record of data editing	ENV domino record system ADEP Sharepoint record system Meteorology lab	Meteorologist
Station descriptions	Types of measurements made, physical description of stations	Meteorology Monitoring at Los Alamos (LA-UR-14-23378) The Weather Machine under Data Requests/Raw Data	Meteorologist

Records associated with data management:

Record	Description	Location	Responsible Person
Code documentation	Documentation of meteorology data management system.	LANL Team Forge software management system	OIO Computer Programmer
Data files	Binary and text data files	Weathernet-prod/data	Meteorology data steward
Backup tapes	Backups for UNIX machines	Stored at meteorology lab daily and weekly, weekly and quarterly back-ups stored at Pueblo Complex	Meteorology Data Steward
Routine weather reports	Monthly summary text, monthly summary graphic, daily observations	ENV domino record system ADEP Sharepoint record system File cabinet, meteorology lab	Meteorologist

Records associated with analysis:

Record	Description	Location	Responsible Person
Technical reports	Official LANL reports describing results of analyses of local meteorological measurements. See bibliography in "Meteorological Analysis Notebook."	Shelved in meteorologist's office (TA-00-1328)	Meteorologist

5.0 WORK PROCESSES

The EPA document "Guidance on Systematic Planning Using the Data Quality Objectives Process" (EPA QA/G-4, 2006) establishes methods for determining Data Quality Objectives. Sections 5.1 and 5.2 address the main elements of a Data Quality Objective (DQO) analysis for the Meteorology Project, including the identification of data objectives, identification of information needed to accomplish these objectives, and the level of certainty that is required of the data.

5.1 Data Objectives

Following the DOE Orders and regulatory requirements listed in 1.0, the Meteorology Program has two main objectives: (1) provide general meteorological support for LANL regulatory compliance activities, operations, hazards assessment, safety analysis, environmental studies, experiments, etc., and (2) maintain expertise in weather forecasting and airborne plume modeling capability for the LANL Emergency Management System.

5.1.1 General Meteorological Support

As described in Section 1, general meteorological support spans a broad range of LANL projects and programs. Site-specific meteorological data are routinely required for demonstrating regulatory compliance in the areas of air quality, water quality, waste management, as well as supporting monitoring programs in biology, hydrology, and health physics, to name a few applications.

To meet this objective, continuous measurement of wind, temperature, humidity, dew point temperature, pressure, shortwave and long wave radiation, and precipitation will be performed, quality-controlled, archived, and made accessible through the Weather Machine (http://weather.lanl.gov).

The program staff will assist customers with meteorological data analysis and interpretation. The program will provide support to Laboratory operations coordinators with forecasts and analyses if future weather conditions may adversely affect safe operations at, and travel around, the Laboratory (e.g., snow, heavy rain, or lightning).

5.1.2 Plume Modeling

The Meteorology Program will provide data and expertise to assist Emergency Operations in the calculation of potential radiological or toxicological hazards in the event of an unplanned release of hazardous materials to the atmosphere. These calculations require meteorological conditions including wind speed and direction, standard deviation of wind direction or some other indicator of stability class, temperature, and precipitation. Meteorology data are delivered to the Emergency Operations Center and to the National Atmospheric Release Advisory Capability in near real-time to support emergency response. Results of the calculations are used to classify the incident, and the incident classification leads to decisions regarding the LANL response.

5.2 Measurements and Accuracy

To serve the broad range of meteorological applications, it is necessary to measure a comprehensive set of variables at multiple locations. It is also necessary to operate stations at the upper and lower elevations of the site due to the significant change in elevation across LANL. Many weather variables have been listed in 5.1.1. The most critical variables, arguably, are those associated with atmospheric dispersion modeling to support regulatory requirements and emergency management including wind speed and direction, a stability indicator (such as standard deviation of wind direction), temperature, precipitation, and humidity. Clearly, however, there is demand for a very broad range of additional variables including, for example, solar and infrared radiation, and pressure.

Customers generally do not provide specific requirements concerning the level of accuracy or precision of the measurements that they use. Therefore, a formal DQO analysis, in which the importance of each variable would be gauged along with required accuracy, would be impractical to perform since it would require input on data and accuracy from so many customers. DOE (2004) has directed that the accuracies of the monitoring measurements should be consistent with the specifications set forth in either ANSI/ANS-3.11-2005 (R2010), or EPA-454R/R-99-005.

A complete list of variables that we measure is presented below, along with our instrumental accuracy and the system accuracy requirement. In every case except for terrestrial radiation and dew point temperature, the instrument accuracy of our measurements matches or exceeds the ANSI standard for system accuracy. However, dew point temperature is derived from temperature and relative humidity. Simple calculations of dew point temperature versus small changes in the dependent variables show that the error obeys the ±1.5 degree limit except where temperature is very high and humidity is very low. Thus, the ±1.5 degree limit is mostly satisfied.

It should be noted, however, that instrument accuracy is a single component of system accuracy which encompasses sensors, data processing equipment, computer, calibrations, etc. The error bars on system accuracy, listed by the DOE, must equal or exceed the error range associated with instrument accuracy.

System accuracy is dominated by the instrument uncertainty. Uncertainties introduced by the datalogger and data management system are less than 0.1%. A demonstration of the adequacy of the program calibration equipment for temperature and wind measurements is presented in Appendix A, User Performed Calibration for the Meteorology Monitoring Program.

There is a source of error associated with set-up. This is error introduced between the time of purchase and calibration (if applicable) and the time that the instruments are set up and collecting data. One clear error of this sort is the orientation of the anemometers. We estimate this error to be 1 degree. Adding this error to the instrument error associated with the anemometers of ±3 degrees, our estimated system accuracy on the anemometers increases to ±4 degrees, still within the ANSI error bounds. There is no apparent set up error associated with the other instruments. During the annual calibration cycle, each instrument boom is checked to assure that the boom continues to be level. In addition, periodic checks are made of the boom direction: the local value of declination will change slowly with time.

Measured Parameter	Units	Instrument Accuracy (±)	ANSI System Accuracy Requirement (±)
Wind speed (u)	meters per second	0.2	0.2 or 5%
Standard Deviation of Wind Speed (σ_u)	meters per second	n/a	n/a
Wind Direction (θ)	degrees azimuth	3	5
Standard Deviation of Wind Direction (σ_θ)	degrees azimuth	n/a	n/a
Vertical Wind Speed (w)	meters per second	+/- 0.25	n/a
Standard Deviation of Vertical Wind Speed (σ_w)	meters per second	n/a	n/a
Temperature (T)	degrees Celsius	0.1	0.5
Barometric Pressure (p)	millibars	0.6	3
Relative Humidity (h)	percent	1	4
Dew point Temperature (T_d)	degrees Celsius	3.3	1.5
Precipitation (r)	inches	0.05r	0.10r
Snow Depth (s_d)	inches	0.4	n/a
Snowfall (s_f)	inches	0.4	n/a
Temperature of 10-hour fuel stick	degrees Celsius	n/a	n/a
10-hour Fine-dead Fuel Moisture (W_{10})	percent	n/a	n/a
Solar radiation (K↓, K↑)	Watts per square meter	0.035K (zenith angle 0–70^o)	10
Terrestrial Radiation (L↓, L↑)	Watts per square meter	0.06L	0.05L

5.3 Categories of Work

The Meteorology Program commits to perform work that naturally divides into the four major work components listed in the table below. Each of the four components is examined in detail in sections **5.3.1** through **5.3.4**.

