ATTACHMENT E

Quality Assurance Manual For
Teledyne Brown Engineering Environmental Services
and
Teledyne Brown Engineering Environmental Services
Annual 2015 Quality Assurance Report

THE REMAINING PORTION OF TELEDYNE BROWN ENGINEERING SERVICES ANNUAL 2015 QUALITY ASSURANCE REPORT WILL BE PROVIDED UPON REQUEST.

139 Pages Follow

TELEDYNE
BROWN ENGINEERING, INC.
A Teledyne Technologies Company

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Quality Assurance Manual

For

Teledyne Brown Engineering

Environmental Services

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REVISION HISTORY

Revision 7	Complete re-write	January 1, 2005	Bill Meyer
Revision 8	Updated organization Chart, minor change to 1.0, 4.4, 7.5.3.2, 10.2.3, and 12.3	October 26, 2005	Bill Meyer
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Revision 11	Reformatted headers, Changed 'Procedure #' to 'procedure TBE-#' throughout document, Table 1-1, Figure 3.1, section 5.5.1	November 15, 2006	Lynne Perry
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Revision 28	Figure 3.1	January 21, 2015	Lynne Perry
Revision 29	Table 1-1	September 15, 2015	Lynne Perry

1.0 Knoxville QAM Section Introduction

This Quality Assurance Manual (QAM) and related procedures describes the Knoxville Environmental Services Laboratory's Quality Assurance (QA) system. The system is designed to meet multiple quality standards imposed by Customers and regulatory agencies and to support customer programs. The standards and regulations include, but are not limited to:

NRC 10 CFR 50 Appendix B
NRC 10 CFR 61
NRC Regulatory Guide 1.21
NRC Regulatory Guide 4.15, Rev 1, 1979
ANSI N 42.23
ANSI N 13.30
NELAC Standard, Chapter 5
ISO Guide 17025

The Environmental Services (ES) Laboratory does low level radioactivity analyses for Power Plants and other customers. It primarily analyzes environmental samples (natural products from around plants such as milk), in-plant samples (air filters, waters), bioassay samples from customer's employees, and waste disposal samples (liquids and solids).

Potable and non-potable water samples are tested using methods based on EPA standards as cited in State licenses (see procedure TBE-4010). The listing [current as of initial printing of this Manual – see current index for revision status and additions / deletions] of implementing procedures (SOPs) covering Administration, Methods, Counting Instruments, Technical, Miscellaneous, and LIMS is shown in Table 1-1. Reference to these procedures by number is made throughout this QAM.

Table 1-1

Number	Title
Part 1	**Administrative Procedures**
TBE-1001	Validation and Verification of Computer Programs for Radiochemistry Data Reduction
TBE-1002	Organization and Responsibility
TBE-1003	Control, Retention, and Disposal of Quality Assurance Records
TBE-1004	Definitions
TBE-1005	Data Integrity
TBE-1006	Job Descriptions

Number	Title
TBE-1007	Training, Qualification and Certification of Personnel
TBE-1008	Document and Document Control
TBE-1009	Calibration Systems
TBE-1010	Nonconformance Controls
TBE-1011	10CFR21 Reporting
TBE-1012	Corrective and Preventive Action
TBE-1013	Audits and Management Review
TBE-1014	RFP, Contract Review, and Project Set Up
TBE-1015	Procurement Controls
TBE-1016	Documentation of Customer Complaints
Part 2	**Method Procedures**
TBE-2001	Alpha Isotopic and Plutonium-241
TBE-2002	Carbon-14 Activity in Various Matrices
TBE-2003	Carbon-14 and Tritium in Soils, Solids, and Biological Samples: Harvey Oxidizer Method
TBE-2004	Cerium-141 and Cerium-144 by Radiochemical Separation
TBE-2005	Cesium-137 by Radiochemical Separation
TBE-2006	Iron-55 Activity in Various Matrices
TBE-2007	Gamma Emitting Radioisotope Analysis
TBE-2008	Gross Alpha and/or Gross Beta Activity in Various Matrices
TBE-2009	Gross Beta Minus Potassium-40 Activity in Urine and Fecal Samples
TBE-2010	Tritium and Carbon-14 Analysis by Liquid Scintillation
TBE-2011	Tritium Analysis in Drinking Water by Liquid Scintillation
TBE-2012	Radioiodine in Various Matrices
TBE-2013	Radionickel Activity in Various Matrices
TBE-2014	Phosphorus-32 Activity in Various Matrices
TBE-2015	Lead-210 Activity in Various Matrices
TBE-2016	Radium-226 Analysis in Various Matrices
TBE-2017	Total Radium in Water Samples
TBE-2018	Radiostrontium Analysis by Chemical Separation
TBE-2019	Radiostrontium Analysis by Ion Exchange
TBE-2020	Sulfur-35 Analysis
TBE-2021	Technetium-99 Analysis by Eichrom® Resin Separation
TBE-2022	**RETIRED** (Total U by KPA)
TBE-2023	Compositing of Samples

Number	Title
TBE-2024	Dry Ashing of Environmental Samples
TBE-2025	Preparation and Standardization of Carrier Solutions
TBE-2026	Renumbered 4019
TBE-2027	Glassware Washing and Storage
TBE-2028	Moisture Content of Various Matrices
TBE-2029	Polonium-210 Activity in Various Matrices
TBE-2030	Promethium-147 Activity in Various Matrices
TBE-2031	Radioactive Iodine in Drinking Water EPA Method 902.0
TBE-2032	10CFR61 Sample Preparation
TBE-2033	Pyrosulfate Fusion Preparation
TBE-2034	Drying and Grinding of Solid Samples
TBE-2035	Ra-226 and Ra-228 in Aqueous Samples
TBE-2036	Standard Test Method for 240h Batch-Type Measurement of Contaminant Sorption in Soils and Sediments
TBE-2037	Radiochemical Determination of Gross Alpha Activity in Drinking Water by Coprecipitation
TBE-2038	Foreign Soil Handling
Part 3	**Instrument Procedures**
TBE-3001	Calibration and Control of Gamma-Ray Spectrometers
TBE-3002	Calibration of Alpha Spectrometers
TBE-3003	Calibration and Control of Alpha and Beta Counting Instruments
TBE-3004	Calibration and Control of Liquid Scintillation Counters
TBE-3005	Calibration and Operation of pH Meters
TBE-3006	Balance Calibration and Check
TBE-3007	**RETIRED** (Reporting Defects and Non Compliances)
TBE-3008	**RETIRED** (Negative Results Evaluation Policy)
TBE-3009	Use and Maintenance of Mechanical Pipettors
TBE-3010	Microwave Digestion System Use and Maintenance
Part 4	**Technical Procedures**
TBE-4001	Renumbered 1014
TBE-4002	Quality Control Checking of Analytical Data
TBE-4003	Sample Receipt and Control
TBE-4004	Preparation of a Data Package
TBE-4005	Quality Control Samples - Blanks, Spikes and Duplicates
TBE-4006	Inter-Laboratory Performance Evaluation Programs
TBE-4007	Method Basis, Validation and Demonstration of Capability

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Number	Title
TBE-4008	Unassigned
TBE-4009	Detection Levels
TBE-4010	State and Government Agency Certifications
TBE-4011	Quality Calculations and Charting (Accuracy, Precision, Recovery, Efficiency, Control Charts and Data Quality Objectives)
TBE-4012	Unassigned
TBE-4013	Unassigned
TBE-4014	Laboratory Facilities
TBE-4015	Documentation of Analytical Laboratory Logbooks
TBE-4016	Uncertainty of Measurements
TBE-4017	Laboratory Information Management Systems (LIMS)
TBE-4018	Instrument Setup, Maintenance, and Calibration
TBE-4019	Radioactive Reference Standard Solutions and Records
Part 5	**Miscellaneous Procedures**
TBE-5001	Laboratory Hood Operations
TBE-5002	Operation and Maintenance of Deionized Water System
TBE-5003	Waste Management
TBE-5004	**RETIRED** (Acid Neutralization and Purification System Operation)
Part 6	**LIMS**
TBE-6001	LIMS Raw Data Processing and Reporting
TBE-6002	Software Development and/or Pilots of COTS Packages
TBE-6003	Software Change and Version Control
TBE-6004	Backup of Data and System Files
TBE-6005	Disaster Recovery Plan
TBE-6006	LIMS Hardware
TBE-6007	LIMS User Access
TBE-6008	LIMS Training
TBE-6009	LIMS Security

Number	Title
Part 7	**Radiation Protection Program Procedures**
TBE-7001	Receiving Packaged Radioactive Materials
TBE-7002	Laboratory Contamination Control
TBE-7003	Facility and Personnel Exposure Monitoring
TBE-7004	Controlled Areas and Radiation Controlled Areas
TBE-7005	Facility Surveys
TBE-7006	Radiation Source Control and Leak Testing
TBE-7007	Radiation Protection Program Assessments
TBE-7008	Radiation Protection Records
TBE-7009	Radiation Waste Management
Part 8	**Environmental Regulatory**
TBE-8001	Attorney-Client Privilege and Work Product Doctrine
TBE-8002	Container Controls
TBE-8003	Data Management System
TBE-8004	Environmental Management System
TBE-8005	Management of Change
TBE-8006	Hazardous Waste Marking and Accumulation
TBE-8007	Facility Inspections
TBE-8008	Waste Minimization Plan
TBE-8009	Slug/Waste Water Operation Discharge Prevention & Contingency Plan
TBE-8010	Hazardous Material Communication Information
TBE-8011	Hazardous Material Security Plan
TBE-8012	Asbestos Management Plan
TBE-8013	Asbestos – Employee Information and Training

2.0 QUALITY SYSTEM

The TBE-ES QA system is designed to comply with multiple customer- and regulatory agency-imposed specifications related to quality. This quality system applies to all activities of TBE-ES that affect the quality of analyses performed by the laboratory.

2.1 Policy

The TBE quality policy, given in Company Policy P-501,is "TBE will continually improve our processes and effectiveness in providing high-quality technical services, manufactured products and engineered systems that adhere to our Quality Management System and exceed our customer's expectations."

This policy is amplified by this Laboratory's commitment, as attested to by the title page signatures, to perform all work to good professional practices and to deliver high quality services to our customers with full data integrity. (See Section 4.0 and procedure TBE-1005).

2.2 Quality System Structure

The Quality System is operated by the organizations described in Section 3.0 of this Manual. The Quality System is described in this Manual and in the procedures Manual, both of which are maintained by the QA Manager. Procedures are divided into 8 sections – Administrative, Methods, Equipment, Technical, Miscellaneous, LIMS, Radiation Protection Program, and Environmental Regulatory. This QA Manual is structured as shown in the Table of Contents and refers to procedures when applicable. Cross references to the various imposed quality specifications are contained in Appendices to procedures, as appropriate.

2.3 Quality System Objectives

The Quality System is established to meet the objective of assuring all operations are planned and executed in accordance with system requirements. The Quality System also assures that performance evaluations are performed (see procedure TBE-4006), and that appropriate verifications are performed (see procedures in the 1000 and 4000 series) to further assure compliance. Verification includes examination of final reports (prior to submittal to customers) to determine their quality (see procedure TBE-4004).

