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Los Alamos
National Laboratory

Environmental, Safety, Health & Quality Directorate

Waste and Environmental Services (WES)

Project Plan

for the

Environmental Continuous Air Monitoring (ECAM) Project

Signatures

Derivative Classifier: Classified Unclassified Signature on File Jean Dewart, WES-EDA	Date: 7/22/2010
Prepared by: Signature on File William Eisele, ECAM Project Task Leader	Date: 7/22/2010
Reviewed by: Signature on File David Webster, QA-IQ	Date: 7/22/2010
Approved by: Signature on File Jackie Hurtle, WES-EDA Deputy Group Leader	Date: 7/26/2010

CONTENTS

HISTORY OF REVISION

Revision	Date	Description of Changes
0	8/2/2010	New document.

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1.0 PURPOSE

Los Alamos National Laboratory (LANL) emits radionuclides that are regulated by the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE). Routine measurement and reporting of radionuclide concentrations in the ambient air is required and this requirement is met through the WES-EDA AirNet program and the ENV-EAQ stack monitoring program. The AirNet program allows for retrospective analysis of radioactive airborne concentrations at receptor locations and the stack monitoring program allows for either retrospective or real-time assessment of airborne emissions at the point of release. In either case, the data is used to project doses to the public retrospectively after environmental releases have occurred. A system has been developed to measure, in real time, the concentration of specific radioactive airborne contaminants at receptor locations in the environment, particularly during activities that have the potential to suspend legacy radioactive contaminants found in soil within environmental remediation sites. This system is the Environmental Continuous Air Monitoring (ECAM) Project. Appropriate actions to assist with mitigation of excessive doses is addressed in EDA-QP-229, On-Call Response To SabreECAM Off-Normal Notifications

This project plan and its implementing procedures describe how real-time environmental air monitoring for radioactive air contaminants is conducted at LANL by the Waste and Environmental Services (WES) Group. Alarm and off-normal notification response directions are also addressed in EDA-QP-229, On-Call Response To SabreECAM Off-Normal Notifications.

1.1 Regulatory Quality Criteria

Quality Assurance criteria governing this Program include DOE Order 414.1C, Quality Assurance, as more specifically addressed in SD330, Los Alamos National Laboratory Quality Assurance Program (LA-UR-07-0503) and EP-DIR-QAP-0001, Quality Assurance Plan for Environmental Programs at http://int.lanl.gov/orgs/adep/qa.shtml.

2.0 ORGANIZATION

The ECAM project Task Leader manages the operation of the ECAM system. The task leader reports to the WES Environmental Data & Analysis (EDA) Group Leader. A software/hardware engineer supports the task leader in maintaining software associated with acquiring data from the individual units in the field as well as the display of the data via the web. The engineer also assists with maintaining the cell phone modem communications system. Others are deployed to work for the task leader to change out filters and maintain the ECAMs in the field, manage databases, provide off-hours response to off-normal status messages and alarms, provide software quality management services, and provide data evaluation. In addition, the ECAMs are calibrated and repaired by the RP-2 Radiation Instrumentation & Calibration (RIC) team.

2.1 Roles and Responsibilities

2.1.1 ECAM Project Task Leader

The project task leader is responsible for the overall direction of the project, including:

- Securing customer service agreements and funding for project
- Maintaining project documentation
- Ensuring configuration management of project hardware and software
- Ensuring software quality management is implemented for project

- Serves as project point-of-contact for reporting of bugs and other software/hardware issues (issues management POC)
- Maintaining project management documentation, including Gantt charts
- Arrange for appropriate calibration/maintenance services

2.1.2 Software/Hardware Engineer

The software/hardware engineer is responsible for maintaining the hardware and software elements of the project, including:

- Development of applicable software modules
- Fix bugs as discovered/reported
- Arrange for database services for data storage
- Issue remote commands to units in field
- Maintain test bed development platforms for hardware/software
- Maintain software configuration management controls
- Configure/maintain communications equipment/systems
- Function as technical liaison between project and hardware/software vendors
- Provide technical assistance, as necessary, during filter changes and field maintenance

2.1.3 ECAM Technician

- Perform biweekly filter changes
- Install/remove ECAMs from AIRNET enclosures for calibration and maintenance
- Perform radioactive source response checks in field
- Configure ECAM operating parameters in the field