Process	Description
Instrumentation	Measurements will be taken using a comprehensive network of instrumented towers, precipitation stations, and SODAR continuously gather meteorological data.
Data management and accessibility	Meteorological data will be acquired, processed, stored, and made available for emergency management and general use. Computer system management and software development are part of this effort.
Analysis	Knowledge and understanding of meteorology will be applied to a broad range of research efforts and problem solving across LANL.
Emergency management support	Software, airborne plume modeling skills, and weather forecasting skills will be maintained as part of a continuing commitment to support consequence assessment.

5.3.1 Instrumentation

A network of six towers gathers meteorological data. Four of the towers are located on mesa tops (TA-6, TA-49, TA-53, and TA-54) and two are in canyons (TA-41, TA-5 Mortandad). The TA-6 tower is the official meteorological measurement site for the Laboratory and the town of Los Alamos. The TA-54 tower is the official meteorological measurement site for the town of White Rock. A sonic detection and ranging (SODAR) instrument is located adjacent to the TA-6 meteorological tower. One additional precipitation measurement location is operated in conjunction with Los Alamos County staff in the North Community neighborhood of Los Alamos.

The following table lists procedures that will be followed with regard to the maintenance of the instrument network.

Procedure Identifier	Title
ENV-CP-SOP-5131	Calibration and Maintenance of Instruments for the Meteorology Monitoring Program
ENV-MAQ-404	Repairing, Maintaining, and Calibrating Meteorological Instruments in the Field
EP-ERSS-SOP-5100	Meteorological Tower Hoist Operation
ENV-ES-MAQ-405	Meteorology Tower Site Inspections

Fig. 1 shows the locations of the Meteorology stations. An abundance of detail on the instrumentation can be found in LA-UR-23378, “Meteorological Monitoring at Los Alamos,” which can be downloaded from the LANL library of from the Weather Machine website.

With the exception of the TA-5 Mortandad Canyon station, all elevated instruments are supported by towers of open-lattice construction with instruments mounted on booms. To reduce flow distortion by the tower, booms face westward into the prevailing wind and boom lengths are more than twice the tower width. The booms at the four mesa top towers are attached to an elevator system; the booms are lowered to the ground by a hoist motor for instrumentation inspection and replacement. The TA-41 tower is a telescoping tower which is lowed using an electric winch. When the tower is in the down position, it is tilted over, using a hand crank, to gain access to the instruments booms.

The TA-5 Mortandad Canyon tower is a 10-meter tower composed of a moveable post mounted on a fixed tripod. The post is mounted on a hinge and can be lowered from the vertical position to a horizontal position by hand. But as with other towers, elevated measurements are taken at a distance from the tower of more than twice the tower width, and the tower itself is leeward to the instruments.

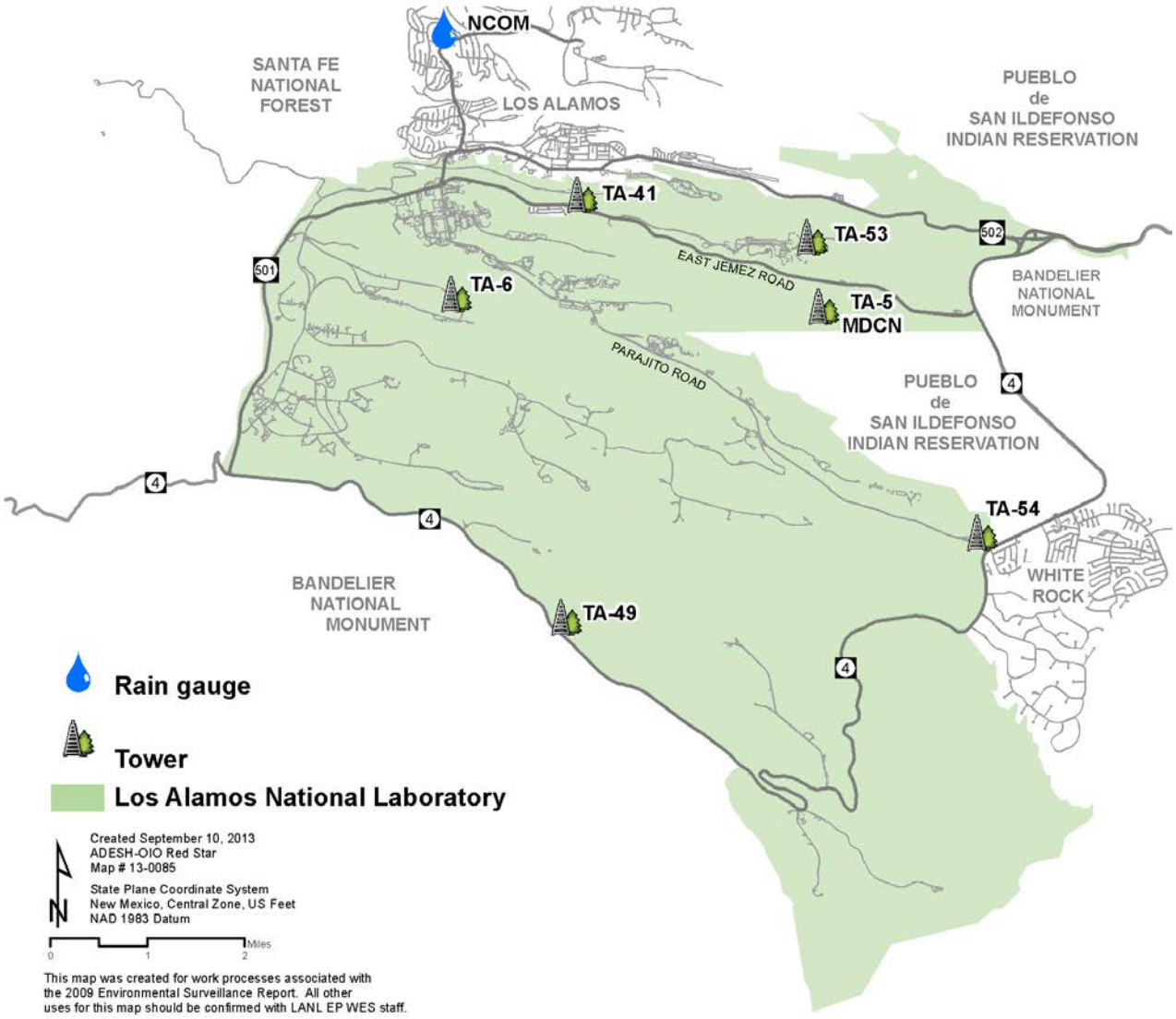


Fig. 1 Map of meteorological stations at LANL

5.3.1.1 Measurements

The table below lists the variables that are measured at the various tower locations, along with the height of the measurement above ground level in meters, marked by a "√ ". Most towers are instrumented at several levels.