To further these objectives, various in-process assessments of data, as well as assessments of the system, via internal audits and management reviews, are performed. Both internal experts and customer / regulatory agencies perform further assessments of the system and compliance to requirements.

2.4 Personnel Orientation, Training, and Qualification

TBE provides indoctrination and training to employees and performs proficiency evaluation of technical personnel. This effort is described in Section 4.0.

3.0 ORGANIZATION, AUTHORITY, AND RESPONSIBILITY

TBE has established an effective organization for conducting laboratory analyses at the Knoxville Environmental Services Laboratory. The basic organization is shown in Figure 3-1. Detail organization charts with names, authorities, and responsibilities are given in procedure TBE-1002. Job descriptions are given in procedure TBE-1006.

This organization provides clearly established Quality Assurance authorities, duties, and functions. QA has the organizational freedom needed to:

(1) Identify problems
(2) Stop nonconforming work
(3) Initiate investigations
(4) Recommend corrective and preventive actions
(5) Provide solutions or recommend solutions
(6) Verify implementation of actions

All Laboratory personnel have the authority and resources to do their assigned duties and have the freedom to act on problems. The QA personnel have direct, independent access to Company management as shown in Figure 3-1.

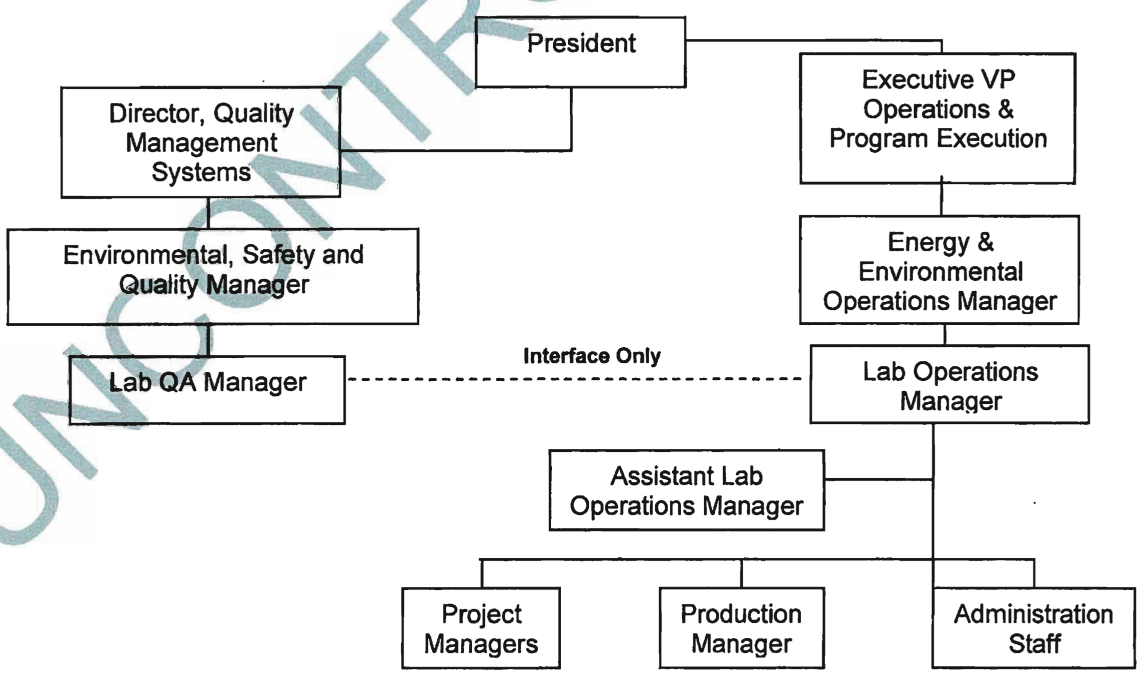

Figure 3.1. Laboratory Organization

4.0 PERSONNEL ORIENTATION, DATA INTEGRITY, TRAINING, AND QUALIFICATION

4.1 Orientation

All laboratory personnel must receive orientation to the quality program if their work can affect quality. Orientation includes a brief review of customer and regulatory agency imposed quality requirements, the structure of the QAM, and the implementing procedures. The goal of orientation is to cover the nature and goals of the QA program.

4.2 Data Integrity

The primary output of the Laboratory is data. Special emphasis and training in data integrity is given to all personnel whose work provides or supports data delivery. The Laboratory Data Integrity procedure (procedure TBE-1005) describes training, personnel attestations, and monitoring operations. Annual reviews of the Laboratory Data Integrity procedure are required.

4.3 Training

The Quality Assurance Manager (QAM) maintains a training matrix indicating laboratory personnel training status in specific procedures. This matrix is updated when personnel change or change assignments. All personnel are trained per these requirements and procedures. This training program is described in procedure TBE-1007. The assigned responsibilities for employees are described in procedure TBE-1002 (See Section 3.0) on Organization and in procedure TBE-1006, Job Descriptions. Refresher training or re-training is given annually as appropriate.

4.4 Qualification

Personnel are qualified as required by their job description. Management and non-analysts are evaluated based on past experience, education, and management's assessment of their capabilities. Formal qualification is required of analysts and related technical personnel who perform laboratory functions. Each applicable person is given training and then formally evaluated by the Operations Manager (or his designees) and by QA. Each analyst must initially demonstrate capability to perform each assigned analytical effort. Each year, thereafter, he or she must perform similar analyses on Interlab Comparison Samples (see procedure TBE-4006) or on equivalent blanks and spikes samples. Acceptable results extend qualifications (certification). Unacceptable results require retraining in the subject method / procedures. (See procedure TBE-1007 for added information, records, forms, etc. used.)

4.5 Records

Records of training subjects, contents, attendees, instructors, and certifications are maintained by QA.

5.0 CUSTOMER INTERFACES

5.1 Interface Personnel

The Laboratory has designated Project Managers as the primary interface with all customers. Other interfaces may be the QA Manager or the Lab Operations Manager.

5.2 Bid Requests and Tenders

The Project Managers respond to customer requests for bids and proposals per procedure TBE-1014 for bids, proposals, and contract reviews. They clarify customer requests so both the customer and the lab staff understand requests. As responses are developed, internal reviews are conducted to ensure that requirements are adequately defined and documented and to verify that the Laboratory has adequate resources in physical capabilities, personal skills, and technical information to perform the work. Accreditation needs are reviewed. If subcontracts are required to perform any analysis, the subcontractor is similarly evaluated and the client notified in writing of the effort. Most qualifications are routine with standard pricing and the review of these quotes is performed by the Project Manager. Larger or more complex quotes are reviewed by the Operations Manager and the QA Manager (or designees). Evidence of review is by initialing and dating applicable papers, signatures on quotations, or by memo.

5.3 Contracts

The Project Managers receive contract awards (oral or written) and generate the work planning for initiation preparation (charge numbers, data structure or contents in LIMS, etc.). They review contracts for possible differences from quotations and, if acceptable, contracts are processed. Documentation of the review is by initials and date as a minimum. Contract changes receive similar reviews and planning.

5.4 TBE's Expectation of Customers

TBE expects customers to provide samples suitable for lab analysis. These expectations include:

- Accurate and unambiguous identification of samples
- Proper collection and preservation of samples
- Use of appropriate containers free from external and internal contamination
- Integrity preservation during shipment and timely delivery of samples that are age sensitive
- Adequate sized samples that allow for retest, if needed

- Specification of unique MOA/MDC requirements
- Alerting the lab about abnormal samples (high activity, different chemical contents, etc.)
- Chain of custody initiation, when required.

5.5 Customer Satisfaction

TBE's quality policy centers on customer satisfaction (See 2.0). TBE will work to satisfy customers through full compliance with contract requirements, providing accurate data and properly responding to any questions or complaints. Customers are provided full cooperation in their monitoring of Laboratory performance. Customers are notified if any applicable State Accreditation is withdrawn, revoked, or suspended.

5.5.1 Customer Complaints

Any customer complaints are documented and tracked to closure per procedure TBE-1016. Most complaints concern analysis data and are received by Project Managers. They log each such complaint, order retests for verification, and provide documented results to customers. Complaints may also be received by QA or Operations.

If complaints are other than re-test type, the nonconformance and corrective action systems (Sections 12 and 13) are used to resolve them and record all actions taken.

5.5.2 Customer Confidentiality

All laboratory personnel maintain confidentiality of customer-unique information.

6.0 DOCUMENTATION GENERATION & CONTROL

6.1 General

The documentation generation and control system is detailed in procedure TBE-1008. An overview is given below. The basic quality system documents are described in Section 2.0.

6.2 New Documentation

Each Procedure and this QAM is written by appropriate personnel, validated if applicable (see Section 7.0), reviewed for adequacy, completeness, and correctness, and, if acceptable, accepted by the authorized approver [QA Manager, Operations Manager (or their designee)]. Both approvals are required if a Procedure affects both QA and Operations. (See Responsibilities in Section 3.0). These procedures control the quality measurements and their accuracy.

Each document carries a unique identification number, a revision level, dates, page numbers and total page count, and approver identification and sign off. If TBE writes code for software, the software is version identified and issued after Verification and Validation per Section 7.0.

6.3 Documentation Changes

Each change is reviewed in the same manner and by the same group as new documentation. Revision identifications are updated and changes indicated by side bars, italicized words, or by revision description when practical. Obsolete revisions are maintained by QA after being identified as obsolete.

Departures from documented policies, procedures or standard specifications shall be put in writing by the Operation Manager, or designee, and distributed to the laboratory technician, as appropriate.

6.4 Documentation Lists and Distributions

Computer indexes of documents are maintained by Quality showing the current authorized revision level of each document. These revisions are placed on the Laboratory server and obsolete ones are removed so that all personnel have only the current documents. If hard copies are produced and distributed, separate distribution lists are maintained indicating who has them and their revision level(s). Copies downloaded off the server are uncontrolled unless verified by the user (on the computer) to be the latest revision.

6.5 Other Documentation

In addition to TBE-generated documentation, QA maintains copies of applicable specifications, regulations, and standard methods.

6.6 Documentation Reviews

Each issued document is reviewed at least every third year by the approving personnel. EPA documents are reviewed every one to two years. Procedures TBE-1002 Organization and Responsibility, TBE-1003 Control and Retention of Quality Assurance Records and TBE-1006 Job Descriptions are reviewed annually. This review determines continued suitability for use and compliance with requirements.

7.0 DESIGN OF LABORATORY CONTROLS

7.1 General

The Laboratory and its operating procedures are designed specifically for low level (environmental and in-plant) radioactive sample analysis. The various aspects of the laboratory design include the following which are discussed in subsequent paragraphs of this Section:

(a) Facility
(b) Technical Processes and Methods
(c) Verification of Design of Processes, Methods, and Software.
(d) Design of Quality Controls
(e) Counting Instrument Controls

7.2 Facility

The facility was designed and built in 2000 to facilitate correct performance of operations in accordance with good laboratory practices and regulatory requirements. It provides security for operations and samples. It separates sample storage areas based on activity levels, separates wet chemistry from counting instrumentation for contamination control, and provides space and electronic systems for documentation, analysis, and record storage. Procedure TBE-4014 describes the facility, room uses, layouts, etc.