2.1.4 On-Call Responder

- Respond to off-normal status messages and alarms via e-mail and/or pager as specified in EDA-QP-229, On-Call Response to SabreECAM Off-Normal Notifications

2.1.5 Environmental Scientist

- Provide interpretation of ECAM data and plots
- Develop appropriate algorithms for processing raw ECAM data, as needed
- Provide analytical tools for interpretation of ECAM data and plots, as needed

2.1.6 RP-2 Radiation Instrumentation and Calibration (RIC) Team

- Develop and maintain ECAM calibration and maintenance procedures
- Provide ECAM calibration and maintenance services

- Provide technical instrumentation services

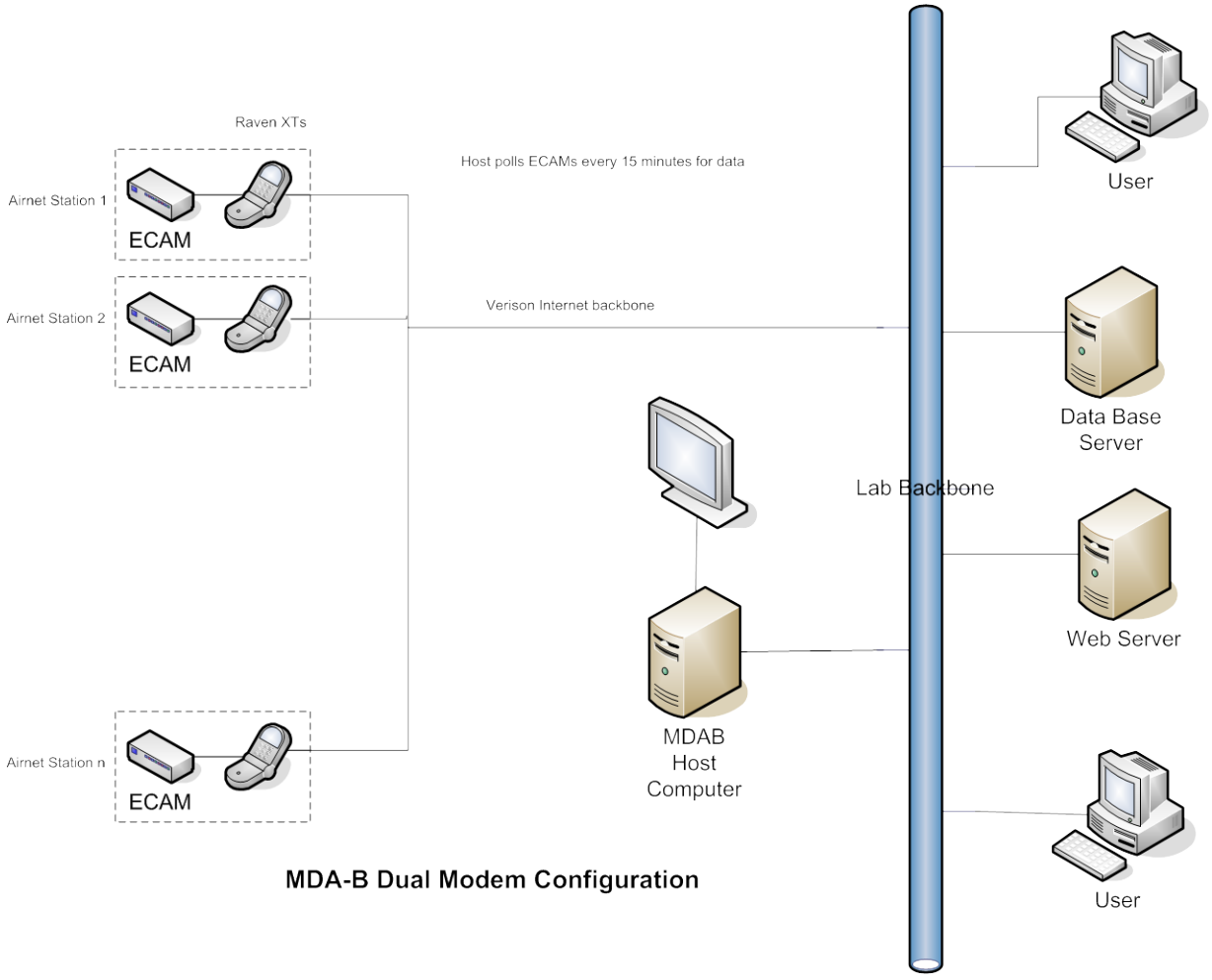
3.0 SYSTEM DESIGN

3.1 Sampling System Design

The primary design objective for the ECAM environmental monitoring system is to provide timely indicators that can be used to determine if the public may be exposed to alpha-emitting radionuclides in air above background levels. To achieve this objective, the system design is based on commercial off-the-shelf instrumentation for near real-time alpha-emitting radionuclide assessment.

The ECAM units contain a multi-channel analyzer that is used by the unit's internal software to measure alpha particle energy levels and estimate the alpha-emitting radionuclide activity levels deposited on the ECAM filter. Each unit is coupled with a cell phone modem which is used by in-house developed software to communicate with and acquire the data.

The following provides a graphical schematic of the ECAM system:



MDA-B Dual Modem Configuration

3.2 ECAM Locations

The ECAMs are Bladewerx SabreECAM Environmental Monitors and reside in AirNet cabinets placed around remediation sites or operating facilities. These units are self-contained ECAMs that

perform air sampling from the surrounding environment, deposit aerosols on a filter, analyze radioactivity collected on the filter, analyze the data, and save it internally for acquisition. Features of this ECAM include alpha spectroscopy and the use of an embedded PC to analyze spectral data and perform data logging and communications functions.

ECAMs are co-located with AIRNET stations to take advantage of the AIRNET station environmental enclosures and 110 volt AC power supplies. ECAMs are either located in the same environmental enclosure as the AIRNET equipment or in adjacent environmental enclosures.

3.3 Sampling Frequencies