Height (m)	Wind						Atmospheric State								Radiative Fluxes			
	u	σ_u	θ	σ_θ	w	σ_w	T	p	h	T_d	r	s_d	s_f		K↓	K↑	L↓	L↑
TA-6 (Official Los Alamos weather station)																		
1.2							√	√	√	√	√	√	√		√	√	√	√
11.5	√	√	√	√	√	√	√											
23.0	√	√	√	√	√	√	√											
46.0	√	√	√	√	√	√	√											
92.0	√	√	√	√	√	√	√											
TA-54 (Official White Rock weather station)																		
1.2							√	√	√	√	√				√	√	√	√
11.5	√	√	√	√	√	√	√											
23.0	√	√	√	√	√	√	√											
46.0	√	√	√	√	√	√	√											
TA-41 (Los Alamos Canyon)																		
1.2							√								√			
11.5	√	√	√	√	√	√	√											
23.0	√	√	√	√	√	√												

Height (m)	Wind						Atmospheric State								Radiative Fluxes			
	u	σ_u	θ	σ_θ	w	σ_w	T	p	h	T_d	r	s_d	s_f		K↓	K↑	L↓	L↑
TA-49 (Bandelier)																		
1.2							√		√	√	√				√			
11.5	√	√	√	√	√	√	√											
23.0	√	√	√	√	√	√	√											
46.0	√	√	√	√	√	√	√											
TA-53 (Neutron Scattering Science Center)																		
1.2							√		√	√	√				√			
11.5	√	√	√	√	√	√	√											
23.0	√	√	√	√	√	√	√											
46.0	√	√	√	√	√	√	√											
TA-5 (Mortandad Canyon)																		
1.2							√								√			
10.0	√	√	√	√	√	√	√											
North Community																		
1.2											√							

Ten hour fuel moisture and fuel temperature are measured at the ground surface at TA-6. These measurements are designated as W_{10} and T_{fuel}. The one hour fuel moisture is calculated based on the ten hour value, incoming solar radiation, ambient relative humidity. This calculation is performed and documented in the TA-6 datalogger.

5.3.1.2 Calibration

The entire network will undergo periodic calibration inspections and refurbishment as required. The calibration frequency requirements are based on the manufacturer's specifications and on operational experience. As part of the refurbishment process, instruments are removed from towers and a post-monitoring calibration is performed to ensure that the instruments were functioning properly. The replacement instruments undergo a rigorous pre-monitoring calibration process to ensure proper future function. Some instrumentation requires calibration less frequently (e.g. solar radiation sensors), therefore not included in the 1-year cycle.

Instrument	Calibration Frequency	Source of calibration frequency requirement
Wind speed Wind direction	6 months	6 months – based on ANSI 3.11 guidance and operational experience
temperature	annual	manufacturer
Relative humidity	annual	manufacturer
pressure	annual	manufacturer
Solar radiation	5 years	manufacturer
Data loggers	3 years	manufacturer

During 2013, the calibration frequency for wind sensors was increased to 6 months, following the ANSI 3.11 recommendations and the DMCC assist visit recommendations from 2006. Due to the increasing dryness of the LANL site, additional dust in the atmosphere could impact the wind speed and direction sensor bearings. Data will be evaluated from the 2013 and 2014 calibration cycles to determine if this is required long-term.

The LANL Standards and Calibration Laboratory (S&CL) has reviewed and approved the User Performed Calibration Plan (UPC) for the Meteorology Monitoring Project (Appendix A). The meteorology program calibrates wind and temperature sensors. All other monitoring equipment is sent to QPA-SCL for calibration, either by S&CL or by a qualified subcontractor. The procedures ENV-ES-SOP-5131 "Calibration and Maintenance of Instruments for the Meteorology Monitoring Program" and ENV-MAQ-404 "Repairing, Maintaining, and Calibrating Meteorological Instruments in the Field" cover wind and temperature instrument calibration in detail.

5.3.1.3 Preventive Maintenance

Manufacturer's guidelines for preventative maintenance are followed. In addition, station sites are visited monthly and instruments are examined for damage. The meteorologist's quality control check, performed once per week using PV-Wave software, is very effective for spotting quality problems quickly. The graphical quality control software shows all tower levels of data simultaneously for each variable, so a malfunctioning instrument at a given level is usually instantly apparent. Chapter 3.0 lists quality improvement activities aimed at preventative maintenance.

The instrumentation technician performs a visual inspection of all instruments once a month. Binoculars are used to inspect instrumentation located on tower booms above ground level. A subcontractor performs a tower inspection once per year to assure the structural integrity of the towers and guy lines is maintained. In conjunction with the annual tower inspection/maintenance, the LANL hoist inspector inspects the instrument boom hoists and tilt over mechanisms at the mesa top towers and the TA-41 tower.

A long term maintenance plan has been documented, to assure long term tower instrumentation performance. This plan is included as Appendix B of this document.

5.3.2 Data Management and Accessibility

The Meteorology Program is committed to maintaining a constant stream of high quality weather data and accessibility to those data. A transition from an HP UNIX server (known as WXMach) to a Red Hat UNIX server (known as Weathernet-prod) was completed during CY14. The data management system is scheduled for upgrades in CY15 to a more modern database structure. Analysis and graphics software will be updated as necessary, following the system upgrade.

The following table lists procedures that will be followed with regard to data management and accessibility.

Procedure Identifier	Title
SOP-5160	Routine Meteorological Data Processing

5.3.2.1 The Weather Machine

The Program distributes data and information to many customers from its website, known as the LANL Weather Machine, at http://weather.lanl.gov, internally and http://www.weather.lanl.gov for users external to the LANL yellow network. The website provides: details and specifications of the instrument network, current and recent conditions around Los Alamos, current regional and national weather conditions, weather forecast products, local climatological information, local meteorological data, and air quality model input data sets

The website's Data Requests section provides a series of web forms for automated data requests, enabling customers to download archived data for use in various projects. Users can also download special meteorological data sets for running some of the more common air dispersion and dose assessment models, which may be used for air permitting or demonstrating regulatory compliance. The meteorological data are pre-formatted for the intended model, requiring minimal additional processing by the user.

5.3.2.2 Software Quality

The meteorology program data management software, routine data processing, and LANL Weather Machine web presentation have been identified as non-safety software, risk level 4 under LANL P1040, Software Quality. The software was migrated to a new UNIX server (FY14) and a new standard database data storage system will be developed (FY15). The OIO has responsibility for documenting the new system following the graded approach for the complexity of this software

5.3.3 Analysis

The Meteorology Program is committed to providing meteorological expertise for effective application of the weather data that we collect, and for many weather-related applications as required by LANL. Due to the widely varying nature of the analyses that we perform, there are no procedures that guide this portion of our work.

5.3.4 Emergency Management Support

The Meteorology Program is committed to assisting the Emergency Response organization of LANL. This takes the form of plume modeling and weather forecasting during emergencies and exercises, and weather forecasting when inclement weather threatens the normal operations of LANL. Guidance for the

emergency management portion of our work is often provided by procedures and other direction from the Emergency Response Division.

