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Los Alamos
National Laboratory

Risk Reduction and Environmental Stewardship Division

Meteorology and Air Quality Group (MAQ)

Quality Assurance Project Plan

for the

Direct Penetrating Radiation Monitoring Network (DPRNET)

Prepared by: _____ Mike McNaughton, DPRNET Project Leader	Date: 4/3/02
Reviewed by: _____ Terry Morgan, QA Officer	Date: 4/3/02
Approved by: _____ Jean Dewart, MAQ Acting Group Leader	Date: 4/11/02

Table of Contents (A2)

Appendices This plan has the following appendices:

Distribution List (A3)

List of document recipients

This document will be controlled under the organization's document control system (RRES-MAQ-030) which will ensure that those performing work for the project will receive a controlled copy and all revisions. Those who will receive a controlled copy include:

- MAQ Group Leader
- MAQ QA Officer
- MAQ DPRNET Project staff members
- MAQ DPRNET Project technicians
- Assistant Area Manager, Office of Environment and Projects, DOE Los Alamos Area Office

Introduction

History of revision

This table lists the revision history of this plan.

Revision	Date	Description Of Changes
0	2/5/87	Original issue.
1	--	Document not available.
2	1/10/90	
3	5/15/91	
4	11/17/95	Extensive revisions, revised into R-5 format.
5	4/15/02	Combined DPRNET-CD plan and extensively updated to reflect use of new dosimeter type.

Purpose of this plan

This Quality Assurance Project Plan was developed to comply with group, laboratory, and DOE requirements for quality assurance plans. This plan also implements requirements for the TLD monitoring. It is patterned after the EPA QA/R-5 guidance for quality assurance project plans and also meets requirements of DOE Order 414.1A *Quality Assurance*.

This Quality Assurance Project Plan is tiered to the MAQ Quality Management Plan (MAQ-QMP) which, together with this plan, ensures that the project addresses all requirements through formal and consistent processes that define the project's mission, the organizational structure, functional responsibilities, levels of authority, and interfaces for managing, performing, and assessing the quality of work within the project.

Standard for this plan

The contents of this plan are based on the standard given in the document "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," EPA QA/R-5, Interim Final, January 1994.

Project document structure

The project quality management system consists of:

- MAQ Quality Management Plan
- QA Project Plan for the DPRNET Project (this document)
- implementing procedures

Introduction, continued

The structure of this plan is based on the following classes of 24 elements in EPA QA/R-5:

- Project Management (A1 through A10)
- Measurement and Data Acquisition (B1 through B6)
- Assessment and Oversight (C1 through C2)
- Data Validation and Usability (D1 through D3)

Revising this plan

This plan will be controlled through the MAQ document control process (RRES-MAQ-030).

The DPRNET Project Leader, a chosen reviewer, and the group leader will approve all revisions to this plan.

Project Organization (A4)

Group organization

The Air Quality Group (RRES-MAQ) of the Risk Reduction and Environmental Stewardship (RRES) Division is responsible for the DPRNET at Los Alamos National Laboratory (LANL). See the Group Quality Management Plan (MAQ-QMP) for a description of the group organization, chain of authorities, and lines of communication. MAQ is organized into two general areas: the Regulatory and Line Services team and the Institutional Monitoring and Surveillance team. These teams are further organized by project function. However, all work remains under the line-management direction and responsibility of the group leader. Project teams are guided by project leaders who have the ultimate responsibility to ensure the project is completed. The DPRNET Project falls under the Institutional Monitoring and Surveillance team.

Project organization

The DPRNET project leader manages the operation of the DPRNET project. A group QA specialist is assigned to work for the project leader to provide quality assurance assistance, advice, and review. Members of the group work for the project leader to collect samples, process collected samples, and provide dose assessment and data evaluation. In addition, representatives from other groups may participate and contribute to this team.

Approval of final products and deliverables

Final products and deliverables resulting from the DPRNET, in the form of exposure summaries by location, will be approved by the DPRNET Project Leader. Final results are used in the annual Environmental Surveillance Report and data summaries are available on the Internet and reported to the group leader.

Problem Definition and Background (A5)

Problem definition

LANL has several sources of external penetrating radiation that could contribute a measurable dose to the environment.