7.3 Technical Processes and Methods

7.3.1 Operational Flow

The laboratory design provides for sample receipt and storage (including special environmental provisions for perishable items) where samples are received from clients and other labs (see Section 9.0). The samples are logged into the computer based Laboratory Information Management System (LIMS) and receive unique identification numbers and bar code labels. (See procedure TBE-4017 for LIMS description and user procedures). The Project Managers then plan the work and assure LIMS contains any special instructions to analysts. Samples then go to sample preparation, wet chemistry (for chemical separation), and counting based on the radionuclides. See procedures in the 2000 and 3000 series. Analysts perform the required tasks with data being entered into logbooks, LIMS, and counting equipment data systems as appropriate. Results are collected and reviewed by the Operations Manager and Project Managers and reports to clients are generated (See Section 14.0). All records (electronic or hard copy) are maintained in files or in back-up electronic copies (see Section 15.0). After the required hold periods and client notification and approval, samples are disposed of in compliance with regulatory requirements (see procedure TBE-5003).

7.3.2 Methods

The laboratory methods documented in the 2000 and 3000 series of procedures were primarily developed by senior TBE laboratory personnel based on years of experience at our prior facility in New Jersey. They have been improved, supplemented and implemented here. Where EPA or other accepted national methods exist (primarily for water analyses under State certification programs - see procedure TBE-4010), the TBE methods conform to the imposed requirements or State accepted alternate requirements. Any method modifications are documented and described in the Procedure. There are no nationally recognized methods for most other analysis methods but references to other method documents are noted where applicable.

7.3.3 Data Reduction and Analysis

Whenever possible automatic data capture and computerized data reduction programs are used. Calculations are either performed using commercial software (counting system operating systems) or TBE developed and validated software is used (see 7.4 below). Analysis of reduced data is performed as described in Section 14.0 and procedure TBE-4004.

7.4 Verification of Technical Processes, Methods, and Software

7.4.1 Operational Flow Verification

The entire QA Manual and related procedures describe the verification of elements of the technical process flow and the establishment of quality check points, reviews, and controls.

7.4.2 Method Verifications

Methods are verified and validated per procedure TBE-4007 prior to use unless otherwise agreed to by the client. For most TBE methods initial validation occurred well in the past. New or significantly revised Methods receive initial validation by demonstration of their performance using known analytes (NIST traceable) in appropriate matrices. Sufficient samples are run to obtain statistical data that provides evidence of process capability and control, establishes detection levels (see procedure TBE-4009), bias and precision data (see procedure TBE-4011). All method procedures and validation data are available to respective clients. Also see Section 7.5 below for the Demonstration of Capability program.

7.4.3 Data Reduction and Analysis Verification

Data reduction is performed by software and analysis verification is performed by personnel who did not generate the data, i.e. the Operations Manager, or designee (See Section 14.0).

7.5 Design of Quality Controls

7.5.1 General

There are multiple quality controls designed into the laboratory operations. Many of these are described elsewhere in this manual and include personnel qualification (Section 4.0), Document control (6.0), Sample identification and control (9.0), Use of reference standards (10.0), intra- and inter- laboratory tests (10.0), etc. This Section describes the basic quality control systems used to verify Method capability and performance.

7.5.2 Demonstration of Capability (D of C)

The demonstration of capability system verifies and documents that the method, analyst, and the equipment can perform within acceptable limits. The D of C is certified for each combination of analyte, method, and instrument type. D of C's are certified based on objective evidence at least annually. This program is combined with the analyst D of C program (See Section 4.0). Initial D of Cs use the method validation effort as covered above. Subsequent D of Cs use Inter-Laboratory samples (procedure TBE-4006) or, if necessary, laboratory generated samples using NIST traceable standards. If results are outside of control limits, re-demonstration is required after investigation and corrective action is accomplished (See Sections 12.0 and 13.0).

7.5.3 Process Control Checks

Process control checks are designed to include Inter-Lab samples, Intra-Lab QC check samples, and customer provided check samples. 10% of laboratory analysis samples are for process control purposes.

7.5.3.1 Inter- Lab Samples

Inter-lab samples are procured or obtained from sources providing analytes of interest in matrices similar to normal client samples. These samples may be used for Demonstration of Capability of analyst's, equipment and methods. They also provide for independent insight into the lab's process capabilities. Any value reported as being in the warning zone (over 2 sigma) is reviewed and improvements taken. Any value failing (over 3 sigma) is documented on an NCR and formal investigation per Section 12.0 and 13.0 is

performed. If root causes are not clearly understood and fixed, re-tests are required using lab prepared samples (See procedure TBE-4006).

7.5.3.2 QC Samples

QC samples, along with Inter-lab samples and customer check samples, are 10% of the annual lab workload for the applicable analyte and method. If batch processing is used, some specifications require specific checks with each batch or each day rather than as continuous process controls (See procedure TBE-4005).

QC samples consist of multiple types of samples including:

(a) Method blanks
(b) Blank spikes
(c) Matrix spikes
(d) Duplicates
(e) Tracers and carriers

Acceptance limits for these samples are given in procedures or in lab standards. The number, frequency, and use of these sample types varies with the method, matrix, and supplemental requirements. The patterns of use versus method and the use of the resulting test data is described in procedure TBE-4005.

7.5.3.3 Customer Provided Check Samples

Customers may provide blind check samples and duplicates to aid in their evaluation of the Laboratory. When the lab is notified that samples are check samples their results are included in the QC sample percentage counts. Any reported problems are treated as formal complaints and investigated per Section 5.

7.6 Counting Instrument Controls

The calibration of instruments is their primary control and is described in Section 11.0. In addition, counting procedures (3000 series) also specify use of background checks (method blank data is not used for this) to evaluate possible counting equipment contamination. Instrument calibration checks using a lab standard from a different source than the one used for calibration are also used. Background data can be used to adjust client and test data. Checks with lab standards indicate potential calibration changes.

8.0 PURCHASING AND SUBCONTRACT CONTROLS

8.1 General

Procurement and Subcontracts efforts use the Huntsville-based Cost Point computer system to process orders. The Laboratory-generated Purchase Requisitions are electronically copied into Purchase Orders in Huntsville. The Laboratory also specifies sources to be used. Procured items and services are received at the Laboratory where receiving checks and inspections are made. Laboratory procedure TBE-1015 provides details on the procurement control system at the Laboratory and references the Huntsville procedures as applicable.

8.2 Source Selection

Sources for procurements of items and services are evaluated and approved by QA as described in procedure TBE-1015. Nationally recognized catalog item sources are approved by the QA Manager based on reputation. Maintenance services by an approved distributor or the equipment manufacturing company are pre-approved. Sources for other services are evaluated by QA, based on service criticality to the quality system, by phone, mail out, or site visit.

Subcontract sources for laboratory analysis services are only placed with accredited laboratories (by NELAP, State, Client, etc.) as applicable for the type of analysis to be performed. QA maintains lists of approved vendors and records of evaluations performed.

8.3 Procurement of Supplies and Support Services

8.3.1 Catalog Supplies

The Laboratory procures reagents, processing chemicals, laboratory "glassware," consumables, and other catalog items from nationally known vendors and to applicable laboratory grades, purities, concentrations, accuracy levels, etc. Purchase Requisitions for these items specify catalog numbers or similar call-outs for these off-the-shelf items. Requisitions are generated by the personnel in the lab needing the item and are approved by the Operations or Production Manager. Reagents are analytical reagent grade only.

8.3.2 Support Services

Purchase Requisitions for support services (such as balance calibration, equipment maintenance, etc.) are processed as in 8.3.1 but technical requirements are specified and reviewed before approvals are given.

8.3.3 Equipment and Software

Purchase Requisitions for new equipment, software programs, and major facility modifications affecting the quality system are reviewed and approved by the Operations Manager and the QA Manager, as appropriate.

8.4 Subcontracting of Analytical Services

When necessary, the Laboratory may subcontract analytical services required by a client. This may be because of special needs, infrequency of analysis, etc. Applicable quality and regulatory requirements are imposed in the Purchase Requisition and undergo a technical review by QA. Quality requirements (calibrations, acceptance criteria, corrective action) for chemical analyses are inherent in chemical methods (e.g. EPA SW-846 Method 1311[TCLP]). TBE reserves the right of access by TBE and our client for verification purposes.

8.5 Acceptance of Items or Services

Items and services affecting the quality system are verified at receipt based on objective evidence supplied by the vendor. Supply items are reviewed by the requisitioner and, if acceptable, are accepted via annotation on the vendor packing list or similar document. Similarly, equipment services are accepted by the requisitioning lab person. Calibration services are accepted by QA based on certification reviews. (See Section 11.0.)

Data reports from analytical subcontractors are evaluated by Project Managers and subsequently by the Operations Manager (or designee) as part of client report reviews.

Items are not used until accepted and if items or services are rejected, QA is notified and nonconformance controls per Section 12.0 are followed, if required. After vendor notification, rejected items are returned. Vendors may be removed from the approved vendor's list if their performance is unacceptable.

9.0 TEST SAMPLE IDENTIFICATION AND CONTROL

9.1 Sample Identification

Incoming samples are inspected for customer identification, container condition, chain of custody forms, and radioactivity levels. If acceptable, the sample information is entered into LIMS which generates bar coded labels for attachment to the sample(s). The labels are attached and samples stored in the assigned location. If environmental controls are needed (refrigeration, freezing, etc.), the samples are placed in these storage locations. If not acceptable, the Project Manager is notified, the customer contacted, and the problem resolved (return of sample, added data receipts, etc.). See procedure TBE-4003 for more information on sample receipt.

9.2 LIMS

The LIMS is used to schedule work, provide special information to analysts, and record all actions taken on samples. See procedure TBE-4017 and the 6000 series of procedures for more information on LIMS operations.

9.3 Sample Control

The sample, with its bar coded label, is logged out to the applicable lab operation where the sample is processed per the applicable methods (procedures 2000 and 3000). The LIMS-assigned numbers are used for identification through all operations to record data. Data is entered into LIMS, log books (kept by the analysts) or equipment data systems to record data. The combination of LIMS, logbooks, and equipment data systems provide the Chain of Custody data and document all actions taken on samples. Unused sample portions are returned to its storage area for possible verification use. Samples are discarded after required time limits are passed and after client notification and approval, if required.

10.0 SPECIAL PROCESSES, INSPECTION, AND TEST

10.1 Special Processes

The Laboratory's special processes are the methods used to analyze a sample and control equipment. These methods are defined in procedures in the 2000 and 3000 series. These processes are performed to the qualified methods (see Section 7.0) by qualified people (see 4.0).

10.2 Inspections and Tests

The quality of the process is monitored by indirect means. This program involves calibration checks on counting equipment (see Section 11.0), intra-laboratory checks, and inter-laboratory checks. In addition, some customers submit quality control check samples (blinds, duplicates, external reference standards). All generated data gets independent reviews.

10.2.1 Intra Laboratory Checks (QC Checks)

The quantity and types of checks varies with the method, but basic checks which may include blanks, spiked blanks, matrix spikes, matrix spike duplicates, and duplicates are used as appropriate for customer samples. This process is described in procedure TBE-4005 and in Section 7.0.

10.2.2 Inter Laboratory Checks

TBE participates in Inter-lab performance evaluation (check) programs with multiple higher level labs. These programs provide blind matrices for the types of matrix/analyte combinations routinely processed by the Lab, if available. This program is described in procedure TBE-4006.