We have established a goal of 95% data capture rate for all wind speed variables, to assure that these data are available for use in plume modeling during an unplanned release.

5.3.5 Air Quality Compliance Support

The meteorology program provides wind speed, direction, and stability information to support atmospheric dispersion calculations performed for air quality compliance activities. The data are used in calculating the annual air pathway maximum exposed individual and in calculating ambient air quality impacts for non-radiological air emissions. We have established a goal of 95% data capture rate for all wind speed variables to assure that these data are available for these compliance demonstrations.

6.0 DESIGN

The basic elements of the Meteorology Program, including standard meteorological measurements, plume calculations, and data storage, were initially designed to meet the basic monitoring requirements set forth in the DOE orders. Over the years these elements have been continually refined to reflect advances in technology, to reflect changes in ideas of what is acceptable and defensible, and to meet the increasing demand for meteorological information. For example, the internet has been utilized to make this meteorological information readily available to the Laboratory community, with the development of the Program's website “The Weather Machine” (http://weather.lanl.gov).

General design considerations are listed in the table below.

Element	Design Requirement
Instrumentation	Must be capable of continuous operation in all weather conditions
Computer systems	Must handle computation- and graphics-intensive applications in a secure and reliable manner
Station network	Must measure adequately the variance in all important meteorological variables across a large site having complex terrain
Archive	Must be accessible and contain useful and accurate data
Automation	Improve cost effectiveness

A study by Lee et al. (1994) attempted to determine the adequacy of the tower network. The study modeled hypothetical particle trajectories from the Chemistry and Metallurgy Research (CMR) building at TA-3, using a $1/r^2$ interpolated wind field driven by data from the four plateau towers. The particle trajectories were then compared with trajectories using a wind field driven by data from an additional temporary tower erected north of the Los Alamos town site.

The conclusion from the study was that the benefits of adding an additional tower north of the Laboratory in the town of Los Alamos would not significantly improve plume modeling. Evacuation decisions by emergency managers would be carried out for entire neighborhoods of Los Alamos, so the additional detail gained from adding an additional mesa-top tower would not change the response strategy.

Specific tower instrumentation is used in the following applications

Instrument	Design Requirement
Horizontal/vertical wind speed, direction	15 minute average data to support emergency response plume modeling, annual average dispersion modeling for regulatory compliance, OSHA safety requirements for crane work, prediction of noise from high explosives tests, weather forecasting, and support for research experiments Longer term averages to support engineering design
temperature	15 minute average data to support emergency response plume modeling and weather forecasting Annual averages, maximum/minimum data for engineering design, support for research experiments
relative humidity	15 minute data to support research experiments, weather forecasting Annual averages, maximum/minimum data for engineering design,
pressure	15 minute data to support emergency response plume modeling, groundwater level measurements, weather forecasting, and support of research experiments
solar radiation	15 minute data to support emergency response plume modeling Daily average data to support alternative energy, building energy conservation
precipitation	15 minute data to support NPDES permits, weather forecasting, engineering design Longer term averages for engineering design
fuel moisture	15 minute and longer term averages to support estimates of wildland fire danger

7.0 PROCUREMENT

The Meteorology Program procures critical items and services in accordance with the LANL policies and procedures for procurement. Specifications are established to meet requirements, and then commercially available equipment is evaluated against these specifications. The Meteorology Program will follow LANL-wide guidance on procurement as provided by the LANL Implementation Support Document P840-1 “Quality Assurance for Procurements.”

The Meteorology Program procures equipment and services from reputable vendors that are recognized for their quality through years of experience. For example, many of our instruments are purchased from Campbell Scientific, a name that is synonymous in the meteorology community with high quality, advanced grade operational weather observation instrumentation. Because of well-established relationships with vendors, we are able to ensure that goods operate as they should; vendors are quick to correct problems such as defects with the interest of maintaining the relationship. We have also been flexible enough to change vendors when warranted. Instrumentation and equipment have been evaluated as Management Level 4, as the instrumentation and equipment performance in monitored following installation.

8.0 INSPECTION AND ACCEPTANCE TESTING

All instruments will be inspected upon receipt to confirm the good condition of the instruments and the correct number of instruments was received. All instruments are calibrated before installation. Calibration is addressed in chapter **5.3.1.2** of this document. The procedures ENV-ES-SOP-5131 “Calibration and Maintenance of Instruments for the Meteorology Monitoring Program” and ENV-MAQ-404 “Repairing, Maintaining, and Calibrating Meteorological Instruments in the Field” cover instrument calibration in detail.

A number of inspections, automated and manual, will be performed to ensure that the data are of good quality and that the instruments are functioning properly. Chapter 3 describes these methods in detail.

9.0 MANAGEMENT ASSESSMENT

LANL-wide guidance on management assessment is provided by P328-3 “Management Assessment” and will be followed by the Meteorology Program.

Beginning in CY2014, the meteorologist will document a review of the meteorology program using the DOE Meteorological Coordinating Council (DMCC) Meteorological Monitoring Program Self-Assessment Tool http://orise.orau.gov/emi/dmcc/files/2011DMCCAssessmentTool.pdf This assessment will be submitted to management with proposed corrective actions.

To assist group management in tracking developments and progress in the Meteorology Program, a monthly status report is prepared and sent to line management. This report highlights accomplishments and improvements in the quality of the Program, tracks budget, and identifies issues.

10.0 INDEPENDENT ASSESSMENT

LANL-wide guidance on independent assessment is provided by P328-2 “Independent Assessment” and this guidance will be followed by the Meteorology Program.

Periodic system and performance audits of the Meteorology Program are conducted by qualified external entities. Formal reports are submitted to the ADESH records system. The most recent system audit, which comprised of an evaluation of the whole of the Program (equipment, procedures, training, records, etc.), was performed by the DOE Meteorological Coordinating Council in 2006. The most recent performance audit, which focused on the measurements aspect of the Program, was performed on the TA-54 tower in 2003. We anticipate beginning annual performance assessments of the User Calibration Program during FY15.

11.0 DOE AND DMCC QAP CRITERIA

The DOE Meteorological Coordinating Council (DMCC) uses QAP criteria that are based on American National Standards Institute recommendations, rather than the DOE QAP criteria used in this QAPP. The crosswalk below is provided as a link between the DMCC QAP Criteria and the chapters in this QAPP. Each of the thirteen DMCC QAP criteria on the left is matched to one or more of the ten criteria used by DOE, which correspond to chapters two through eleven in this QAPP.