The ECAMs continuously sample the ambient environmental atmosphere at approximately 6.0 liters per minute under no load. Counts from the alpha-emitting radionuclides deposited on the ECAM filter are integrated over 240-minute windows for the determination of chronic air concentration and dose estimates. This window moves forward in time every minute in order to track these concentration and dose parameters in real time. Chronic dose estimates are based on the counts in the 240 minute window closest in time to the present. Chronic concentration estimates are based on the difference of the counts for the 240 minute window closest in time to the present and the counts for the previous non-overlapping 240 minute window. A separate short time frame window, typically 120 seconds, is also established for acute dose measurements. Each ECAM is polled by the data acquisition software residing on a host computer approximately every 15 minutes. The polling process uploads two text files, a chronic data log file and a spectrum file. The chronic data log file typically consists of 15 one-minute sets of measurement parameters described below in a comma-delimited format. The spectrum file also consists of a comma-delimited format and is typically an every 15 minute snapshot of the energy spectrum of the isotope of interest, usually Pu-239, and three short-lived radon progeny, Po-212, P-214, and Po-218. This energy spectrum is based on the differential of the cumulative spectra at the beginning and end of the 240 minute chronic window. The ECAM filters are changed out on a bi-weekly basis and are then archived.

3.4 Measurement Parameters

Several measurement parameters are provided by the ECAM system. The following measurement parameters are included in the chronic data log file:

- Date and time of measurement
- Cumulative filter time in hours and minutes
- Battery charge (percent of full charge)
- Goodness of fit (spectrum curve fit)
- Isotope of interest (typically Pu-239)
- Status (normal/calibration status, alarm status, failure status)
- DAC (derived air concentration)
- MDC (minimum detectable concentration)
- DACHr (DAC-Hour or dose)
- MDD (minimum detectable dose)
- Counts (raw counts under isotope of interest peak)

- Flow rate (lpm)
- Auxiliary channel
- Checksum

The following measurement parameters are included in the spectrum log file:

- Peak width coefficient (average of all peaks)
- Peak tail coefficient (average of all peaks)
- Peak area in counts (for isotope of interest and three radon progeny peaks)
- Peak channel number (for isotope of interest and three radon progeny peaks)
- Channel number, counts and fit for channels 0 through 255

3.5 ECAM Siting Evaluation Criteria

As the ECAMs are typically co-located with AIRNET stations, the primary ECAM siting evaluation criteria are determined through the AIRNET siting criteria SOP-5147, Evaluation of Sampler Sites Against Siting Criteria. Secondary criteria would be based on the desire to have real-time measurement capabilities in place at certain locations for situational awareness, typically downwind of the operation or facility.