10.2.3 Data Reviews

Raw data and reports are reviewed by the Operations Manager, or designees. This review checks for data logic, expected results, procedure compliance, etc. (See Section 14.0).

10.3 Control of Sampling of Samples

Samples for analysis are supplied by customers preferably in quantities sufficient to allow re-verification analyses if needed. For state reportable drinking water samples, if the client does not specify the sampling procedure(s) to be followed, the laboratory must inform the client as to how the samples should be obtained. This process is described in procedure TBE-1014.

The samples are prepared for analysis by analysts and then an aliquot (partial sample extraction) is taken from the homogeneous customer sample for the initial analysis. Methods specify standard volumes of sample material required. Sampling data is recorded in LIMS and/or logbooks.

10.4 Reference Standards / Material

10.4.1 Weights and Temperatures

Reference standards are used by the Laboratory's calibration vendor to calibrate the Labs working instruments measuring weights and thermometers.

10.4.2 Radioactive Materials

Reference radioactive standards, traceable to NIST, are procured from higher level laboratories. These reference materials are maintained in the standards area and are diluted down for use by laboratory analysts. All original and diluted volumes are fully traceable to source, analyst, dilution, and reference dates (See Section 11.0 and procedure TBE-1009).

11.0 EQUIPMENT MAINTENANCE AND CALIBRATION

11.1 General

There are two types of equipment used by the Laboratory: support equipment (scales, glassware, weights, thermometers, etc.) and instruments for counting. Standards traceable to NIST are used for calibration and are of the needed accuracy for laboratory operations. Procedures TBE-1009, TBE-4018, and TBE-4019 describe the calibration and maintenance programs.

11.2 Support Equipment

Analytical support equipment is purchased with the necessary accuracies and appropriate calibration data. If needed, initial calibration by the Laboratory or its calibration vendor is performed. Recalibration schedules are established and equipment recalibrated by the scheduled date by a calibration vendor or by Laboratory personnel. Maintenance is performed, as needed, per manufacturer's manuals or lab procedures.

In addition to calibrations and recalibrations, checks are made on the continued accuracy of items as described in procedure TBE-1009. Records are maintained of calibration and specified checks.

11.3 Instruments

Instruments receive initial calibration using radioactive sources traceable to NIST. The initial calibration establishes statistical limits of variation that are used to set control limits for future checks and recalibration. This process is described in procedure TBE-4018. Instruments are maintained per Instrument Manual requirements. Recalibrations are performed per the instrument procedure.

Between calibrations, check sources are used to assure no significant changes have occurred in the calibration of items. Background checks are performed to check for possible radioactive contamination. Background values are used to adjust sample results. Hardware and software are safeguarded from adjustments that could invalidate calibrations or results.

11.4 Nonconformances and Corrective Actions

If calibrations or checks indicate a problem, the nonconformance system (Section 12.0) and corrective action system (Section 13.0) are initiated, if required, to document the problem and its resolution. Equipment is promptly removed from service if questionable.

11.5 Records

Records of calibrations are maintained. Calibration certificates from calibration vendors are maintained by QA. Other calibration data and check data is maintained in log books, LIMS, or instrument software as appropriate and as described in procedures TBE-1009, TBE-4018, and TBE-4019.

12.0 NONCONFORMANCE CONTROLS

12.1 General

The nonconformance control system is implemented whenever a nonconforming condition on any aspect of Laboratory analysis, testing, or results exist. The system takes graded actions based on the nature and severity of the nonconformance. Nonconforming items or processes are controlled to prevent inadvertent use. Nonconformances are documented and dispositioned. Notification is made to affected organizations, including clients. Procedure TBE-1010 describes the procedures followed. Sample results are only reported after resolution.

12.2 Responsibility and Authority

Each Laboratory employee has the responsibility to report nonconformances and the authority to stop performing nonconforming work or using nonconforming equipment. Laboratory supervision can disposition and take corrective actions on minor problems. Any significant problem is documented by QA using the Laboratory's NCR system per procedure TBE-1010. QA conducts or assures the conduct of cause analyses, disposition of items or data, and initiation of corrective action if the nonconformance could recur.

12.3 10CFR21 Reporting

The QA Manager reviews NCRs for possible need of customer and/or NRC notification per the requirements of 10CFR21. Procedure TBE-1011 is followed in this review and for any required reporting.

13.0 CORRECTIVE AND PREVENTIVE ACTION

13.1 General

The Laboratory takes corrective actions on significant nonconformances (see Section 12.0). It also initiates preventive and improvement actions per the Company Quality Policy (see Section 2.0). The procedures for Corrective Action/Preventive Action systems are contained in procedure TBE-1012.

13.2 Corrective Actions

Corrective actions are taken by Operations and Quality to promptly correct significant conditions adverse to quality. The condition is identified and cause analysis is performed to identify root causes. Solutions are evaluated and the optimum one selected that will prevent recurrence, can be implemented by the Laboratory, allows the Laboratory to meet its other goals, and is commensurate with the significance of the problem. All steps are documented, action plans developed for major efforts, and reports made to Management. QA verifies the implementation effectiveness. Procedure TBE-1012 provides instructions and designates authorities and responsibilities.

13.3 Preventive Actions

Preventive actions are improvements intended to reduce the potential for nonconformances. Possible preventive actions are developed from suggestions from employees and from analysis of Laboratory technical and quality systems by management. If preventive actions or improvements are selected for investigation, the issues, investigation, recommendations, and implementation actions are documented. Follow up verifies effectiveness.

14.0 RESULTS ANALYSIS AND REPORTING

14.1 General

The Laboratory's role is to provide measurement-based information to clients that is technically valid, legally defensible, and of known quality.

14.2 Results Review

The results obtained from analytical efforts are collected and reviewed by the Operations Manager and the Project Manager. This review verifies the reasonableness and consistency of the results. It includes review of sample and the related QC activity data. Procedure TBE-4002 describes the process. Any deficiencies are corrected by re-analyses, recalculations, or corrective actions per Sections 12.0 and 13.0. Use of the LIMS with its automatic data loading features (see procedure TBE-4017) minimizes the possibility of transcription or calculation errors.

14.3 Reports

Reports range from simple results reporting to elaborate analytical reports based on the client requirements and imposed specifications and standards. (See procedure TBE-4004.) Reports present results accurately, clearly, unambiguously, objectively, and as required by the applicable Method(s). Reports include reproduction restrictions, information on any deviations from methods, and any needed data qualifiers based on QC data. If any data is supplied by analytical subcontractors (see Section 8.0), it is clearly identified and attributed to that Laboratory by either name or accreditation number.

If results are faxed or transmitted electronically, confidentiality statements are included in case of receipt by other than the intended client.

Reports are reviewed by the Program Manager and approved by the Operations Manager, or designee, and record copies kept in file (See Section 15.0).

15.0 RECORDS

15.1 General

The Laboratory collects generated data and information related to quality or technical data and maintains them as records. Records are identified, prepared, reviewed, placed in storage, and maintained as set forth in procedure TBE-1003.

15.2 Type of Records

All original observations, calculations, derived data, calibration data, and test reports are included. In addition QA data such as audits, management reviews, corrective and preventive actions, manuals, and procedures are included.

15.3 Storage and Retention

Records are stored in files after completion in the lab. Files are in specified locations and under the control of custodians. Filing systems provide for retrieval. Electronic files are kept on Company servers (with regular back up) or on media stored in fireproof file cabinets. Records are kept in Laboratory files for at least 2 years after the last entry and then in Company files for another year as a minimum. Records generated for nonpotable and potable water are maintained for 5 years and 10 years, respectively. Some customers specify larger periods – up to 7 years – which is also met. Generic records supporting multiple customers are kept for the longest applicable period.

15.4 Destruction or Disposal

Records may be destroyed after the retention period and after client notification and acceptance, if required. If the Laboratory closes, records will go in to company storage in Huntsville unless otherwise directed by customers. If the Laboratory is sold, either the new owner will accept record ownership or the records will go into Company storage as stated above.

16.0 ASSESSMENTS

16.1 General

Assessments consist of internal audits and management reviews as set forth in procedure TBE-1013.

16.2 Audits

Internal audits are planned, performed at least annually on all areas of the quality system, and are performed by qualified people who are independent from the activity audited. Audits are coordinated by the Quality Manager who assures audit plans and checklists are generated and the results documented. Reports include descriptions of any findings and provide the auditor's assessment of the effectiveness of the audited activity. Report data includes personnel contacted.

Audit findings are reviewed with management and corrective actions agreed to and scheduled. Follow up is performed by QA to verify accomplishment and effectiveness of the corrective action.

16.3 Management Reviews

The Annual Quality Assurance Report, prepared for some clients, is the Management Review vehicle. These reports cover audit results, corrective and preventive actions, external assessments, and QC and inter-laboratory performance checks. The report is reviewed with Management by the QA Manager for the continued suitability of the Quality Program and its effectiveness. Any needed improvements are defined, documented, and implemented. Follow ups are made to verify implementation and effectiveness.

ATTACHMENT A

EPA Manual Cross Reference to TBE's QA Manual

EPA QA Manual Element	TBE QA Manual Section	TBE Procedure Number
1. Laboratory Organization and Responsibility	3.0 Organization, Authority and Responsibility	TBE-1002 Organization and Responsibility TBE-1006 Job Descriptions
2. Process used to identify clients' data quality objectives	1.0 Knoxville QAM Section Introduction 5.0 Customer Interfaces	TBE-1014 RFP, Contract Review, and Project Set Up
3. SOPs with dates of last revision	1.0 Knoxville QAM Section Introduction, Table 1-1 6.0 Documentation Generation & Control	TBE-1008 Documents and Document Control
4. Field sampling procedures	9.0 Test Sample Identification and Control (Knoxville currently does no field sampling)	TBE-4003 Sample Receipt and Control
5. Laboratory sampling receipt and handling procedures	7.0 Design of Laboratory Controls 9.0 Test Sample Identification and Control	TBE-4003 Sample Receipt and Control
6. Instrument calibration procedures	11.0 Equipment Maintenance and Calibration	TBE-1009 Calibration Systems TBE-3001-3006, 3009 individual systems TBE-4018, Instrument Setup, Maintenance and Calibration
7. Analytical procedures	1.0 Knoxville QA Section Introduction, Table 1-1	Procedures 2000 series
8. Data reduction, validation, reporting and verification	7.0 Design of Laboratory Controls 14.0 Results Analysis and Reporting	TBE-1001 Validation and Verification of Computer Programs for Radiochemistry Data Reduction TBE-4002 Quality Control Checking of Analytical Data TBE-4011 Quality Calculations and Charting TBE-4017 LIMS
9. Type of QC checks and the frequency of their use	7.0 Design of Laboratory Controls 10.0 Special Processes, Inspection and Test	TBE-4005 Quality Control Samples
10. List schedule of internal and external system and data quality audits and Interlaboratory comparisons	16.0 Assessments 7.0 Design of Laboratory Controls 10.0 Special Processes, Inspection and Test	TBE-1013 Audits and Management Review TBE-4006 Inter-Laboratory Performance Evaluation Programs
11. Preventive maintenance procedures and schedules	11.0 Equipment Maintenance and Calibration	TBE-1009 Calibration Systems TBE-3001-3006, 3009 individual systems TBE-4018, Instrument Setup, Maintenance and Calibration

EPA QA Manual Element	TBE QA Manual Section	TBE Procedure Number
12. Corrective action contingencies	13.0 Corrective and Preventive Action	TBE-1012 Corrective and Preventive Action
13. Record keeping procedures	15.0 Records	TBE-1003 Control, Retention and Disposal of Quality Assurance Records TBE-1008 Documents and Document Control

TELEDYNE
BROWN ENGINEERING
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TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Knoxville Laboratory

Annual 2015 QUALITY ASSURANCE REPORT

January – December 2015

Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931-3133

Annual 2015 Quality Assurance Report

Review and Signature

Quality Assurance Manager: ~~Lynne Perry~~ 5/9/16
Contractual Review **Lynne Perry** **Date**

Laboratory Operations Manager: Keith O. Jeter 5/9/16
Technical Review **Keith O. Jeter** **Date**

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I. INTRODUCTION

This report covers the Quality Assurance (QA) Program for the Analytical Services function of the Teledyne Brown Engineering Environmental Services (TBE-ES) laboratory for January through September 2015.