1. Project organization and responsibilities: 1.0 Program Structure and Responsibilities
2. Data Quality Objectives: 5.0 Work Processes
3. Sampling procedures: 4.0 Documents and Records, 5.0 Work Processes
4. Sample custody: 4.0 Documents and Records
5. Calibrations: 5.0 Work Processes
6. Analytical procedures: 4.0 Documents and Records, 5.0 Work Processes
7. Data reduction, validation, and reporting: 3.0 Quality Improvement, 4.0 Documents and Records, 5.0 Work Processes, 8.0 Inspection and Acceptance Testing
8. Internal quality control checks: 3.0 Quality Improvement
9. Performance and system audits: 9.0 Management Assessment, 10.0 Independent Assessment
10. Preventative Maintenance: 5.0 Work Processes

11. Assessment of data precision, accuracy, and completeness: 5.0 Work Processes, 8.0 Inspection and Acceptance Testing
12. Corrective actions: 3.0 Quality Improvement, 9.0 Management Assessment, 10.0 Independent Assessment
13. Quality Assurance reports to management: 9.0 Management Assessment

12.0 LIST OF ACRONYMS AND ABBREVIATIONS

ADESH	Associate Director for Environment Safety and Health
ANSI	American National Standards Institute
ANS	American Nuclear Society
DCC	Document Control Coordinator
DMCC	DOE Meteorological Coordinating Council
DOE	U.S Department of Energy
EMS	Emergency Management System
ENV	Environmental Protection (Division)
EP	Environmental Programs
EPA	Environmental Protection Agency
ER	Environmental Restoration
ETSC	Emergency Technical Support Center
FTE	Full Time Employee
G&A	General and Administrative
ISD	Implementation Support Document
ISMS	Integrated Safety Management System
LANL	Los Alamos National Laboratory
MAQ	Meteorology and Air Quality
MEI	Maximum Exposed Individual
NARAC	National Atmospheric Release Advisory System
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	Nation Pollutant Discharge Elimination System
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QPA-SCL	Quality and Performance Assurance Standards and Calibration Laboratory
RCRA	Resource Conservation and Recovery Act
RRES	Risk Reduction and Environmental Stewardship (Division)
SAR	Safety Analysis Report
SODAR	Sonic Detection and Ranging
SOP	Standard Operating Procedure
TA	Technical Area

13.0 REFERENCES

ANSI 2010: ANSI/ANS-3.11-2005 (R2010), “American National Standard for Determining Meteorological Information at Nuclear Facilities”.

DOE YEAR: US Department of Energy, “Radiation Protection of the Public and the Environment,” DOE Order 458.1.

DOE YEAR: US Department of Energy, “Comprehensive Emergency Management System,” DOE Order 151.1

DOE 2004: US Department of Energy, “Environmental Regulatory Guide for

Radiological Effluent Monitoring and Environmental Surveillance,” DOE/EH-0173T.

EPA 2000: US Environmental Protection Agency, “Meteorological Monitoring

Guidance for Regulatory Modeling Applications,” EPA-454/4-99-005.

Lee et al. 1994: J. T. Lee, J. Archuleta, and D. Hoard, “Evaluation of a

Diagnostic Wind Field Model for the Los Alamos Area,” Los Alamos National Laboratory document LA-UR-94-3587.

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14.0 APPENDIX A: USER PERFORMED CALIBRATION PLAN

Los Alamos NATIONAL LABORATORY

Effective Date: 1/15/2014 Next Review Date: 1/15/2016

Environment, Safety, Health Directorate

Environmental Protection – Compliance Programs

User Calibration Plan – Meteorology Monitoring

Reviewers:

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Derivative Classifier: ☐ Unclassified ☒ DUSA ENVPRO

Name:	Organization:	Signature:	Date:
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Subject Matter Expert: Greg Stanton	Organization: ENV-CP	Signature: Gregg T. Stanton	Date: 1/9/2014
Standards and Calibration Lab Allen, Mark L.; 247415	Organization: QPA-SCL, GL	Signature:	Date: 1/14/14
Quality and Performance Assurance Division Petru, Ernie F.; 236452	Organization: QPA-DO, A-DL	Signature:	Date: 1/14/14

CONTOLLED DOCUMENT

Printed copies are deemed uncontrolled. The controlled copy can be found on the ENV Division Webpage. Users are responsible for ensuring they work to the latest approved version.

User-Performed Calibration (UPC), ENV-CP Meteorology

User Performed Calibration (UPC)

1.0 INTRODUCTION

This Program Plan describes the requirements for assuring that User Calibrations performed by the meteorology monitoring program at Los Alamos National Laboratory will result in with sufficient accuracy and traceability in accordance with controlled procedures to support the objectives of the activity. The User Performed Calibration program for meteorology is managed by the Environmental Compliance Programs Group (ENV-CP) which is part of the Environmental Protection Division (ENV).

2.0 PURPOSE

The meteorology program has an integral requirement that systems are operating correctly to support emergency response at LANL. This requirement is implemented through daily and weekly instrument checks – a more frequent requirement than the meteorology program calibration intervals. The program has been staffed to perform these instrument checks. The meteorology instruments to be calibrated in the UPC are wind speed, wind direction, vertical wind speed, and temperature.

3.0 ACRONYMS

ENV	Environmental Protection Division
CP	Compliance Programs Group
ANSI	American National Standards Institute
S&CL	Standards and Calibration Laboratory
EPA	Environmental Protection Agency
NCR	Nonconformance report
SOP	standard operating procedure
QP	quality procedure
N/A	not applicable

4.0 IMPLEMENTATION

4.1 Document Control

ENV-DO-QP, Document Control, is the local document control process and procedure that meet P1020-2, *Laboratory Document Control.*

4.2 Records Management

ENV-DO-QP-110, Records Management, is the local Records Management process and procedure for the identification, collection, retention, indexing, access, filing, storage, maintenance, and disposal of quality and technical records associated with the UPC Program that meet P1020-1, *Laboratory Records Management.*

User-Performed Calibration (UPC), ENV-CP Meteorology

4.3 Training

The ENV Division Personnel Training Procedure, ENV-DO-QP-115.1, requires that training requirements for work be documented in ENV Technical Project Plans and implementing procedures. ENV-CP ensures the competence of ENV-CP personnel to perform calibrations by hiring individuals that meet the qualification requirements listed in the Technical Project Plan for Meteorological Monitoring (WES-PLAN-300).

All employees must train to the applicable calibration procedures prior to performing work. The meteorology instrument technician must train to ENV-ES-SOP-5131, "Calibration, Refurbishment, & Maintenance of Meteorology Program Equipment. In addition, the meteorology instrument technician must obtain all safety related training identified in the IWDs covering meteorology instrumentation work. All training is documented in the LANL U-train system.

4.4 Implementing Procedures

The plan and procedure required for all UPC activities (i.e,. calibration, Outsource calibration certificate reviews, outsourcing processes, MAP Activities, etc.) are: ENV-ES-SOP-5131, "Calibration, Refurbishment, & Maintenance of Meteorology Program Equipment," ENV-PLAN-300, "Technical Project Plan for Meteorological Monitoring."

4.5 Assuring the Quality of the Calibration

ENV-ES-SOP-5131 was independently reviewed by a technically qualified expert, to assure conformance to manufacturer's requirements (OIO-13-001, November 2013). The procedure was updated to address the review.

Each calibration report (i.e. forms generated through the use of ENV-ES-SOP-5131 or prepared by an outside supplier) is independently reviewed by the meteorologist following Attachment 1. In addition, control charts of calibration results are developed and maintained by the meteorologist, to review the results of calibrations over time.