Monitoring of these facilities and of the general environment around the Laboratory is required by the Department of Energy (DOE). DOE Order 5400.1, *General Environmental Protection Program*; DOE Order 5400.5, *Radiation Protection of the Public and the Environment*; and DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, requires and recommends, respectively, that DOE-owned facilities measure external penetrating radiation to gather the following information:

- background radiation levels in the area
- the site contribution to the surrounding environment
- compliance with DOE radiation protection standards
- the occurrence and magnitude of unplanned releases

Measurements are made to monitor activities at LANL. The results are used by the Meteorology and Air Quality group and the operating groups that conduct the monitored activities to assure compliance with applicable requirements, to determine background radiation levels, and to determine the LANL contributions to the surrounding environment. Additionally, this information is recorded in the annual Environmental Surveillance Report (ESR). The operating groups are informed of any trends or unusual results so that any needed changes can be made to operations to mitigate the magnitude and/or effect of their operations. In general, the Environmental TLD Surveillance project supplements other LANL monitoring systems. It can also indicate unexpected or unusual changes in environmental external penetrating radiation levels that are not monitored by other means.

Problem Definition and Background (A5), continued

Decision makers

The principal decision-maker is the DPRNET Project Leader.

Report of results

A quarterly report with the analytical results of the DPRNET measurements will be placed on the internet. Data will be included in the annual report *Environmental Surveillance at Los Alamos*.

Project Description (A6)

Purpose of the project	The Environmental TLD Project is intended to comply with the requirements of DOE Order 5400.5 and the guidance of DOE/EH-0173T.
Measurements to be made	The DPRNET project measures direct, external penetrating (photon and some neutron) radiation levels at or near natural background levels using TLDs at locations around the laboratory (see the section on siting).
Applicable regulatory quality criteria	DOE Order 5400.5 requires the monitoring of external penetrating radiation. The guidance for implementing the monitoring project is in DOE/EH-0173T. Quality assurance requirements and guidance for this project come from DOE Order 414.1A, *Quality Assurance*. Because the DPRNET project is an environmental data collection operation, the EPA QA/R-5 guidance for quality assurance project plans has been adopted as the format and content guide for this project plan.
Special personnel requirements	Trained technicians perform the replacement of the DPRNET dosimeters in the field, readout and annealing of the dosimeters, placement of dosimeters in new locations, and preliminary data reduction activities through the use of computer software and codes.

Project Description (A6), continued

Special equipment

The project uses standard, commercially available materials and equipment that respond to both photons (gamma radiation) and neutrons. Currently, the group uses the "8823" albedo dosimeter from HSR-4. This dosimeter contains TLD chips that respond to photons and neutrons

Assessments and reviews

Periodically, this project will be assessed according to RRES-MAQ-029 ("Management Assessment") for any applicable regulations, the MAQ-QMP, implementing procedures, and the requirements found in this project plan.

Schedule for the monitoring

The monitoring of environmental penetrating radiation is an ongoing project at LANL. The dosimeters are changed out every calendar quarter and immediately after an unexpected release and unplanned or special events.

Required records

Several records will be generated as a consequence of the project. They include quarterly raw TLD data and analyses consisting of integrated output for each TLD, the resulting dose for each TLD (millirems, mrem), and summaries of the dose (average) and standard error for each station. Other records will include a database and logbooks that contain calibration data/information and field data sheets used during dosimeter change outs. HSR-4 maintains records on the reading of the badge dosimeters. See the sections *Documentation and Records (A10)* and *Reports to Management (C2)*.

Quality Objectives and Criteria for Measurement Data (A7)

What are DQOs?

Data quality objectives (DQOs) are qualitative and quantitative statements derived from the DQO process that:

- clarify the study objective
- define the most appropriate type of data to collect
- determine the most appropriate conditions from which to collect data
- specify tolerable limits on decision errors.

The DQOs are then used to develop a scientific and resource-effective data collection design.

Problem statement

Los Alamos National Laboratory has operations that may produce external penetrating radiation to the public and environment. DOE Orders 5400.1 and 5400.5 require environmental radiological monitoring and surveillance to ensure doses to the public are not exceeded. DOE/EH-0173T provides guidance for implementing these DOE orders.

NOTE: The AIRNET project is designed to measure air pathway dose contribution (alpha, beta, and gamma) from air particles and tritium, but it cannot measure direct penetrating radiation. The DPRNET project measures this direct penetrating radiation.

Decision

Principal Study Question

What is the Laboratory's contribution of radiation dose to the public and environment from external penetrating radiation?

Alternative Action Resulting from the Study Question

If Laboratory external penetrating radiation emissions are found to be a contributing factor to a high public and environment dose, then action will be taken to reduce the Laboratory emissions or operations.

Quality Objectives and Criteria for Measurement Data (A7), continued

For example, Laboratory external penetrating radiation emissions could be reduced by:

1. Applying ALARA principles at the source.
2. Cleaning up and remediating waste and spill sources.
3. Applying engineering and administrative controls at facilities.
4. Stopping external radiation-producing operations.