4.0 ECAM SYSTEM PROCESSES

4.1 Project Management

The task leader provides management of the overall project by developing operating budgets, obtaining funding, developing milestones, and directing and tracking the completion of those milestones.

4.2 Siting an ECAM

ECAMs are sited as described above in section 3.5.

4.3 Deploying and Maintaining an ECAM in the Field

Deploying and maintaining an ECAM in the field are described in the Installing and Operating the Bladewerx SabreECAM Environmental Continuous Air Monitor procedure.

4.4 ECAM Data Acquisition, Storage, and Display

Data acquisition software, written in Visual Basic 2008, has been developed and implemented to acquire data from the ECAMs in the field. The software is designed to connect every 15 minutes to remotely located ECAMs, acquire environmental data, and store the data in a SQL Server data base located on a dedicated data base server. The software acquires environmental data, parses it for validity, logs data to the data base server along with any commentary (e.g., errors in parsing data). The software runs on a Windows PC using the MS XP Professional operating system.

Dynamic web display software, written in ASP.NET 2008, has been developed and implemented to display the ECAM environmental data in tabular or plot format via standard web browsers on the yellow network . The web pages allow users to select various time/date ranges and various presentation formats. Refer to http://camnet.lanl.gov/Description.aspx link for further information on what type of data is displayed on this web site. The software runs on a Windows server machine running IIS.

4.5 ECAM Data Review and Analysis

Data review and analysis steps for on call personnel are described in EDA-QP-229, On-Call Response To SabreECAM Off-Normal Notifications.

4.6 ECAM Calibration and Maintenance

ECAMs are calibrated and maintained by the RP-2 RIC team. The RP-2 RIC team uses RP-RIC-SOP-07, Safe Operating Procedure for the Central Health Physics Calibration Facility (TA-36-001 & 46).

4.7 ECAM Software/Hardware Procurement

In the event procurement of products or services is required by the project, project personnel follow the Institutional procurement processes as well as local requirements that may exist or apply to the project.

Procurement related tasks must include durations, dependent relationships, and milestones. The procurement specifications include quality requirements and as applicable safety and/or security requirements as well as methods for ensuring procured software meet the procurement specifications.

4.8 ECAM Software Development

Development and/or modification of software specific to data acquisition and display are controlled through the software configuration management system. This process is described in WES-EDA-CSPMP-3-Custom, Consolidated Software Project Management Plan, SabreECAM Data Acquisition and Web Display Software. Software specific to the ECAM remote data acquisition protocol is also controlled through the software configuration management system. This process is described in WES-EDA-CSPMP-SabreECAM Remote Data Acquisition Protocol-C3-Acquired, Consolidated Software Project Management Plan, SabreECAM Remote Data Acquisition Protocol.

5.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Data Quality Objectives are confidence levels on certain parameters in the data acquisition system that help to assure the user that correct and valid data are being received.

5.1 Spatial Boundary of the System

The spatial boundaries of interest for the ECAM measurements include the region surrounding or downwind of the particular remediation site or facility of concern.

5.2 Temporal Boundary of the System

Temporal boundaries of the system specified by sampling frequencies are described in section 3.3. Otherwise, the time frame for monitoring a particular remediation site or facility of concern would preferably be at least 3 months prior to start up of the operation to monitor background levels and deal with any logistical issues.

5.3 Practical Constraints on the System

Since this system is not mandated by any particular requirements, it is limited by:

- funding levels,
- equipment capabilities:
    - operating temperature range: 0 to 122 °F (-17 to 50 °C)

- operating humidity range: 5 to 95% (non-condensing), splash-proof electronics

- damage to stations due to weather, people, or animals, and
- damage to infrastructure due to weather, people, animals, power outages, etc.

5.4 Measurements to be made

Refer to section 3.4 of this document.