A. Operational Quality Control Scope

1. Interlaboratory

The Teledyne Brown Engineering Environmental Services Laboratory Quality Control (QC) Program is designed to monitor the quality of analytical processing associated with environmental, effluent (10CFR Part 50), and waste characterization (10CFR Part 61) samples.

Quality Control of radioanalyses involves the internal process control program, and independent third party programs administered by Analytics and Environmental Resource Associates (ERA).

TBE-ES also participates in the Department of Energy's (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) administered by the U. S. Department of Energy. The MAPEP is a set of performance evaluation samples (e.g., water, soil, air filters, etc.) designed to evaluate the ability and quality of analytical facilities performing measurement on samples that contain hazardous and radioactive (mixed) analytes.

Quality Control for radioanalyses during this reporting period consisted of internal process check samples. Third-party process checks prepared by Analytics, ERA and the DOE's MAPEP are not reported during the first quarter of the year.

Inter-laboratory cross-check samples are received and reported as follows:

Analytics provides cross check samples quarterly in March, June, September, and November.

MAPEP provides samples semi-annually in February and September with required reporting dates in May and November, respectively, following sample receipt.

ERA provides samples semi-annually in April and October with required reporting dates in May and November, respectively, following sample receipt.

2. Intralaboratory

The internal QC program is designed to include QC functions such as instrumentation checks (to insure proper instrument response), blank samples (to which no analyte radioactivity has been added), for contamination checks, and instrumentation backgrounds. Process controls (or process checks) are either actual samples submitted in duplicate (duplicates) in order to evaluate the accuracy of laboratory measurements, or blank samples which have been "spiked" with a known quantity of a radioisotope that is of interest to laboratory clients. QC samples are intended to evaluate the entire radiochemical and radiometric process. Process control and qualification analyses samples seek to mimic the media type of those samples submitted for analysis by the various laboratory clients. The magnitude of the process control program combines both internal and external sources targeted at 10% of the routine sample analysis load.

3. Quality Assurance Program

To provide direction and consistency in administering the quality assurance program, TBE-ES has developed and follows a Quality Manual and a set of Standard Operating Procedures (SOP). The plan describes the scheduled frequency and scope of Quality Assurance and Quality Control (QA/QC) considered necessary for an adequate QA/QC program conducted throughout the year.

Internal audits are performed to an annual schedule.

The laboratory may be audited by prospective customers during a pre-contract audit, and/or by existing clients who wish to conduct periodic audits in accordance with their contractual arrangements. State audits are conducted to maintain state certification specific to client requirements and for the National Environmental Laboratory Accreditation Conference (NELAC) accreditation. The Nuclear Utilities Procurement Issues Committee (NUPIC) conducts audits of TBE-ES as a function of a Utilities Radiological Environmental Monitoring Program (REMP).

For this period, the Internal QA Audit was conducted on September 15-17 and November 9-11, 2015. The purpose of this audit was to verify compliance to requirements stated in Revision 29 of the TBE QA Manual, Sections 1 through 16, and implementation of procedures. The internal audit identified four (4) findings and seven (7) observations, administrative in nature. The findings and observations have been addressed. Based on the internal audit, it was determined

that the laboratory's Quality Assurance program remains effective. This audit is considered closed.

For this period, two external audits were hosted by TBE from Babcock & Wilcox (B&W) on October 19 - 21, 2015 and from the State of New York (ELAP) on November 3 - 5, 2015.

The purpose of the B&W audit was to evaluate the TBE quality program and determine, on a sample basis, if the subcontractor is meeting the minimum requirements invoked by their documented quality program, and the requirements stated in the active BWXT purchase orders. The B&W audit identified one (1) nonconformity, two (2) observations and one (1) suggestion, administrative in nature. The finding, observations and suggestion have been addressed. This audit is considered closed.

The New York State Department of Health's Environmental Laboratory Approval Program (ELAP) on November 3 through November 5, 2015. The purpose of the audit was to verify TBE's capability to perform radiochemistry analysis of environmental samples and laboratory services for the National Environmental Laboratory Accreditation Conference (NELAC) certification through the New York State accreditation Environmental Laboratory Approval Program (ELAP). One finding and two suggestions were identified during the audit, which are considered administrative in nature. A corrective action plan was submitted and accepted. A copy of the audit report is attached. This audit is considered closed.

B. Performance Characteristics

Interlaboratory Accuracy

TBE-ES has adopted a QC acceptance protocol based upon two external performance models. For the interlaboratory programs that have established performance criteria (e.g., established warning and failure limits), the laboratory uses those established criteria to evaluate QC sample results. For the interlaboratory QC programs which have no pre-set acceptance criteria (e.g. Analytics Cross Check Program), results are evaluated in accordance with TBE-ES internal acceptance criteria.

a) Analytics' Evaluation Criteria

Analytics' evaluation report provides a ratio of TBE's result and Analytics' known value. Since flag values are not assigned, TBE-ES evaluates the reported ratios based on internal QC requirements, which are based on the DOE MAPEP criteria.

b) DOE Evaluation Criteria (Handbook for the Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP), Revision 13 (June 2012), pp 37-38, retrieved from http://www.id.energy.gov/resl/mapep/handbookv13.pdf)

MAPEP's evaluation report provides an acceptance range with associated flag values.

The MAPEP defines three levels of performance: Acceptable (flag = "A"), Acceptable with Warning (flag = "W"), and Not Acceptable (flag = "N"). Performance is considered acceptable when a mean result for the specified analyte is ± 20% of the reference value. Performance is acceptable with warning when a mean result falls in the range from ±20% to ±30% of the reference value (i.e., 20% < bias < 30%). If the bias is greater than 30%, the results are deemed not acceptable.

False positive/negative testing and sensitivity evaluations are used in radiological performance evaluations. The specific analytes used for testing vary among performance evaluation test sessions.

The MAPEP program uses false positive testing to identify laboratory results that indicate the presence of a particular radionuclide in a MAPEP sample when, in fact, the actual activity of the radionuclide is far below the detection limit of the measurement. Not acceptable ("N") performance, and hence a false positive result, is indicated when the range encompassing the result, plus or minus the total uncertainty at three standard deviations, does not include zero (e.g. 2.5 ± 0.2; range of 1.9 – 3.1). Statistically, the probability that a result can exceed the absolute value of its total uncertainty at three standard deviations by chance alone is less than 1%. The MAPEP uses a three standard deviation criterion for the false positive test to ensure confidence about issuing a false positive performance evaluation. A result that is greater than three times the total uncertainty of the measurement represents a statistically positive detection with over 99% confidence.

Sensitivity evaluations are routinely performed to complement the false positive tests. In a sensitivity evaluation the radionuclide is present at or near the detection limit, and the difference between the report result and the MAPEP reference value is compared to the propagated combined total uncertainties. The results are evaluated at three standard deviations. If the observed difference is greater than three time the combined total uncertainty, the sensitivity evaluation in "Not Acceptable". The probability that

such a difference can occur by chance alone is less than 1%. If the participant did not report a statistically positive result, a "Not Detected" is noted in the text field of the MAPEP performance report. A non-detect is potentially a false negative result, dependent upon the laboratory's detection limit for the radionuclide.

False negative tests are also performed in combination with the sensitivity evaluations. In this scenario, the sensitivity of the reported measurement indicates that the known specific activity of the targeted radionuclide in the performance evaluation sample should have been detected, but was not, and a "Not Acceptable" performance evaluation is issued. The uncertainty of the MAPEP reference value and of the reported result at three standard deviations is used for the false negative test.

The false positive/negative and sensitivity evaluation tests are conducted in a manner that assists the participants with their measurement uncertainty estimates and helps ensure they are not under estimating or over inflating their total uncertainties. If the total uncertainty is over inflated to try to pass a false positive test, it will result in a "Not Detected" if the test is actually a sensitivity evaluation, and vice versa for a false positive test. False negatives and failed sensitivity evaluations can also result from under estimating the total uncertainty. An accurate estimate of measurement uncertainty is required for consistent performance at the acceptable level.

c) ERA Evaluation Criteria

The ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. The ERA's acceptance limits are established per the USEPA, NELAC, state specific performance testing program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

d) NRC Resolution

The laboratory also participates in the NRC Resolution Criteria with some laboratory clients to primarily evaluate double-blind 10 CFR Part 50 performance. The NRC Resolution Criteria are based on an empirical relationship, which combines prior experience and

the accuracy needs of the program. The data is restricted to the individual client and is not included in this report.

2. Intralaboratory Accuracy

a) Internal Intralaboratory Acceptance Criteria

1.) Process Controls

For a group of test measurements to a given spike level, the measure of accuracy is the percent recovery of the spike activity found versus the spike activity put in. The percent recovery is calculated as follows:

$$(A_m / A_s)\ 100$$

Where: A_m = the activity measured

A_s = the spiked activity

Internal Process Control results use TBE-ES acceptance criteria of 70% - 130% recovery. Warning limits are set from 70% -80% and 120% - 130%. Results evaluated as Warning are evaluated for trends of low bias or high bias and are used to detect potential problems. The laboratory's internal acceptance criteria are based on MAPEP's defined performance levels of bias greater than 30%.

A matrix spike (MS) sample is an aliquot of a sample spiked with a known concentration of a target analyte prior to sample preparation and analysis. The matrix spike is used to document the bias of a method in a sample matrix. Matrix spike results use acceptance criteria of 60% – 140% recovery.

2.) Other Measures

Backgrounds represent the ambient signal response, recorded by measuring instruments, which are independent of radioactivity contributed by the radionuclides being measured in the sample. Backgrounds must not contain any three-sigma statistically positive activity of the target parameters.

Blank samples are acceptable if they do not contain any three-sigma statistically positive activity of the target parameters, unless the associated samples are positive. If

all sample results associated with the blank are greater than the MDC, then the blank MDC shall be less than the activity of the least active sample in the work order. If possible, equivalent media for preparing laboratory processing blanks will be used.