Combined Principal Study Question and Alternative Action

Determine whether Laboratory contributions to the external penetrating radiation doses received by the public and environment are within DOE requirements.

Inputs to decision

Information Required to Resolve the Decision

The external penetrating radiation (photon and neutron) dose at the Laboratory boundary and perimeter are needed to resolve the decision.

Supporting information to this statement are:

- Location of Laboratory devices and sources producing external penetrating radiation
- Location of public receptors
- Location of natural and man-made radiation shields
- Location of active and inactive radioactive material disposal areas
- Operating schedule of LANSCE
- Knowledge of neutron producing facilities
- On and offsite topography
- Knowledge of solar storms, as needed
- Knowledge of locations of on-site LANL worker exposures

Sources of Each Item of Information

The TLD monitoring and surveillance network radiation detection instruments and historical measurement data are the main sources of information.

This statement is supported by the following information sources:

Quality Objectives and Criteria for Measurement Data (A7), continued

- DOE/EH-0173T
- US, New Mexico, and LANL geological surveys
- Laboratory operating groups
- Laboratory, state, county, and local community maps
- Area topographic maps, Laboratory building maps, and visual surveys
- Active TLD measurements, radiation detection instruments, and historical measurement data
- Waste operations group, present working knowledge, and historical information
- Environmental Restoration survey reports, and historical information
- LANSCE operating group
- TA-18 facilities
- US Geological Survey topographic maps
- MAQ meteorological team
- US Weather Service
- Historical data
- Radiation Protection Manager for worker exposures

Information Needed to Establish Action Level

DOE Order 5400.5 (Radiation Protection of the Public and the Environment)

Confirm that Appropriate Measurement Methods Exist to Provide Necessary Data

DOE/EH-0173T identifies several instruments (e.g., PICs and TLDs) suitable for use in environmental monitoring and surveillance projects. TLDs are suitable for ongoing environmental dosimetry at DOE facilities because of extensive scientific testing, proven record, and low operational costs.

The lower limit of quantification for environmental LiF TLD analytical systems is about 10 mrem. This value is consistent with operational experience.

Study boundaries

The Parameter of Interest

The parameter of interest is the environmental external penetrating radiation levels contributed by the Laboratory to offsite areas.

Quality Objectives and Criteria for Measurement Data (A7), continued

Spatial Boundary of the Study

Between the Laboratory boundary (0 km) and the surrounding regions (<80 km) is where members of the public live and work, and where the collective dose to the public is evaluated (DOE Order 5400.5 Chapter II Section 6b). In practice, the inverse-square law and absorption in the atmosphere limit the dose at larger distances. In the past at Los Alamos, TLDs have not been able to measure a dose beyond 0.5 km from the source. In the case of an unplanned release, the TLD data would need to be combined with data from AIRNET. Therefore, TLDs will be deployed as follows:

- 0-1 km: stand-alone monitors
- 1-80 km: only at AIRNET stations

Temporal Boundary of the Study

The TLD data will be collected on a calendar quarter basis to evaluate the doses of external penetrating radiation to the environment and public.

The Scale of Decision Making

Decisions will be made at each location.

Practical Constraints on Data Collection

- Accessibility to monitoring sites
- Adverse weather during field collection
- Potential loss of dosimeters or data due to animals, people, or weather

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Decision rule

Statistical Parameter that Characterizes the Population (Parameter of Interest)

The parameter of interest is the quarterly dose equivalent of external penetrating radiation measured at each of the monitoring locations.

Action Level

The action level will be a measured total dose of 65 mrem on any dosimeter during a quarter. This action level does not mean the dose requirement has been exceeded, only that the dose is approaching a level where it is *possible* that the requirement could be exceeded.

Quality Objectives and Criteria for Measurement Data (A7), continued

Decision Rules

If the action level is reached for any dosimeter during a quarter, the results will be compared to applicable historical data and professionally evaluated to determine if the DOE dose requirement is being or is likely to be exceeded. If so, LANL will take appropriate action (if possible) to remain within the dose requirement.

Tolerable limits on decision errors

The action level is set relatively low and it is unlikely that a net LANL dose of over 100 mrem in a year to anyone would be missed. The decision errors that could occur are 1) deciding that compliance has not been achieved when it truly has, and 2) deciding that compliance has been achieved when it truly has not.

The consequences of error 1 are that LANL would unnecessarily commit added resources to achieve compliance. The consequences of error 2 are that a later determination of noncompliance could result in violating a DOE requirement or, potentially, in further litigation. Thus, error 2 is considered to have the more severe consequences. Therefore, it is in the best interest of LANL to not exceed any dose limits.