4.6 Out-of-Tolerance (OOT) and Nonconformance Reporting (NCR)

The required specifications to meet the "as-found" or "as left" configuration are documented for each type instrument in ENV-ES-SOP-5131. For those instruments not meeting these tolerances, a NCR is documented per P330-6, Nonconformance Reporting. The process for determining whether a nonconforming condition exists is documented in the calibration procedure. When an instrument does not meet the tolerances specified in ENV-ES-SOP-5131, a nonconforming conditions exists and an NCR is documented.

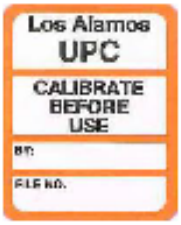
4.7 Inactivation and Closing the Calibration

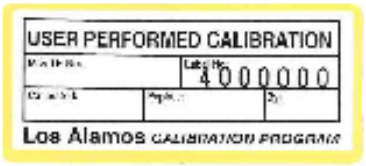
The process for determining whether a nonconforming condition exists is documented in the calibration procedure ENV-ES-SOP-5131. When an instrument does not meet the

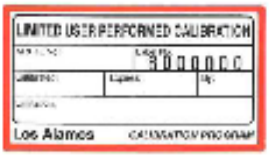
tolerances specified in ENV-ES-SOP-5131, a nonconforming conditions exists and an NCR is documented using the LANL Institutional NCR process.

4.8 UPC Label Control

The meteorology instrument technician obtains UPC labels from the S&CL. ENV-CP maintains a calibration tracking list and logs UPC labels as part of the tracking list. The only labels used in the UPC meteorology program are User Performed Calibration and calibration expired or inactive stickers as depicted below.











4.9 Software Quality Management

Campbell Scientific dataloggers are used in the calibration process, to record results. The datalogger program is documented and controlled through the ENV-ES-SOP-5131. The only calculations done in the datalogger are to convert units of measurement (e.g. voltage) to meteorology units (e.g. azimuth).

4.10 Calibration/ Reference Standards

The standards used in the calibration process are listed below, including the list of standards, calibration source, and calibration interval.

User-Performed Calibration (UPC), ENV-CP Meteorology

Table 1.0 – Calibration / Reference Standards

Equipment	Function/Where Used	Calibrated/Verified Interval	Source of Calibration
Model 18310 Torque Disc R.M. Young	Used to verify the start-up threshold torque for the horizontal and vertical RM Young Anemometers	Verified/Calibrated -No User Selectable Weights Replace if Damaged	N/A
Model 18331 Vane Torque Gauge R.M. Young	Used to verify the Horizontal Anemometer Vane (Directional Rotation/Azimuth) Torque	Verified/Calibrated-Yes Annually	S&CL
Model 18112 Vane Angle Fixture R.M. Young	Used to verify the Horizontal Anemometer Vane Angle Transducer Output Signal to Azimuth & to make setting adjustments	Verified/Calibrated-No Fixed Value References	N/A
Model 18802 RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals variable from 200 to 15,000rpm in 100 rpm increments	Verified/Calibrated –Yes Annually	S&CL
Model 18801 Fixed RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals variable from 100 to 10,000rpm in 1-rpm increments	Verified/Calibrated –Yes Annually	S&CL
Fixed 300RPM RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals	Verified/Calibrated –Yes 5-year cycle	S&CL
Fixed 1800RPM RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals	Verified/Calibrated –Yes 5-year cycle	S&CL
Fixed 3600RPM RM Young Anemometer Drive	Used to verify the Horizontal and Vertical Anemometer Wind Speed Transducer Output Signals	Verified/Calibrated –Yes 5-year cycle	S&CL

User-Performed Calibration (UPC), ENV-CP Meteorology

Equipment	Function/Where Used	Calibrated/Verified Interval	Source of Calibration
Model 87V Handheld Fluke Multimeter	Used to verify resistance and DC voltage measurements during temperature sensor , horizontal & vertical anemometer verifications (as appropriate)	Verified/Calibrated –Yes Annually	S&CL
Model 177 Handheld Fluke Multimeter	Used to verify resistance and DC voltage measurements during temperature sensor , horizontal & vertical anemometer verifications (as appropriate)	Verified/Calibrated –Yes Annually	S&CL
Model 8846A Fluke Precision Multimeter	Used to verify resistance and DC voltage measurements during temperature sensor , horizontal & vertical anemometer verifications (as appropriate)	Verified/Calibrated –Yes Annually	S&CL
Model 884X-RTD Fluke Platinum RTD Thermometer	Used to verify the ambient air temperature monitoring sensors (060A-*) outputs during test	Verified/Calibrated – Yes Annually	S&CL
Campbell Scientific 21X Data Logger	Interface Device between Laptop Computer & Horizontal Anemometers Under Test; processes sensor input readings	Verified/Calibrated – Yes –	S&CL sends to Campbell Scientific every other year

User-Performed Calibration (UPC), ENV-CP Meteorology

4.11 Calibration Intervals

Calibration intervals are based on the manufacturer's specifications for each sensor type. The meteorology program is documenting instrument performance in control charts.

The meteorology program has identified that horizontal and vertical wind speed and horizontal wind direction may be impacted by an increase in ambient dustiness, due to long term drought conditions at Los Alamos. During FY14, wind instrument calibration frequency has been increased over manufacturer's specifications. Calibration data will be charted and reviewed to determine if more frequent calibration is required.

4.12 Calibration Recall System

The meteorology instrument tracking spreadsheet is used to track calibration dates. The meteorology instrument technician reviews the tracking list, to identify upcoming calibration requirements and schedules the calibrations. The calibration schedule is reviewed with the meteorologist monthly.

4.13 Uncertainty and Traceability

Overall system uncertainty requirements for wind speed, direction, and temperature and defined by the ANSI-3.11-2005. Uncertainties in LANL meteorological measurements have been identified following the examples provided in ANSI-3.11-2005.

Temperature Measurement Uncertainty:

Sensor = 0.1 °C
Aspirators = 0.03 °C
RSS Error = 0.126
ANSI requ't = 0.5 °C
Meets? = Yes

Horizontal Wind Speed Measurement Uncertainty:

RM Young Sensor is Accurate to +/- 0.2 m/s or 1% of reading

Table 2.0 – Horizontal Uncertainty

Speed	Accuracy of sensor	RSS Error	ANSI Required Accuracy	Meets ANSI Specification
0.4	0.2	0.205	0.22	Yes
1.0	0.2	0.205	025	Yes
2.0	0.2	0.205	0.30	Yes
4.0	0.2	0.205	0.40	Yes
8.0	0.2	0.205	0.60	Yes
16.0	0.2	0.205	1.00	Yes
32.0	0.32	0.323	1.80	Yes
64.0	0.64	0.323	3.40	Yes

User-Performed Calibration (UPC), ENV-CP Meteorology

Vertical Wind Speed Measurement Uncertainty:
RM Young Sensor is Accurate to +/- 1.4% of reading