5.5 Comparability

Comparability is a measure of the confidence with which one data set can be compared to another. Comparability of the ECAM data is ensured because of the use of the same equipment, processes, and analytical methods at each station location. In addition, while no one station is directly adjacent to another, there is typically, based on ECAM siting evaluation criteria, an ECAM located in adjacent downwind sectors, that is useful for comparison in the event of an unplanned release close in to the station locations. However, these stations are not in close enough proximity to expect similar readings in the presence of a measurable concentration of an airborne transuranic radionuclide.

5.6 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions. Data may be lost due to equipment malfunction, power failure, station destruction, human error, or unacceptable data uncertainty. Chronic data log and spectrum completeness levels should be at least 95% over a rolling 12-month measurement period per ECAM station location based on either the real-time delivery of data or the ability to recover data from the ECAM buffer when communications are re-established in the event of a communications failure. Failure to achieve the minimum level will result in an investigation to determine the cause of the problem and the development of a corrective action plan to return the completeness level to at least 95%.

5.7 Timeliness

Timeliness of data delivery to the web display for viewing and interpretation is important because the real-time nature of the ECAM system is a unique capability. In addition, the ability to provide immediate notifications of off-normal status messages, i.e., high alarms, to project personnel via e-mail or commercial paging services is another unique capability. The acceptable level of data delivery timeliness to the web display is 60 minutes between the time of the ECAM generating the data and availability of the data on the web. The acceptable level of off-normal status message delivery timeliness is 60 minutes between the time of the ECAM generating the off-normal status message and receipt of the e-mail notification. There is no minimum acceptable level of timeliness for delivery of pages because this system is outside the control of the Laboratory. Failure to achieve the objective will result in an investigation to determine the cause of the problem and the development of a corrective action plan to return the timeliness to an acceptable level.

5.8 Precision and Accuracy

The ECAM was initially type tested in accordance with ANSI N42.17B, American National Standard Performance Specifications for Health Physics Instrumentation – Occupational Airborne Radioactivity Monitoring Instrumentation, and found to be in conformance with the coefficient of variation (precision) test requirements in section 5.4 of the standard and with the accuracy test

requirements in section 6.2 of the standard. However, these are one time tests only and do not reflect the long term stability of operating parameters of the ECAM units in the field.

An additional radiation source response check may optionally be performed during biweekly filter changes that tracks the stability of the radiation sensing and analysis portion of the ECAM unit. This check is described in section 4 of the user's manual entitled "Response Check Routine." The high and low limits are set within 20% of the source activity in dpm. An automated routine indicates whether the unit passes or fails the response check. A failure just outside the limits is not cause to take the unit out of service, but indicates a need to re-run the response check again. If the unit fails just outside the limits, the test may be repeated twice. If three failures occur in a row, the unit must be taken out of service and returned to RP-2 for inspection and calibration. A control chart should be maintained for each unit by serial number.

5.9 ECAM Operating Limits and Notifications

Certain operating limits of the ECAM are either "hard wired" into the ECAM software or are configured by the user. These limits define the normal operating boundaries of the ECAM. Any parameter that exceeds these limits will result in a notification to the user as a status message in the chronic data log. Certain status messages trigger either an e-mail notification or pager alert. The ECAM operating limits are specified below.

- Low Flow Limit: < 2.0 Lpm (action: remove unit from service and return to RP-2 for service)
- High Flow Limit: > 10.0 Lpm (action: remove unit from service and return to RP-2 for service)
- Low Flow Fail Limit: < 1.5 Lpm (action: remove unit from service and return to RP-2 for service)
- High Alarm (action: refer to on-call response SOP)
    - Chronic DAC-Hr: 2.0
    - Chronic DAC: 1.0
    - Acute DAC-Hr: 40.0
- Poor Fit: > 2 (action: remove unit from service and return to vendor for service)
- Detector Fail: no counts received from detector (action: remove unit from service and return to RP-2 for service)
- Low Battery: 6.7 Volts
- Internal Comm: no communications with SabreMCA (multichannel analyzer) (action: remove unit from service and return to vendor for service)
- Out of Calibration: > 180 days (action: remove unit from service and return to RP-2 for calibration)

6.0 CONFIGURATION MANAGEMENT

The production ECAM system has been rated at management level 3 in accordance with AP-341-02. To the extent possible, hardware, software, and services for the production ECAM system are procured at the ML 3 level. Because the system encompasses a wide range of sub-systems (refer

to figure in section 3.1 of this document) inside and outside the Laboratory outside the control of the project, it will not always be possible to procure hardware and software at this level, e.g., LANL network infrastructure (referred to as “backbone” in Figure), Verizon cellular services, commercial pager services. It is acceptable to procure less than ML 3 rated items for any part of the system that will not be deployed as long as the items are clearly marked or otherwise designated not for production use, e.g., development test bed units, and clearly segregated from deployed items.