Criteria for measurement data

The determination of whether LANL has met the dose requirement is based on the magnitude of valid data. The criteria that may be used to determine the validity and magnitude of data include precision, accuracy and bias, and uncertainty. Each of these aspects is discussed in the following subsections.

Representativeness

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

To representatively measure the dose equivalent at the measuring station, measurement locations will be selected based on the siting criteria given in the section *Sampling Process Design (B1)*, "Dosimeter micro-siting," page 22. At any particular site, measurements will be representative of the quarterly external dose one would receive if continuously present at that location.

Quality Objectives and Criteria for Measurement Data (A7), continued

Comparability

Comparability is a measure of the confidence with which one data set can be compared to another.

Because several factors affect the amount of penetrating radiation which actually reaches the dosimeters (e.g., elevation, soil moisture, etc.), dose measurements from one site may not be directly comparable with those from another site unless additional calculations or conversions are made.

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. A measurement is considered complete if the measurement was taken, measurement data were generated, and if all data generated are determined to be valid.

The possibility exists for the loss of some of the dosimeters. Dosimeters have been lost to curious public, construction, and weather. Occasionally, data may also be lost because of dosimeter degradation, equipment failure, and collection problems.

Completeness criteria

Completeness will be determined by the number of valid measurements recovered during a quarter. The annual completeness criterion is 90%.

Precision

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed conditions. It refers to the difference in a measured value that could occur if the same analysis were performed again on the same sample with no change in conditions. Precision is typically expressed mathematically in terms of the standard deviation or derivative values such as coefficient of variation or percent standard deviation.

The precision of the measurement process is affected by processes such as: sample collection, sample handling and storage, analysis, and data processing.

For this project, the precision of the data is reviewed at two stages in the measurement process, as described in the next two subsections.

Quality Objectives and Criteria for Measurement Data (A7), continued

Criteria for precision of dosimeter measurements

The first review of the precision of measurement is the chip-to-chip variability of the individual chips in each dosimeter. The variability comes from differences in chip efficiencies and the reading processes.

The criterion for dosimeter precision is that the coefficient of variation among chips #1, #6, and #7 must be less than 30%. If the coefficient of variation exceeds this value, the data will be considered imprecise, and causes will be determined and corrected to the extent practicable. The validity of such data will be determined by professional evaluation.

The coefficient of variation is defined as:

CV% = [100*(standard deviation)/(mean value)]

Where:

- standard deviation: $s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})}$
- mean value is the mathematical average of the chip readings

Criteria for precision of duplicate measurements

The second review is of the precision of LANL duplicate dosimeters placed side-by-side in the field. This review evaluates the overall precision of data for the entire measurement system. The data variability results from variability in all parts of the system: environmental exposure, sample collection and storage, variability in chip efficiencies, and the reading processes.

If the difference between a field dosimeter and a duplicate at the same monitoring location is more than 10 mrem, the process will be considered to be generating imprecise data, and causes will be determined and corrected to the extent practicable.

Accuracy and bias

Accuracy is the degree of agreement of a measured value with the true value.

One component of accuracy is bias (EPA QA/G-4), which may be present if there are systematic differences between measured and expected values. Bias can be estimated by comparison of the values measured by multiple dosimeters with the expected values. The discussion below describes the process used for these measurements.

Quality Objectives and Criteria for Measurement Data (A7), continued

Criteria for accuracy and bias

Dosimeters that have been exposed to a known radiation field accompany field dosimeters. The overall bias is determined as outlined in ANSI N13.29-Draft.

ANSI N13.29-Draft calls for the determination of a "performance quotient" and establishes the bias as the average of the performance quotient from each QC dosimeter read. ANSI N13.29-Draft requires the performance quotient to be less than or equal to 0.35 (i.e., ≤35% of the expected exposure or dose equivalent).

The performance quotient is defined as:

$$P = (H' - H)/H$$

Where:

- H' is the reported exposure or dose equivalent, and
- H is the expected exposure or dose equivalent

In addition to the bias determination, ANSI N13.29-Draft also sets limits for the standard deviation of the performance quotient at ≤0.35 and when combined with the absolute value for the bias, the tolerance level for field measurements is 0.5.

For this project, bias will be calculated as described in the ANSI standard.

Uncertainty

Uncertainty is an indication of the variability associated with a measured value that takes into account two major sources of error: (1) bias, and (2) precision (random error attributed to the imprecision of the measurement process).