Replicate (duplicate [DUP]) and matrix spike duplicates (MSD) samples are produced by taking two aliquots from the same process check sample and assigning each aliquot a different Lab Sample Number. In cases of replicate analyses where there are no "known" values, the analyses will be evaluated for precision only. The matrix spike duplicates are split samples spiked with identical concentrations of a target analyte used to evaluate precision and bias. They are carried through the complete sample preparation and analytical procedure. Precision is evaluated by calculating the Relative Percent Difference (RPD) between the two samples. Relative Percent Difference is calculated as the absolute difference between two values normalized to the average value, expressed as a percentage:

% RPD = (abs[org – dup] / [Org + dup]/2) x 100

The matrix spike duplicate is calculated as the absolute value of the original activity minus the duplicate activity divided by the spike activity expressed as a percentage. If the original activity is not detected then the activity is considered zero (0).
MSD % Recovery = (abs[org activity – dup activity]/spike activity) x 100

For purposes of analytical reporting, each analytical result specifies the radionuclide concentration and the *a posteriori* Minimum Detectable Concentration (MDC). TBE-ES calculates the *a posteriori* MDC using the sample's actual measurement parameters (i.e., sample volume, chemical recovery, instrument background, etc.) to demonstrate that the Nuclear Regulatory Commission's (NRC) *a priori* MDC has been met for each radionuclide/sample. By TBE-ES policy, the *a posteriori* MDC must be less than the required NRC *a priori* MDC and is typically one-half the required detection limit.

b.) Instrumentation

TBE-ES uses the statistical principle method of evaluation for instrument quality control check data based on the mean, 2 sigma and 3 sigma set point model or uses pre-set tolerance limits. Each detector is checked prior to use for that day and the resulting data points are automatically compared to statistical baselines to determine the instrument's acceptability for counting. Copies of control charts showing this data are available during audits or upon request.

1.) Gamma Spectroscopy:

Gamma detectors are routinely monitored for energy, full width at half maximum, efficiency, and background. TBE-ES gamma detectors operated without incident during this reporting period. Occasional second runs (as allowed by our QA program) were necessary to verify acceptable operation. Some amplifier fine gain adjustments and liquid nitrogen addition to the dewars were also necessary when data trends indicate an energy drift on the detector.

2.) Liquid Scintillation Counters (LSC):

LSC instruments, used in tritium, C-14, Ni-63, and other low energy beta emitters, are monitored for background and efficiency. The reliability of these instruments is exceptional with minimal instances of background or efficiency values outside of control limits.

3.) Alpha/Beta Gas Flow Proportional (GFP) Counters:

GFP detectors, used for gross alpha/beta, Sr-89/90, I-131 (Low Level), and other nuclides, are monitored for background and efficiency. TBE-ES GFP detectors operated without incident during this reporting period. Occasionally, second runs (primarily for alpha due to the sensitivity of source placement) were necessary to verify acceptable operation or because of low P-10 pressure. After gas change out and purging, control check values return to control norms.

4.) Alpha Spectroscopy:

Alpha detectors are routinely monitored for energy, full width at half maximum, efficiency, and background. TBE-ES alpha detectors operated without incident during

this reporting period. Occasional second runs (as allowed by our QA program) were necessary to verify acceptable operation.

3. Investigations and Nonconformance Reports

   QC investigations are initiated when QC results fall outside of the QC criteria. Other investigations may arise from unanticipated situations which are not clearly defined in the procedures or bounded by pre-established performance criteria, but have the potential of becoming QA related issue(s). The QA investigation is the mechanism to quickly ascertain if there is "due cause" to issue a formal NCR.

   An NCR is issued when an investigation finds "due cause" to document formal investigation into the root cause of the failure, the corrective action taken, and the action taken to prevent recurrence. Investigations may include review of procedures, interviews of personnel, review of laboratory and instrument logbooks, observation of analyst techniques and any other items identified as necessary to resolve the issue.

   For intercomparison performance evaluation samples it is TBE policy to issue an NCR for unacceptable results.

II. ANALYTICAL SERVICES QUALITY CONTROL SYNOPSIS

A. Inter-laboratory Cross-Check Program

During this reporting period, 25 nuclides associated with six media types (Air Filter, Charcoal [Air Iodine], Milk, Soil, Vegetation and Water) were analyzed. Samples were obtained from Analytics, the Department of Energy's (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) and Environmental Resource Associates (ERA). Media types representative of client analyses performed during this reporting period were selected. The results for this program are presented in Attachment A.

1. Analytics Environmental Cross Check Program

Thirteen nuclides in milk, air particulate, air iodine (charcoal) and water samples were evaluated during April and July 2015. All analyses performed were within the acceptable/acceptable with warning criteria except for one Cr-51 in an air particulate sample.

NCR 15-18 was initiated to address the failure. All raw data and associated QC data were reviewed and fell within acceptance criteria.

The air particulate sample is counted on a shelf (above the detector), which is the ideal geometry for this sample. But due to the fact that Cr-51 has the shortest half-life and the weakest gamma energy, this geometry produces a larger error for the Cr-51.

If you take into account the error of the Cr-51, the ratio of found to known would be 1.19 of the reference value, which would be considered acceptable.

This failure is specific to the Analytics sample and had no impact on client samples.

2. DOE's MAPEP Quality Assessment Program

Fifteen nuclides in water, air particulate, soil and vegetation samples were evaluated in May 2015. All except three of the environmental analyses (AP – gross alpha, U-233/234; Soil - Sr-90) performed were within the acceptable criteria.

NCR 15-13 was initiated to address the in-house MAPEP failures. All raw data and associated QC data were reviewed and fell within acceptance criteria.

AP U-234/233:

The AP U-238 passed with acceptable results (95.7% recovery, found to known) while the U-234/233 was evaluated as not acceptable. Due to the extremely low activity of U-234/233 (7X less than the U-238 activity), it was difficult to quantify the U-234/233. Taking into consideration the uncertainty, the activity of U-234/233 overlaps with the known value, which is statistically considered the same value.

AP gross alpha:

In reviewing historical data, we are always low on gross alpha. The efficiency we use for gross alpha is made from a non-attenuated alpha standard. The MAPEP filter has the alphas embedded in the filter. In order to correct the low bias, TBE has created an attenuated efficiency for the MAPEP air particulate filters

AP SR-90:

It appears there was incomplete digestion of the original sample. The sample had been consumed for the original analyses. TBE incorporated the use of a stirring hotplate during digestion to improve the digestion process

These failures are specific to the MAPEP samples and had no impact on client samples.

3. ERA Environmental Cross Check Program

Thirteen nuclides in water were evaluated during 2015. All except the Sr-89 and Sr-90 environmental analyses performed were within the acceptable criteria. One MRAD sample was lost during processing.

NCR 15-09 was initiated to address the in-house ERA failures.

The sample had been consumed during the original analysis; therefore a rerun could not be performed. In reviewing the raw data it was noted that the yields associated with these samples were on the high side of our acceptance range indicating the possibility of calcium interference. Higher yields would result in lower activities. A second fuming HNO_3 separation will be performed on samples with high yields.

Impact:
It appears there is a slightly low bias to the strontium results. Historical data is monitored through our LIMS with an Out of Scope report which automatically prints each morning notifying project managers of any

analyses that have fallen outside of the low or high range normal for the particular analyte. None of the historical data indicates that any of our clients observed strontium activities have fallen outside of their normal low range.

NCR 15-23 was initiated to address an ERA MRAD particulate filter for gross alpha that was lost during processing.

The MRAD-23 particulate filters for gross alpha go through a digestion procedure, rather than being a direct count. While digesting the filter, an air bubble caused the sample to 'burp' out of the beaker.

B. Intra-laboratory Cross-Check Program

During this reporting period, 17 nuclides associated with water were analyzed by means of the laboratory's internal process control program. The compilation of intralaboratory comparison data for this reporting period is summarized in Attachment B.

The TBE-ES laboratory's internal process control program evaluated 5939 analyses during this period.

1. Blanks

During this reporting period, all of 1491 environmental blanks analyzed were less than the MDC.

2. Spikes

During this reporting period, all of 1548 environmental spikes and matrix spikes analyzed were within the acceptance criteria.

3. Duplicates

All except one of the 2900 duplicate sets analyzed were within acceptance criteria. The associated samples were reanalyzed with acceptable QC results.

C. Non-Conformance Reports

Twenty-two (22) non-conformance reports were issued for this reporting period. See Attachment C for the non-conformance reports. Section II A gives detailed accounts of the non-conformances initiated for inter-laboratory cross-check program failures.

NCR 15-01 was initiated to address a client's milk K-40 being incorrectly reported as <25.9 pCi/L.

The milk sample had been switched with a water sample in the count room. The samples were recounted and revised reports were sent to the clients.

Impact:
This was specific to the two samples; therefore there is no impact on other client samples.

NCR 15-02 was initiated to address a client sample with detected K-40 activity in a solid sample that was a non-detect on the recount.

It appears the detected K-40 may have been from interference from background radiation.

Impact:
No other client samples were affected; therefore there is no impact on client samples.

NCR 15-03 was initiated to address a client provided Analytics air particulate (AP) Sr-89 sample that failed acceptance criteria. The known value of the cross check sample was not disclosed to TBE.

The sample was rerun. The RPD of the original and rerun result was 12.9%, falling within the acceptance criteria of <30% for air particulates. The original and rerun results overlapped at the 95% confidence level, indicating it was statistically the same number.

Impact:
TBE feels the failure was specific to the client sample; therefore there is no impact on client samples.

NCR 15-04 was initiated to address several Analytics samples from 2014 provided by a client that failed the acceptance criteria. Three Co-60 in air particulates failed high with ratios of 1.32 – 1.37; one I-131 low level in milk failed low at a ratio of 0.79 and one soil Cr-51 failed high with a ratio of 1.38. Due to the late notification of the failures, reruns were not possible.

The in-house Analytics air particulate sample Co-60 result during the same period passed with a ratio of 1.22. No indication could be found as to why the Co-60 results had significantly higher ratios than all the other gamma emitters in the sample.

The in-house Analytics milk sample I-131 low level result during the same period passed with a ratio 0.95. The I-131 sample had been recounted prior to reporting with a comparable result. A rerun could not have been performed at the time of the initial analysis due to consumption of the entire sample for the original I-131 low level analysis.

No indication could be found as to why the Cr-51 in soil had a ratio of 1.38 when all the other gamma emitters' ratios ranged from 0.94 to 1.19.

Impact:
TBE feels the failures were specific to the client's samples; therefore there is no impact on client samples.

NCR 15-05 was initiated to address a client's preliminary report of a higher than normal H-3 result due to an incorrect reference year.

The reference year had been manually logged in as 2005 rather than 2015.

Impact:
The failure was specific to the client's sample; therefore there is no impact on other client samples.

NCR 15-06 was initiated to address air particulate samples from week 01/21/15–02/18/15 that could not be located for the quarterly air particulate composite.

Per the tracking number and the Incoming Shipment Record maintained in the TBE LIMS, the envelope containing the air particulate samples was received at TBE on 01/29/15. Air iodine analyses are not required for the site so the envelope containing the samples would be flat and could appear to be empty. It appears a new sample receiving person that was being trained at the time threw the envelope away believing it was empty.

Impact:
The failure was specific to the client's samples; therefore there is no impact on other client samples.

NCR 15-07 was initiated to address two Ru-106 values that were reported as having positive activity. When recalculated, the results were non-detect.