6.1 Hardware

Hardware subject to configuration management requirements is the ECAM. Other hardware components of the ECAM system are either not within the control of the project or are standard off-the-shelf components such as cell phone modems, serial cables, desktop computers, servers, and network routers. The ECAM is the Bladewerx SabreECAM (model #BIN-SABR-ECM). The physical configuration of the ECAM is described in the Bladewerx SabreECAM Operations Manual and the Final Design Report, SabreECAM. A list of spare parts with part numbers for the SabreECAM is provided in Appendix A. Replacement parts shall either be those specified in the spare parts list or those specified by Bladewerx as suitable substitutes. Replacement parts may be acquired directly from Bladewerx or from another vendor as long as it is a “like-for-like” replacement verified through matching model numbers or other means.

Modifications must not be made to the ECAM unless approved by Bladewerx. If the modification could affect the performance of the ECAM, appropriate sections of the type test specified in ANSI N42.17B must be performed to ensure that performance has not been degraded, e.g., if the sample head has been modified such that aerosol collection could be impacted, an aerosol penetration test specified in ANSI N42.17B must be performed and evaluated.

6.2 Software

Software configuration management is implemented in accordance with the intent of PLAN-3001, EP Directorate Software Configuration Management (SCM) Plan. There are two primary software programs that fall under SCM, the custom SabreECAM data acquisition software and the web display software. The data acquisition and web display software have been categorized as non-safety grade and risk level 3. Consolidated software project management plans have been developed and implemented for these software programs and are listed in the references section.

The SabreECAM operating system software, which includes the RDAP, calibration routines, and analysis routines, is identified by a version number. Each ECAM is labeled on its exterior with the version number of the operating system software and the version number is separately tracked for each SabreECAM via a spreadsheet or other mechanism.

All software under the control of the project that could affect the operation of the ECAM system is first tested on a parallel development platform prior to migration to the deployed system. This pre-deployment software is subjected to the appropriate tests specified in the consolidated software project management plans that were affected by the version upgrade before migration to the fielded system. However, the calibration and analysis routines contained within the SabreECAM operating system software are generally tested by the performance of the radioactive source energy and efficiency calibrations and the pump flow calibration. Successful completion of these calibrations by the RP-2 RIC team is sufficient and no further software testing of these routines is necessary.

6.3 Calibration

Only ECAMs that have a current RP-2 RIC team calibration sticker are fielded. The radioactive source used for performing the efficiency calibration shall be traceable to NIST. The radioactive

source and pump flow calibration is valid for 180 days and the valid calibration period is indicated on the RP-2 RIC team calibration sticker affixed to the ECAM housing. If an ECAM is left in the field beyond the valid calibration period, the data provided by that ECAM may be accepted for use if an acceptable source response check is performed before the ECAM is removed from the field and documented in the logbook. The review validates that the instrument was performing within normal bounds.

6.4 Alarms and Other Limits

Modifications to alarm and other limit set points as specified in section 4.9 of this document may be made if documented in the system logbook with appropriate calculations and/or justifications. The logbook entries documenting the modifications must be approved via the signature and date of the project task leader prior to implementing them in the production system.

6.5 Chain-of-Custody (COC)

Unlike the AIRNET system, there is no requirement to maintain COC for ECAM filters. These filters are not routinely sent to an off-site vendor laboratory for further analysis. The activity on the filter is analyzed in real time and automatically recorded in the database. On occasion, there may be a need to have an individual filter analyzed by the RP-2 Health Physics Analysis Laboratory (HPAL) for verification of transuranic activity on the filter. However, this process is handled on an informal basis.