Criteria for uncertainty

Each measuring station must be able to measure levels around 30 mrem per quarter. The total uncertainty of the measurements must be under 10 mrem when measuring levels less than 100 mrem and under 10% for levels over 100 mrem.

Special Training Requirements and Certification (A9)

Required personnel training and education

Personnel working for the project must understand the basics of radiation measurement, have a high school-level knowledge of basic physics, and understand the general operation of the TLD system. Data interpretation personnel must have additional education and experience as health physicists. Documentation of education qualification is maintained by the LANL Human Resources Division and in accordance with the MAQ Quality Management Plan (MAQ-QMP).

All personnel performing project-related work are required to obtain appropriate training prior to performing work governed by a procedure. Training for MAQ personnel will be performed and documented according to the MAQ procedures "Personnel Training" (RRES-MAQ-024) and "New Employee Orientation" (RRES-MAQ-032). Training of personnel in other groups will be performed and documented according to the appropriate group's training procedure.

Documentation and Records (A10)

Records resulting from the project

The number, type, and detail of all records to be kept will provide sufficient information to allow an individual with equivalent education and training to verify or reconstruct the results. All implementing procedures are required to specify the records, forms, logbook entries, or other information to be kept as documentation of the performance of the procedure.

Records to be kept include:

- Logbook entries and/or field forms to record sample collection
- Updates of the siting study
- Calibration of the dosimeters
- Integrated output from the TLD reader
- Resulting dose equivalent value
- Interpretation of the results
- Data sheets showing data reduction and the techniques used
- TLD database with specific dosimeter and station information
- Results of personnel dosimetry record review

The documentation and records generated by this project are maintained by the MAQ records manager according to RRES-MAQ-025 ("Records Management"). Logbooks are maintained according to RRES-MAQ-011 ("Logbook Use and Control").

Procedure development

Procedure RRES-MAQ-022 ("Preparation, Review, and Approval of Procedures") specifies the process to develop all implementing procedures for this project.

Document control system

MAQ operates a document control system to control and manage the distribution of procedures and plans that govern work or specify requirements to those who perform the work. Procedure RRES-MAQ-030 ("Document Distribution") describes the process for procedure and plan distribution.

Sampling Process Design (B1)

Sampling system design

The function of the project is to measure the direct external penetrating radiation dose from photons and neutrons in mrem for the Los Alamos area. The goal of the project is to provide measurements of the combined direct, external penetrating radiation dose from background, any LANL contribution, and other sources.

Types of samples

The types of externally penetrating radiation that are monitored are photons and neutrons.

Sampling frequencies

The dosimeters are routinely deployed on a calendar quarter basis.

Sample matrices

The LANL-model-8823 badge-type of dosimeter consists of eight TLD chips as described in ESH4-PDO-TBD-02.

For neutron measurements, the albedo dosimeter consists of a model-8823 dosimeter mounted on a 4-inch-thick hydrogenated slab of Lucite or polyethylene.

Measurement parameters

Dose equivalent in terms of mrem is the resulting parameter from this project. The project measures the external penetrating radiation exposure in air. After exposure in the field, the TLDs release light when heated in a reader. The light output is converted to electrical current which is measured over discreet time intervals. The resulting charge in nanocoulombs is related to the exposure of the TLDs in roentgens (R). A computer program converts the charge value to dose equivalent (mrem) through conversion factors and the calibration data for the dosimeters (see procedure RRES-MAQ-221, “Using the TLDNET Database”).

Dosimeter siting

The siting criteria and the specific locations of the DPRNET dosimeters are specified in the report *Siting of Environmental DPR Dosimeters*, LA-UR-00-1168. This report will be updated by the DPRNET Project Leader at least every 2 years.

Sampling Process Design (B1), continued

Dosimeter micro-siting

The "micro-siting" locations use applicable criteria given in DOE/EH-0173T. Some of the criteria that may be used include (where practicable) locating dosimeters about one meter (±0.3 m) off the ground in areas that are reasonably flat and in areas away from structures that could shield or reflect radiation. The dosimeters are typically attached to stakes, small trees, bushes, or fences about 1 meter above ground. A map or list of all the monitoring locations will be maintained by the project leader.

Analysis frequency

Normally the dosimeters will be collected and analyzed or read quarterly. Dosimeters may be collected earlier or later than the end of the quarter, due to scheduling problems. On rare occasions, dosimeters may be left in the field for more than one quarter.

Sampling Methods Requirements (B2)

Monitoring methods

Measurements of external penetrating radiation are made for a calendar quarter by placing the TLD in the ambient air about one meter above ground in an open area at each monitoring station (see the section *Sampling Process Design (B1)* for more details).