The gamma library was corrupted for the Ru-106 and Ag-110m, causing the Ag-110m energy line to interfere with the processing of Ru-106. The energy lines for the Ru-106 and the Ag-110m were the same in the Canberra library. Canberra was contacted and stated the activity values

for both isotopes was wrong. The interference only occurs in the presence of positive Ag-110m activity.

Impact:
The data base was queried for positive Ru-106 over the last three years. One other client sample was found, the gamma library was recompiled, the result recalculated and the client was notified. A revised report was sent to that client. No other client samples were impacted by this non-conformance.

NCR 15-09 was initiated to address in-house ERA Sr-89 and Sr-90 water results that were evaluated as failing low.

The sample had been consumed during the original analysis; therefore a rerun could not be performed. In reviewing the raw data it was noted that the yields associated with these samples were on the high side of our acceptance range indicating the possibility of calcium interference. Higher yields would result in lower activities. A second fuming HNO_3 separation will be performed on samples with high yields.

Impact:
It appears there is a slightly low bias to the strontium results. Historical data is monitored through our LIMS with an Out of Scope report which automatically prints each morning notifying project managers of any analyses that have fallen outside of the low or high range normal for the particular analyte. None of the historical data indicates that any of our clients observed strontium activities have fallen outside of their normal low range.

NCR 15-10 was initiated to address a client supplied Analytics Ni-63 in a liquid result that failed low with a found result of 1.11 E-03 uCi/cc vs the known value of 4.04 E-03 uCi/cc, resulting in a found to known ratio of 0.27.

The rerun activity of 4.20 E-03 uCi/cc passed the acceptance criteria. It was determined that the aliquot of the original sample should have been 3 mL but was incorrectly logged in as 10 mL, resulting in the low result. Recalculating the original result with the correct aliquot of 3 mL would have given a result of 3.70 E-03 uCi/cc. The sample would have passed the acceptance criteria with a found to known ratio of 0.92. Sample aliquots are typically 10 mL, but due to the activity of cross check samples, the aliquot is reduced to 3 mL

Impact:
The failure was specific to the client's sample; therefore there is no impact on other client samples.

NCR 15-11 was initiated to address a client supplied Analytics Sr-89 in a liquid result that failed low with a found result of 1.44 E-02 uCi/mL vs the known value of 2.01 E-02 uC/mL, resulting in a found to known ratio of 0.72.
In reviewing the original raw data it was noted that the yield of 88.5% associated with this sample was on the high side of our acceptance range. Higher yields result in lower activities. A second fuming HNO_3 separation will be performed on samples with high yields.

The sample was rerun. The rerun activity was 1.77E-02 uCi/mL with a yield of 51.4%, resulting in a found to known ratio of 0.88, which would have passed the acceptance criteria.

Impact:
It appears there is a slightly low bias to the strontium results. Historical data is monitored through our LIMS with an Out of Scope report which automatically prints each morning notifying project managers of any analyses that have fallen outside of the low or high range normal for the particular analyte. None of the historical data indicates that any of our clients observed strontium activities have fallen outside of their normal low range.

NCR 15-12 was initiated to address a client groundwater sample that was not logged in for the requested gamma analysis. Due to the late addition of the gamma, three LLDs were missed.

Even though an electronic chain of custody was sent with the sample, the technician manually logged in the sample and failed to log in the requested gamma analysis. The reviewer of the login failed to notice the omission. The reference date of the sample was 04/01/15 but the omission wasn't noticed until the AREOR was being pulled together. Due to the delay in counting the sample, the I-131, Ba-140 and La-140 LLDs were missed.

Impact:
The failure was specific to the client's sample; therefore there is no impact on other client samples.

NCR 15-13 was initiated to address the in-house MAPEP failures for the soil Sr-90 and air particulate Gross Alpha results that were evaluated as failing low and the air particulate U-234/233 result that was evaluated as failing high. All raw data and associated QC data were reviewed and fell within acceptance criteria.

Air Particulate U-234/233:

The AP U-238 passed with acceptable results (95.7% recovery, found to known) while the U-234/233 was evaluated as not acceptable. Due to the extremely low activity of U-234/233 (7X less than the U-238 activity), it was difficult to quantify the U-234/233. Taking into consideration the uncertainty, the activity of U-234/233 overlaps with the known value, which is statistically considered the same value.

AP gross alpha:

In reviewing historical data, we are always low on gross alpha. The efficiency we use for gross alpha is made from a non-attenuated alpha standard. The MAPEP filter has the alphas embedded in the filter. In order to correct the low bias, TBE has created an attenuated efficiency for the MAPEP air particulate filters

These failures are specific to the MAPEP samples and had no impact on client samples.

NCR 15-14 was initiated to address a client Sr-89 in an air particulate that failed low.

The Strontium 89 rerun mount was counted as soon as possible after filtering, which resulted in an acceptable result. The Sr-89 calculation program performs an ingrowth correction for Sr-90/Y-90. It appears that the Y-90 in-growth is causing too big a correction for the Sr-90/Y-90 therefore artificially lowering the Sr-89 result. Counting the samples as soon as possible after counting will minimize the ingrowth interference.

Impact:
While the lowest acceptance limit for this cross check is set at 0.75, TBE would evaluate this as acceptable with warning. All client Sr-89 data was reviewed against historical ranges. No other client samples were affected.

NCR 15-15 was initiated to address a client H-3 in soil result that did not match the client's result.

All the raw data and QC sample data were reviewed. A dilution was made on the original sample. The reruns were undiluted aliquots of 1 mL. Based on the fact that the difference between the original and rerun activities is approximately 5 times, we assume that a dilution error was made during aliquoting of the original sample. Revised reports with recalculated data were sent to the clients.

Impact:
All client H-3 data was reviewed against historical ranges. No other client samples were affected.

NCR 15-16 was initiated to address 22 H-3 results that had been calculated using an incorrect efficiency curve on Liquid Scintillation Counter (LSC) identified as LS7.

LS7 was defaulting to an efficiency >0.600 rather than the correct efficiency of approximately 0.385. As a result, the correct efficiency had to be manually entered. This is a glitch that had only recently been noticed on this detector. Historical data was reviewed and no other samples were affected by this error. Of the 22 samples affected, 13 samples were non-detects and nine has positive activity that increased when the data was recalculated. Three samples had missed MDCs but the original results had missed the MDCs also due to the age of the samples at receipt. The results were recalculated using the correct efficiency and revised reports were sent to the clients

Impact:
The failure was specific to the 22 samples identified in the NCR and there was no impact on other client samples.

NCR 15-17 was initiated to address a client's eleven (11) work orders where the air iodine volumes did not match the air particulate volumes on the chain of custodies provided by the sampler.

During a review of air sample results for the report of analysis L64893, it was noted that the air iodine volumes did not match the air particulate volumes. A query was run to determine if any other air iodine volumes did not match the air particulate volumes. Per the query, eleven (11) work orders for one (1) client were affected. Seven (7) of the work orders had been reported and four (4) were still in house pending analysis. The client was notified immediately.

It was determined that some of the 'Run Time' formulas for the air iodine volumes on the eCOC provided by the sampler had been corrupted, resulting in the incorrect air volumes.

The volumes were corrected in LIMS for the eleven (11) work orders. The previously reported data was corrected for the seven (7) work orders and revised reports were sent to the client.

Impact:
The failure was specific to one client and the eleven (11) work orders identified by the query and there was no impact on other client samples.

NCR 15-18 was initiated to address air particulate Cr-51 that failed high. All raw data and associated QC data were reviewed and fell within acceptance criteria.

The air particulate sample is counted on a shelf (above the detector), which is the ideal geometry for this sample. But due to the fact that Cr-51 has the shortest half-life and the weakest gamma energy, this geometry produces a larger error for the Cr-51.

If you take into account the error of the Cr-51, the ratio of found to known would be 1.19 of the reference value, which would be considered acceptable.

Impact:
This failure is specific to the Analytics sample and had no impact on client samples.

NCR 15-19 was initiated to address the in-house ERA failure for a natural uranium result that was evaluated as failing high. All raw data and associated QC data were reviewed and fell within acceptance criteria.

In talking with the technician that ran the analysis, it was discovered that the technician did not dilute the sample as required, but used the entire 12 mL sample.

When recalculated using the aliquot of 12 mL, the result of 57.16 agreed with the assigned value of 53.2.

Impact:
The failure was specific to the ERA sample and there was no impact on other client samples.

NCR 15-20 was initiated to a client provided Analytics air particulate Ni-63 result that was evaluated as failing low with a 0.72 ratio. All raw data and associated QC data were reviewed and fell within acceptance criteria.

A rerun was order. The rerun passed with a ratio of 0.96. After reviewing the QC, yield, and associated raw data of the original analysis, we were unable to determine the cause for the slightly low activity of the originally reported result. Historically, Ni-63 has fallen within acceptance criteria.

Impact:
The failure was specific to the client's Analytics sample and there was no impact on other client samples.

NCR 15-21 was initiated to address the in-house MAPEP failures for Water Ni-63 that was evaluated as failing high and air particulate and vegetation samples for Sr-90 that were evaluated as failing low. All raw data and associated QC data were reviewed and fell within acceptance criteria.

Water Ni-63:

This is the first failed Ni-63 in 10 years. The original sample was run with a 10 mL aliquot which was not sufficient for the low level of Ni-63 in the sample. The sample was rerun using a 30 mL aliquot and produced acceptable results. MAPEP does not provide enough water to be able to use the same aliquot that we use for client samples.

Air Particulate and Vegetation Sr-90:

Both samples were rerun with acceptable results. It appears that the Sr-90 was lost during the separation chemistry although the exact cause could not be identified. In the past, MAPEP has added substances (unusual compounds found in DOE complexes) to various matrices that have resulted in incomplete removal of the isotope of interest for the laboratories analyzing the cross checks. We feel that this is possibly the case with these two samples.

Impact:
The failures were specific to the MAPEP samples and there was no impact on other client samples.

NCR 15-22 was initiated to address a client C-14 result that looked unusually high. All raw data and associated QC data were reviewed and fell within acceptance criteria.

The sample was rerun. The rerun result was considerably lower than the original result.

In comparing the data in the workgroup, one sample appeared to be too low. The original vials were recounted and it was determined that two of the sample results were switched. This indicates the samples were accidentally switched in the count room when being loaded into the liquid scintillation counter

Impact:
The failure was specific to the two (2) samples associate with this issue and there was no impact on other client samples.

NCR 15-23 was initiated to address an ERA MRAD particulate filter for gross alpha that was lost during processing.

The MRAD-23 particulate filters for gross alpha go through a digestion procedure, rather than being a direct count. While digesting the filter, an air bubble caused the sample to 'burp' out of the beaker.

Impact:
The failure was specific to the MRAD-23 sample and there was no impact on client samples.

D. Observation Reports

No observation reports were issued for this reporting period.

E. Instrumentation

TBE-ES uses the statistical principle method of evaluation for instrument quality control check data based on the mean, 2 sigma and 3 sigma set point model or uses pre-set tolerance limits. Each detector is checked prior to use for that day and the resulting data points are automatically compared to statistical baselines to determine the instrument's acceptability for counting. Control charts showing this data are available during audits or upon request.
Gamma Spectroscopy:

Gamma detectors are routinely monitored for energy, full width at half maximum, efficiency, and background. TBE-ES gamma detectors operated without incident during this reporting period. Occasional second runs (as allowed by our QA program) were necessary to verify acceptable operation. Some amplifier fine gain adjustments and liquid nitrogen addition to the dewars were also necessary when data trends indicate an energy drift on the detector.