7.0 TRAINING

All personnel performing ECAM-related work obtain appropriate training prior to performing work governed by a procedure. Training is performed and documented according to EP-DIR-SOP-2011, Personnel Training and Qualification. Personnel working for the ECAM project must understand the basics of radiation measurement and air sampling, and understand the general operation of the system. Individuals performing data review and interpretation must have additional education and/or experience as health physicists or environmental scientists. Documentation of education and training qualifications is maintained by the LANL Human Resources Department via the Employee Development System (EDS), Workforce Capabilities Interface (WCI), and the Education and Qualification view within the Oracle E-Business Suite.

8.0 DOCUMENTATION AND RECORDS

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

The following records are kept:

- logbook entries and/or field forms to record status of ECAM system performance,
- data assessments and assumptions,
- internal training documentation (e.g., on-the-job training forms), and
- general correspondence that affects the system

The following records are kept by RP-2 RIC:

- ECAM calibration and maintenance procedures,
- ECAM calibration and maintenance records,
- radioactive calibration source certificates, and
- laboratory instrument calibration and maintenance records.

The LANL Performance Feedback and Improvement Tracking System (PFITS) is used to document and track to closure, those quality affecting problems at the level of a non-conforming item as specified in P330-6, Nonconformance Reporting. All other quality affecting problems of lesser significance may be documented and tracked to closure using tracking systems internal to the project.

9.0 REFERENCES

AP-341-502, Management Level Determination for Structures, Systems, and Components.

SD330, Los Alamos National Laboratory Quality Assurance Program (LA-UR-07-0503)

P330-6, Nonconformance Reporting.

RP-RIC-SOP-07, Safe Operating Procedure for the Central Health Physics Calibration Facility (TA-36-001 & 46).

EP-DIR-SOP-2011, Personnel Training and Qualification

SOP-5147, Evaluation of Sampler Sites Against Siting Criteria

PLAN-3001, Environmental Programs Directorate Software Configuration Management Plan.

ANSI N42.17B-1989, American National Standard Performance Specifications for Health Physics Instrumentation – Occupational Airborne Radioactivity Monitoring Instrumentation, March 28, 1990.

WES-EDA-CSPMP-SabreECAM Remote Data Acquisition Protocol-C3-Acquired, Consolidated Software Project Management Plan, SabreECAM Remote Data Acquisition Protocol.

WES-EDA-CSPMP-3-Custom, Consolidated Software Project Management Plan, SabreECAM Data Acquisition and Web Display Software.

Bladewerx SabreECAM Operations Manual, version 1.0, September 19, 2006.

Final Design Specification, SabreECAM, (Bladewerx Model #BIN-SABR-ECM).

WES QP-229, On-Call Response To SabreECAM Off-Normal Notifications.

WES QP-230, Installing and Operating the Bladewerx SabreECAM Environmental Continuous Air Monitor.

APPENDIX A — *Bladewerx SabreECAM Spare Parts List*

Filters, Qty. 100 Bladewerx PTFE 1.5 µm pore 37mm (for flow rates below 10 LPM)	BSP-FILT-B037-15
Filters, Qty. 100 Bladewerx PTFE 5.0 µm pore 37mm (for flow rates above 10 LPM)	BSP-FILT-B037-50
Filter Support, pkg. of 10	BSP-SPRT-037
Pump, 6.0VDC 6LPM	BSP-PUMP-6L
Battery, 4150 mAh Li-Ion	BPT-LION-4100
Detector, Ion-Implanted Solid State, 450 mm^2	BPT-DETC-SD450
Fingertip3 Board, WinCE 4.2, pre-installed SW	BPT-FT3-ECAM
Memory Stick with current version SabreECAM software	BSP-MUPD-ALT
SabreMCA board	BSP-SMCA-A1
SabreAUX board	BSP-SAUX-A1
Sabre Preamp board	BSP-PAMP-P1
AC charging Adapter for SabreECAM	BPT-ACADP-1222
Flow Calibration Aid for SabreECAM	BPT-FLOW-AID1

Note: Specification for Bladewerx SabreECAM is delineated in “Final Design Specification, SabreECAM, (Bladewerx Model #BIN-SABR-ECM)” on file in project documentation.