Sample preservation methods

Collected dosimeters will be transported in a cooler and kept out of the sun and other hot locations.

The badge dosimeters will be delivered to HSR-4 for processing immediately after collection.

Sample holding times

The maximum holding time from retrieval until delivery to HSR-4 normally will be seven days. Appropriate adjustments for fade or exposure are made by using control dosimeters so the results are not sensitive to the holding time.

Sample Handling and Custody Requirements (B3)

Sample handling

At the beginning of the calendar quarter, the changeout of the DPRNET monitoring stations begins. Uniquely identified dosimeters are exchanged for others at each monitoring station. Each changeout is recorded along with any unusual events. Since the dosimeters are sealed containers, ambient weather conditions (humidity, rain) are not important. During the changeout and back at the TLD laboratory, the dosimeters are always under the control of the DPRNET technician(s). A record in the logbook or an electronic printout will be made to indicate who participated in the changeout, station locations changed, and dates. All of the dosimeters are processed at LANL. When comparisons with other systems or vendors are conducted, those dosimeters will be returned for processing to their respective sources. The dosimeter changeout is described in procedure RRES-MAQ-210 ("Placing and Retrieving Field Dosimeters").

Temperature control

Because excessive heat could re-anneal the chips, dosimeters will not be left on counter tops where sun could warm them and will be transported in coolers and kept out of warm environments.

Sample tracking

Samples are tracked using either "Field Data" sheets or a portable computer/bar code reader. These data sheets or a printout from the computer indicate which station was visited, which dosimeter was retrieved and deployed, dates and times, and any anomalies found (procedure RRES-MAQ-210, "Placing and Retrieving Field Dosimeters"). Back at the reading lab, these data assist in entering the relevant information into the TLD database.

Sample control

Sample control is maintained by the technician performing the changeout. The badge dosimeters are delivered to the analytical laboratory group for reading.

Analytical Methods Requirements (B4)

Monitoring analytical methods

Thermoluminescent dosimeters (TLDs) are used in the DPRNET project. To get the exposure information, the chips are heated in a reader. When the chips are heated, light is released in proportion to the radiation absorbed. The resulting light from the chip is converted via a photomultiplier tube to an electrical charge measured in nanocoulombs (nC) and through the use of a computer database, into a measurement of dose equivalence (mrem). If a malfunction of the reader is detected, the technician will stop the processing of dosimeters, repair the reader as necessary, bring it back to proper operating specifications, and contact his or her supervisor for further instructions.

Quality Control Requirements (B5)

LANL field QC

Additional precision checks of the measurements will be provided by five stations that will have side by side measurements (that is, two or more sets of dosimeters or duplicates). Differences in sample results throughout the year can be due to (1) natural variations, or (2) random errors in measurement of the dose.

Laboratory QC

Checks of TLD reader instrumentation at the TLD laboratory consist of reference test light readings, photomultiplier tube (PMT) noise readings, and readings of irradiated and unirradiated (blank) TLD chips.

Data Management (B6)

Data transfer and management

The DPRNET database is a relational Microsoft Access database that resides on the network drive for MAQ and is backed up at least weekly (RRES-MAQ-034, "Computer Network Server Backup").

Data are transferred to the database as soon as they are available. To keep the number of data entry errors to a minimum, the data are normally transferred by electronic files. In some cases, data will have to be manually entered into the database and electronically stored. All data entered into the database will be reviewed as outlined in RRES-MAQ-221.

Database calculations

On a quarterly basis, reports of the dose equivalent and environmental exposure due to external penetrating radiation are generated and transmitted to the DPRNET team for evaluation, interpretation, and a completeness review. Once the data in the reports have been thoroughly analyzed and deemed acceptable, they are transmitted to the project leader.

Data reports are filed in the MAQ records center following RRES-MAQ-025 ("Records Management"). Resulting readouts from the TLD chips and the information generated during the running of the data reduction/dose conversion codes are backed up quarterly soon after the TLDs are read for that quarter.

Assessments and Response Actions (C1)

Internal management assessments

Internal management assessments will be conducted in accordance with the MAQ QMP and procedure RRES-MAQ-029 ("Management Assessments"). This procedure requires periodic assessments by the group leader of the effectiveness of programs or projects. These assessments are documented and filed as records.

LANL required audits

LANL audit groups external to MAQ may be delegated responsibility for assessments of the DPRNET project.

MAQ requested audits

The MAQ Group Leader may request assessments of any program or project within MAQ. These assessments may also include MAQ assessment of organizations which supply information to MAQ (e.g., LANSCE or TLD analytical laboratory).