Table 3.0 – Vertical Uncertainty

Speed	Accuracy of sensor	Datalogger Uncertainty	RSS Error	ANSI Required Accuracy	Meets ANSI Specification
0.4	0.01		0.006	0.22	Yes
1.0	0.01		0.014	0.25	Yes
2.0	0.03		0.028	0.30	Yes
4.0	0.06		0.056	0.40	Yes
8.0	0.11		0.112	0.60	Yes
16.0	0.22		0.224	1.00	Yes
32.0	0.45		0.448	1.80	Yes

The test uncertainty ratio is documented as follows:

Table 4.0 - TUR

Meteorology Measurement	Probe Accuracy	Calibration Equipment Accuracy	Test/Uncertainty Ratio
Temperature	0.1 °C	0.05 °C	2:1
Horizontal Wind Speed	0.2 m/sec	0.0005 m/sec	400:1
Horizontal Wind Direction	3 degrees	0.5 degrees	6:1
Vertical Wind Speed	+/- 1.4% of reading At 0.5 m/sec vertical speed, the accuracy is 0.007 m/sec	0.0005 m/sec	14:1

The Test Uncertainty Ratio for wind speed (horizontal and vertical) and wind direction are larger than the LANL requirement. Although the Test Uncertainty ratio for the calibration of temperature probes does not meet the LANL standard value of 4, the temperature probes are much more accurate than the ANSI system requirements. Purchase of a more accurate temperature sensor for additional calibration sensitivity is not warranted.

The traceability of each calibration is documented on the ENV-ES-SOP-5131 calibration forms. The specific equipment used in the calibration and the equipment calibration dates are recorded.

User-Performed Calibration (UPC), ENV-CP Meteorology

4.14 Environmental Conditions

Wind speed and direction calibrations are performed at the TA-54-1001 laboratory. These indoor conditions are sufficient to accurately calibrate wind sensors.

Temperature calibrations are performed at the TA-54-1001 laboratory. Temperature sensors are calibrated using liquid baths at specified temperatures. The calibration standard is used to verify the stability of the bath temperatures. that can affect the results of calibrations. Environmental conditions may include: biological sterility, dust, electromagnetic disturbances, and radiation, humidity, temperature, and sound and vibration levels.

4.15 Equipment

All equipment used in calibration meteorology instruments in controlled by the ENV-CP meteorology program. All calibration equipment is tracked in the calibration tracking list; the calibration list is checked each month, to assure that all calibration equipment is in calibration when used. All calibration equipment is tracked using an S&CL assigned number.

All calibration equipment and manuals are stored at TA-54-1001. Only ENV-CP employees are allowed unescorted access to TA-54-1001, to assure that calibration equipment are not tampered with.

A listing of all calibration equipment is presented in Section 4.10.

4.16 Calibration Reporting

ENV-ES-SOP-5131, "Calibration and Maintenance of Instruments for the Meteorology Monitoring Project" is the calibration procedure used to document the results of each calibration accurately, clearly, unambiguously, and objectively.

4.17 Subcontracted Calibration and Report Reviews

Identify when the UPC may be required to use an ISO 17025 accredited calibration subcontractor, or a NNSA Nuclear Weapons Complex Site rather than a subcontractor approved through a QPA-DO assessment (if applicable). As necessary, ENV-CP will work with QPA-DO to have unapproved sources evaluated and placed on the IESL.

Standards or reference materials used for the calibration of data loggers, pressure, solar radiation, and humidity sensors are calibrated by S&CL or are sent out to calibration suppliers by S&CL.

When ENV-CP receives results from these laboratories, the instrument technician reviews the reports and updates the Master Equipment tracking list with calibration dates. The reports are reviewed to assure that the instrument successfully met instrument accuracy requirements. The review is documented using Attachment 1.

User-Performed Calibration (UPC), ENV-CP Meteorology

4.18 Reference Materials

Identify the process of verification on procured reference materials. Reference materials (in this case, calibration equipment) are procured using standard LANL purchasing process. Calibration equipment is procured using Quality Assurance Supplement Form 838c to identify the specifications. Wind speed and direction calibration equipment must be procured from the manufacturer (RM Young) for compatibility with RM Young wind speed and direction sensors. Platinum resistance thermometers used in calibrations are purchased from Fluke.

4.19 Measurement Assurance Program (MAP)

Meteorology data are reviewed on a daily basis, to assure that data are being successfully collected. Meteorology data are automatically reviewed daily to assure that data are within known, appropriate meteorology ranges. Daily screening of the data is done by both the meteorologist and the instrument technician to identify obvious data outliers.

All meteorology data are reviewed in detail by a meteorologist within 7 to 10 days of collection. The data are reviewed using graphics software which plots meteorology data versus time. Parameters are plotted so that data from different tower levels can be compared and are plotted so that meteorology consistency can be checked (e.g. higher humidity values are associated with rain events).

Instrument issues are identified by the meteorologist or by the instrument technician are documented via email and the instrument technician schedules instrument replacement (field repair is typically not feasible). Bad data are identified and removed from the long term data archive.

An annual data quality report is written by the meteorologist (beginning in CY14), to document instrument performance. Data completeness is documented and data issues are documented.

4.20 Use of a Calibration Supplier not on the IESL

Calibration suppliers which are not on the LANL IESL are approved by S&CL and are identified as compliant calibrations. These suppliers calibrate dataloggers, pressure sensors, and solar radiation instruments as there are no known suppliers which qualify for the LANL IESL.

User-Performed Calibration (UPC), ENV-CP Meteorology

Attachment 1: Review of Calibration Reports

Name of Calibration Report: _____

Date of Calibration Reports: _____

Calibration Report Reviewed By: _____ Date _____

Requirement	Met	Does not meet	Follow up action
Identification of Customer			
Unique M&TE number			
Identification of procedure used in calibration			
description of, the condition of, and unambiguous identification of the item(s) calibrated			
date(s) of performance of the calibration			
"as-found" and "as-left" data;			
Calibration results with units of measurement			
Name, Z#, signature and date identifying the person(s) conducting the calibration			
Name, Z#, signature and date identifying the person(s) authorizing the calibration			
Statement of compliance/non-compliance with requirements and/or specifications			
Level 0			
Level 1			
Level 2			
Level 3			
Level 4			
Conditions under which the calibrations were made that have an influence on the measurement results			
Evidence that the measurements are traceable (a listing of standards used)			
Calibration interval and calibration expiration date			
NCR required?			
Notes			

Technical Project Plan for Meteorology: Appendix A
ENV-CP Meteorology UPC Program Plan, R0

15.0 APPENDIX B: LONG-TERM MAINTENANCE PLAN

[Tower Sites are listed in order of monitoring/need importance]

Priority	Monitoring Site
1	TA-6
1	TA-54
2	TA-53
2	TA-41
2	TA-49
2	TA-5 (MDCN)
3	NCOM

The service/maintenance items listed below for each tower are based upon physical assessments at each site along with annual inspection findings from Phoenix Tower Service and requirements directed in the LANL Institutional policies and procedures for Tower & Hoisting/Lifting Equipment.