Corrective actions within MAQ

The group has adopted the word "deficiency" to replace other commonly used terms such as finding, condition adverse to quality, and nonconformance. The group QMP defines a ***deficiency*** as a malfunction of a process that negatively impacts the quality specifications of MAQ products.

MAQ will document and track external and internal audit findings, or other deviations from requirements found during an audit or assessment, as deficiencies. The deficiency, corrective actions, and any resulting root cause analyses, follow-ons, and closures, will be handled in accordance with RRES-MAQ-026 ("Deficiency Reporting and Correcting").

Trending deficiencies

Periodically, the project leader will review the deficiency reports and other records of equipment problems to look for trends in the occurrence of deficiencies. Trending is intended to determine the existence of systematic design or implementation problems. The trending analysis results will be documented in a memo or report, forwarded to the responsible managers, and copied to the records system for filing as a record.

Assessments and Response Actions (C1), continued

Intercomparison evaluations

On an irregular basis, the DOE sponsors International Environmental TLD Intercomparison Studies. There have been twelve so far, the latest in 2001. These intercomparisons show that the LANL TLD dosimeter project results compare well with the results of other such projects world-wide. The DOE correspondence detailing the intercomparisons and results are maintained in the MAQ records room.

Reports to Management (C2)

DPRNET reports

Each quarter following readout of the TLDs, a report will be prepared and the data will be placed on the internet. Additional reports may be issued as needed or as requested by management.

Data Review, Validation, and Verification Requirements (D1)

Criteria used to accept, reject, or qualify data

All data will be evaluated for one of three outcomes: accept, qualify, or reject. Data evaluation will include:

- Reviewing data to ensure there are no data entry errors
- Determining if any data are missing
- Evaluating the chip-to-chip variation within each dosimeter
- Comparing the dose equivalent to historical values
- Evaluating duplicate dosimeters used in the TLD monitoring network
- Evaluating QC dosimeters
- Determining whether approved handling and readout methods were used
- Checking the total uncertainty of the dose equivalent

The limits for acceptability are given in the section *Quality Objectives and Criteria for Measurement Data (A7)* (starting on page 11) and the methods used are explained in the next two sections: *Validation and Verification Methods (D2)* and *Reconciliation with Data Quality Objectives (D3)*.

Data types to be evaluated

Data will be evaluated each quarter after dosimeters are read and dose equivalents are calculated. Much of the evaluation information is obtained through database calculations and database query reviews. The types of data that may be evaluated are:

- Issue/pickup field data
- Reader output data
- Dose equivalent data
- QA/QC data

Data reporting

TLD reader data are in units of nanocoulombs (nC) or Cs-137-equivalent dose. Calculated dose equivalent data are expressed in units of millirem (mrem).

Validation and Verification Methods (D2)

Evaluation of data

The data types listed in the previous section will be evaluated after collection each quarter to determine if they are acceptable, qualified, or rejected (invalid). All data not meeting the established criteria will be marked as needing further evaluation and their final acceptability determined.

Data entry

Errors in data entry may be evaluated using the DPRNET database. This database is designed in such a way that errors in the Issue/Pickup table or the Reader Output table will show up as blank lines in the query for all quarterly data. If there is a blank line in this query, assignable causes will be determined and appropriate corrections will be made and documented in the database.

Missing data

Each monitoring location should have a dosimeter assigned for each field cycle (normally one quarter). Assignable causes will be determined and appropriate corrections will be made and documented in the database. Missing data points could be caused by a number of conditions including:

- chips lost or damaged prior to or during reading
- failure to place or retrieve dosimeters at monitoring sites
- dosimeters removed or damaged by animals, people, or weather
- dosimeters lost or damaged in transit or in storage
- reader errors or malfunctions
- data transfer errors from the reader to the database

Chip-to-chip variability

The average, standard deviation, and coefficient of variation will be calculated for each dosimeter. The coefficient of variation will be compared to the criteria and data from dosimeters exceeding the chip-to-chip criteria will be marked as needing further evaluation. Additional data evaluation may eliminate outlier measurements within the dosimeter.

Comparison of the dose equivalent to historical values

For most TLD monitoring locations, the historical dose equivalent and its associated standard deviation are available. The dose equivalent will be compared to this historical value. For dosimeters that exceed the criteria of the historical comparison, assignable causes will be investigated and documented in the quarterly report.

Validation and Verification Methods (D2), continued

Professional evaluation of flagged data

All data marked as needing further evaluation will be professionally evaluated to determine if they will be used or rejected in the ambient dose equivalent calculations. All data not marked will be accepted for all calculations. If a datum is rejected or missing, it will be labeled as "R" and maintained in the database but not used.

All flagged data will receive further validation and evaluation. Professional judgment will be applied to flagged data, but if the datum cannot be logically amended, it will be marked as "rejected" and not used in calculations. Any amended datum will be accepted but will continue to be marked as "qualified." All decisions on the reasons for qualifying data will be documented.

Calculation of dose

Dose calculations will be consistent with generally accepted practices for environmental dosimetry. Results will be expressed as dose equivalent in mrem per quarter or other convenient time unit.

Reconciliation with Data Quality Objectives (D3)

Duplicate dosimeters

Duplicate dosimeters for the TLD monitoring network are used to evaluate the overall precision of the measurement system. The differences will be compared to the criteria listed in *Quality Objectives and Criteria for Measurement Data (A7)*, "Criteria for precision of duplicate measurements," page 17.

QC dosimeters

QC dosimeters are dosimeters that have been irradiated to a known value and read with field dosimeters. These are used to determine whether the reader is functioning properly and to determine the accuracy of the reading. The performance quotient will be calculated and the resultant will be compared to the criteria established in *Quality Objectives and Criteria for Measurement Data (A7)*, "Criteria for accuracy and bias," page 18. All data from QC dosimeters that exceed the criteria will be marked as needing further evaluation. Assignable causes will be determined before any data are released.

Uncertainty

The total uncertainty associated with the ambient dose equivalent will be calculated by the DPRNET database and compared to the criteria established in *Quality Objectives and Criteria for Measurement Data (A7)*, "Criteria for uncertainty," page 18. If it exceeds the criterion or statistical uncertainty calculations for data exhibit an obvious departure from expected or typically observed values, the resulting data will be flagged as needing further evaluation.

Comparison to action levels

All quarterly data will be compared to the 65 mrem action level given in the section *Quality Objectives and Criteria for Measurement Data (A7)*, "Decision rule," page 14.

Calculating data completeness

At least annually, data completeness for each quarter will be determined (see the section *Quality Objectives and Criteria for Measurement Data (A7)*, "Completeness criteria," page 16). If a large portion of data are rejected, or if the data from a specific location are rejected (e.g., missing), the remaining data may no longer represent the site. If this is the case, the situation will be documented and the explanation will accompany the reported data.

Reconciliation with Data Quality Objectives (D3), continued

Failure to meet specified DQOs

When differences are identified between specified evaluation or performance criteria above [see the sections *Quality Objectives and Criteria for Measurement Data (A7)* and *Validation and Verification Methods (D2)*] and measured values, assignable causes will be determined and documented in the report to management.

Click here to record “self-study” training to this procedure.

APPENDIX A

References

Requirements and guidance documents:

ANSI N545, "Performance, Testing, and Procedural Specifications for TLD Dosimetry (environmental applications)" 1975.

ANSI N13.29-Draft, "Environmental Dosimeter Performance - Criteria for Testing," 1995.

DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," January 1991.

DOE Order 414.1A, "Quality Assurance," changed July 12, 2001 (supersedes DOE Order 5700.6C, "Quality Assurance")

DOE Order 5400.1, "General Radiation Protection Program," changed June 29, 1980

DOE Order 5400.5, "Radiation Protection of the Public and the Environment," changed January 7, 1993.

EPA QA/G-4, "Guidance for the Data Quality Objectives Process," final, September 1994.

EPA QA/R-5, "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," Interim Final, January 1994.

FFCA, "Appendix A Compliance Plan" of the "Federal Facility Compliance Agreement," June 1996.

MAQ Group Air Quality documents:

MAQ-QMP, "MAQ Quality Management Plan"

RRES-MAQ-022, "Preparation, Review, and Approval of Procedures"

RRES-MAQ-024, "Personnel Training"

RRES-MAQ-025, "Records Management"

RRES-MAQ-026, "Deficiency Reporting and Correcting"

RRES-MAQ-029, "Management Assessments"

RRES-MAQ-030, "Document Distribution"

RRES-MAQ-032, "Orienting New Employees"

RRES-MAQ-034, “Computer Network Server Backup”

RRES-MAQ-210, “Placing and Retrieving Field Dosimeters”

RRES-MAQ-211, “Annealing TLDs Using the Model 550 TLD Reader”

RRES-MAQ-212, “Irradiating TLD-100 (1/8”) Dosimeters”

RRES-MAQ-213, “Using the Model 5500 TLD Reader”

RRES-MAQ-221, “Using the TLDNET Database”