Towers with Elevator or hoist type Systems are: (TA6, TA54, TA53, TA41, & TA49)
Tilt capable Towers: (TA5, TA41)

TA-6

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked Annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor; replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspected prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY 16) Replace every 3 years unless use increases; per agreement with LANL tower hoist inspectors.
    d. Drive Unit: Replace V-Belt every 4 years, (Due FY16) monitor belt for cracking.
    e. Elevator Carriage Cable: (Replaced in FY13) included in monthly and pre-op inspections; should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Changed in FY12) Annual Inspection Item; should be changed when wear dictates, possibly due in 5 years (FY17).
    g. Carriage System Control Panel Lights: Inspect during each use of tower hoist.
4. Communications System: Due to the change to LANL telephone systems to Voice over Internet Protocol (VOIP), we will upgrade our data communications to DSL during FY15.
5. TA6 Snow Depth Station: maintenance issues in-process FY14.
6. Solar Radiation Station: Replace all cabling; projected for FY14/FY15 to accommodate updated approach to instrument measurements.

TA-54

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor; replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspected prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY 16) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Drive Unit: Replace V-Belt every 4 years, monitor belt for cracking. Drive Unit S/B ok barring a catastrophic failure.
    e. Elevator Carriage Cable: cable inspection included in monthly and pre-op inspections; cable is older but shows no signs requiring change; when replaced it should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Changed in FY12) Annual Inspection Item; should be changed when wear dictates, possibly due in 5 years (FY17).
    g. Carriage System Control Panel Lights: inspect at each use.
4. 4. Communications System: Due to the change to LANL telephone systems to VOIP, we will upgrade our data communications to DSL during FY15. The distance from the TA-54 tower to the switching gear at TA-50 may require the use of additional DSL modems to boost the signal. NIE will assist with testing.
5. Solar Radiation Station: Replace all cabling; projected for FY14/ FY15 to accommodate updated approach to instrument measurements.

TA-53

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor. Light was replaced in FY12; lights are replaced as needed.
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspected to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY 16) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Drive Unit: Replace V-Belt every 4 years, monitor belt for cracking. Drive Unit S/B ok barring a catastrophic failure.
    e. Elevator Carriage Cable: cable inspection included in monthly and pre-op inspections; cable is older but shows no signs requiring change; when replaced it should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Changed in FY12) Annual Inspection Item; should be changed when wear dictates, possibly due in 5 years (FY17).
    g. Carriage System Control Panel Lights: All Lights working as of last function.
4. Communications System: Due to the change to LANL telephone systems to Voice over Internet Protocol (VOIP), we will upgrade our data communications to DSL during FY15.
5. Solar Radiation Station: Replace all cabling; projected for FY15 to accommodate updated approach to instrument measurements.

TA-41

1. Tri-Ex Tilt Tower Structure; Inspections: Annually
2. Tower Lowering & Tilt Systems:
    a. Non-Operational Inspection monthly & inspect prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY 16) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Tower Extension (Telescoping) System: Replace V-Belt every 4 years, (Due FY16) monitor belt for cracking. Tower Extension System and Gearbox should be seriously considered for replacement in FY15, original/very old leaking gearbox lubricant; System Control Panel needs to be upgraded ASAP; planned replacement FY14.
    e. Tower Tilt System: Gearbox is showing signs of leaking fluid and should be considered for replacement inside of 5 years; projected replacement in FY15.
    f. Tower Sheaves (Pulley's): Annual Inspection Item; should be changed when wear dictates, appear to be original equipment; will know more with next annual inspection; planned replacement FY14.
3. Communications System: Telephone land line replaced in FY14. Due to the change to LANL telephone systems to VOIP, we will upgrade our data communications to DSL during FY15.
4. Fiberglass enclosure is rotting; projected replacement FY15. Should require no further maintenance.
5. GFCI outdoor rated power strip planned for replacement FY15.

TA-49

1. Tower Structure, Paint, and Guy Wire Tensioning/ Inspections: Checked annually by tower maintenance subcontractor; painted as necessary to meet requirements.
2. Tower Warning Beacon Lights: Checked annually by tower maintenance subcontractor; replaced as needed..
3. Hoist/Carriage System:
    a. Non-Operational Inspection monthly & inspect prior to each operation event.
    b. Annual Inspection by LANL Hoist Inspectors
    c. Gearbox Lubrication Replacement: (Due FY 16) Replace every 3 years unless use increases; per agreement with LANL hoist inspector.
    d. Drive Unit new in FY13: Replace Cogged Drive Belt every 4 years, monitor belt for cracking. Drive Unit S/B ok barring a catastrophic failure.
    e. Elevator Carriage Cable: (Replaced in FY13) included in monthly and pre-op inspections; should be good for 10+ year's normal operation.
    f. Elevator Sheaves (Pulley's): (Due FY17) Annual Inspection Item; should be changed when wear dictates, possibly at 5 year intervals.
4. Communications System: Land-Line Communications; Due to the change to LANL telephone systems to VOIP, we will upgrade our data communications to DSL during FY15.
5. Tower Base Junction box Enclosure on Tower is rusting/very corroded; unknown cost to replace due to extensive wiring located in enclosure; continue to monitor, possibly seek quotation on work.
6. Tower needs to be transitioned to 24Vdc Aspiration fans from the now existing 120Vac Aspiration fans as noted in an earlier (I believe 2009 Electrical Safety PFITS Item). Change may require additional MSS Resources for underground conduit installation and cable pulling; plus purchase of cabling. More planning needed.
7. Solar Radiation Station: Replace all cabling; projected for FY14FY15 to accommodate updated approach to instrument measurements.

TA-05 (MDCN)

1. Tilt Over 10-Meter Tower: Annual Inspection
2. Tilt Over Hand Crank System:
    a. Inspect monthly & inspect prior to each operation event.
    b. Annual hoist inspection is not necessary assembly does not fall under the existing LANL definition of hoisting/lifting. Wire Rope/Cable & Hand Crank: (Hand Crank Replaced FY2012) unit is included in monthly and pre-op inspections; should be good for 15+ year's normal operation. Hand crank tilt-over assist system is an option and is not necessary to work on tower.
3. Communications System: Old Analog Model 3600 AirLink Cellular Network Modems; Verizon support for analog networks is supposed to go away. Projected transition to digital cell phone modem in FY15.
4. Sensor/Equipment Mounting Assembly at top needs to be reworked for a more secure installation (now using RTV & Friction Fit) does not appear to be urgent.

NCOM (Old Fire Station on Arkansas Street)

1. Roof Mounted Heated Tipping Bucket Rain Gauge (Very Low Priority Installation)
2. Access: Instrument is Roof Mounted; access to this roof by LANL personnel is not permitted, we are required to solicit keys from LA County and have county employees do any roof work.
3. Data Logger is situated at the rear of the facility in the basement portion.
4. Initial assessment in 2010 viewed installation as hap-hazard and may have other concerns.
5. ASAP need to Replace Datalogger with newly calibrated unit.
6. ASAP need to replace battery backup system with larger unit & confirm charging system.
7. Communications System: Presently on analog cell phone; system communications is becoming more intermittent; recommend update to digital cellular modem or land-line to increase reliability; Initial contacts have been made with Los Alamos County facilities manager to discuss.