Liquid Scintillation Counters (LSC):

LSC instruments, used in tritium, C-14, Ni-63, and other low energy beta emitters, are monitored for background and efficiency. The reliability of these instruments is exceptional with zero instances of background or efficiency values outside of control limits.

Alpha/Beta Gas Flow Proportional (GFP) Counters:

GFP detectors, used for gross alpha/beta, Sr-89/90, I-131 (Low Level), and other nuclides, are monitored for background and efficiency. TBE-ES GFP detectors operated without incident during this reporting period. Occasionally, second runs (primarily for alpha due to the sensitivity of

source placement) were necessary to verify acceptable operation or because of low P-10 pressure. After gas change out and purging, control check values return to control norms.

Alpha Spectroscopy:

Alpha detectors are routinely monitored for energy, full width at half maximum, efficiency, and background. TBE-ES alpha detectors operated without incident during this reporting period. Occasional second runs (as allowed by our QA program) were necessary to verify acceptable operation.

ATTACHMENT A

Interlaboratory Quality Control Program Results

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A.1

Analytics Cross Check Program Results

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 1 OF 3)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2015	E11181	Milk	Sr-89	pCi/L	88.9	97.2	0.91	A
			Sr-90	pCi/L	12.2	17.4	0.70	W
	E11182	Milk	I-131	pCi/L	61.3	65.1	0.94	A
			Ce-141	pCi/L	104	113	0.92	A
			Cr-51	pCi/L	265	276	0.96	A
			Cs-134	pCi/L	138	154	0.90	A
			Cs-137	pCi/L	205	207	0.99	A
			Co-58	pCi/L	178	183	0.97	A
			Mn-54	pCi/L	187	188	0.99	A
			Fe-59	pCi/L	182	177	1.03	A
			Zn-65	pCi/L	345	351	0.98	A
			Co-60	pCi/L	379	405	0.94	A
	E11184	AP	Ce-141	pCi	107	85.0	1.26	W
			Cr-51	pCi	261	224	1.17	A
			Cs-134	pCi	74.6	77.0	0.97	A
			Cs-137	pCi	99.6	102	0.98	A
			Co-58	pCi	99.8	110	0.91	A
			Mn-54	pCi	99.2	96.9	1.02	A
			Fe-59	pCi	109	119	0.92	A
			Zn-65	pCi	188	183	1.03	A
			Co-60	pCi	200	201	1.00	A
	E11183	Charcoal	I-131	pCi	82.9	85.4	0.97	A
	E11185	Water	Fe-55	pCi/L	1950	1900	1.03	A
June 2015	E11234	Milk	Sr-89	pCi/L	94.9	92.6	1.02	A
			Sr-90	pCi/L	14.3	12.7	1.13	A
	E11238	Milk	I-131	pCi/L	93.2	95.9	0.97	A
			Ce-141	pCi/L	Not provided for this study			
			Cr-51	pCi/L	349	276	1.26	W
			Cs-134	pCi/L	165	163	1.01	A
			Cs-137	pCi/L	143.0	125	1.14	A
			Co-58	pCi/L	82.0	68.4	1.20	A
			Mn-54	pCi/L	113	101	1.12	A
			Fe-59	pCi/L	184	151	1.22	W
			Zn-65	pCi/L	269	248	1.08	A
			Co-60	pCi/L	208	193	1.08	A
	E11237	AP	Ce-141	pCi	Not provided for this study			
			Cr-51	pCi	323	233	1.39	N (1)
			Cs-134	pCi	139	138	1.01	A
			Cs-137	pCi	111	106	1.05	A
			Co-58	pCi	54.0	57.8	0.93	A
			Mn-54	pCi	96.8	84.9	1.14	A
			Fe-59	pCi	162	128	1.27	W
			Zn-65	pCi	198	210	0.94	A
			Co-60	pCi	178	163	1.09	A
	E11236	Charcoal	I-131	pCi	93.9	80	1.17	A

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
June 2015	E11238	Water	Fe-55	pCi/L	1890	1790	1.06	A
September 2015	E11289	Milk	Sr-89	pCi/L	95.7	99.1	0.97	A
			Sr-90	pCi/L	15.4	16.4	0.94	A
	E11290	Milk	I-131	pCi/L	94.9	99.9	0.95	A
			Ce-141	pCi/L	228	213	1.07	A
			Cr-51	pCi/L	499	538	0.93	A
			Cs-134	pCi/L	208	212	0.98	A
			Cs-137	pCi/L	270	255	1.06	A
			Co-58	pCi/L	275	263	1.05	A
			Mn-54	pCi/L	320	290	1.10	A
			Fe-59	pCi/L	255	226	1.13	A
			Zn-65	pCi/L	392	353	1.11	A
			Co-60	pCi/L	350	330	1.06	A
	E11292	AP	Ce-141	pCi	104	85.1	1.22	W
			Cr-51	pCi	262	215	1.22	W
			Cs-134	pCi	86.1	84.6	1.02	A
			Cs-137	pCi	93.0	102	0.91	A
			Co-58	pCi	106	105	1.01	A
			Mn-54	pCi	117	116	1.01	A
			Fe-59	pCi	94.8	90.2	1.05	A
			Zn-65	pCi	160	141	1.13	A
			Co-60	pCi	146	132	1.11	A
	E11291	Charcoal	I-131	pCi	85.9	81.7	1.05	A
	E11293	Water	Fe-55	pCi/L	2090	1800	1.16	A
	E11294	Soil	Ce-141	pCi/kg	209	222	0.94	A
			Cr-51	pCi/kg	463	560	0.83	A
			Cs-134	pCi/kg	231	221	1.05	A
			Cs-137	pCi/kg	311	344	0.90	A
			Co-58	pCi/kg	245	274	0.89	A
			Mn-54	pCi/kg	297	302	0.98	A
			Fe-59	pCi/kg	248	235	1.06	A
			Zn-65	pCi/kg	347	368	0.94	A
			Co-60	pCi/kg	328	344	0.95	A
December 2015	E11354	Milk	Sr-89	pCi/L	96.2	86.8	1.11	A
			Sr-90	pCi/L	14.8	12.5	1.18	A
	E11355	Milk	I-131	pCi/L	95.1	91.2	1.04	A
			Ce-141	pCi/L	117	129	0.91	A
			Cr-51	pCi/L	265	281	0.94	A
			Cs-134	pCi/L	153	160	0.96	A
			Cs-137	pCi/L	119	115	1.03	A
			Co-58	pCi/L	107	110	0.97	A
			Mn-54	pCi/L	153	145	1.06	A
			Fe-59	pCi/L	117	108	1.08	A
			Zn-65	pCi/L	261	248	1.05	A
			Co-60	pCi/L	212	213	1.00	A

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
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Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
December 2015	E11357	AP	Ce-141	pCi	89.9	84	1.07	A
			Cr-51	pCi	215.0	184	1.17	A
			Cs-134	pCi	103.0	105	0.98	A
			Cs-137	pCi	76.6	75	1.02	A
			Co-58	pCi	76.2	72	1.06	A
			Mn-54	pCi	91.4	94	0.97	A
			Fe-59	pCi	78.6	70	1.12	A
			Zn-65	pCi	173.0	162	1.07	A
			Co-60	pCi	138.0	139	0.99	A
	E11422	AP	Sr-89	pCi	98.0	97	1.01	A
			Sr-90	pCi	10.0	14	0.71	W
	E11356	Charcoal	I-131	pCi	74.9	75	1.00	A
	E11358	Water	Fe-55	pCi/L	2160.0	1710	1.26	W
	E11353	Soil	Ce-141	pCi/kg	252.0	222	1.14	A
			Cr-51	pCi/kg	485.0	485	1.00	A
			Cs-134	pCi/kg	319.0	277	1.15	A
			Cs-137	pCi/kg	292.0	276	1.06	A
			Co-58	pCi/kg	193.0	190	1.02	A
			Mn-54	pCi/kg	258.0	250	1.03	A
			Fe-59	pCi/kg	218.0	186	1.17	A
			Zn-65	pCi/kg	457.0	429	1.07	A
			Co-60	pCi/kg	381.0	368	1.04	A

(1) AP Cr-51 - Cr-51 has the shortest half-life and the weakest gamma energy of the mixed nuclide sample, which produces a large error. Taking into account the error, the lowest value would be 119% of the reference value, which would be considered acceptable. NCR 15-18

(a) Teledyne Brown Engineering reported result.

(b) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) Analytics evaluation based on TBE internal QC limits: A= Acceptable, reported result falls within ratio limits of 0.80-1.20. W-Acceptable with warning, reported result falls within 0.70-0.80 or 1.20-1.30. N = Not Acceptable, reported result falls outside the ratio limits of < 0.70 and > 1.30.

A.2

MAPEP Quality Assessment Program Results

DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 1 OF 1)

Month/Year	Identification Number	Media	Nuclide*	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
March 2015	15-MaW32	Water	Am-241	Bq/L	0.632	0.654	0.458 - 0.850	A
			Ni-63	Bq/L	2.5		(1)	A
			Pu-238	Bq/L	0.0204	0.0089	(2)	A
			Pu-239/240	Bq/L	0.9	0.8	0.582 - 1.082	A
	15-MaS32	Soil	Ni-63	Bq/kg	392	448.0	314 - 582	A
			Sr-90	Bq/kg	286	653	487 - 849	N (3)
	15-RdF32	AP	Sr-90	Bq/sample	-0.0991		(1)	A
			U-234/233	Bq/sample	0.0211	0.0155	0.0109 - 0.0202	N (3)
			U-238	Bq/sample	0.095	0.099	0.069 - 0.129	A
	15-GrF32	AP	Gr-A	Bq/sample	0.448	1.77	0.53 - 3.01	N (3)
			Gr-B	Bq/sample	0.7580	0.75	0.38 - 1.13	A
	15-RdV32	Vegetation	Cs-134	Bq/sample	8.08	7.32	5.12 - 9.52	A
			Cs-137	Bq/sample	11.6	9.18	6.43 - 11.93	W
			Co-57	Bq/sample	-0.0096		(1)	A
			Co-60	Bq/sample	6.53	5.55	3.89 - 7.22	A
			Mn-54	Bq/sample	0.0058		(1)	A
			Sr-90	Bq/sample	0.999	1.08	0.76 - 1.40	A
			Zn-65	Bq/sample	-0.108		(1)	A
September 2015	15-MaW33	Water	Am-241	Bq/L	1.012	1.055	0.739 - 1.372	A
			Ni-63	Bq/L	11.8	8.55	5.99 - 11.12	N (4)
			Pu-238	Bq/L	0.727	0.681	0.477 - 0.885	A
			Pu-239/240	Bq/L	0.830	0.900	0.630 - 1.170	A
	15-MaS33	Soil	Ni-63	Bq/kg	635	682	477 - 887	A
			Sr-90	Bq/kg	429	425	298 - 553	A
	15-RdF33	AP	Sr-90	Bq/sample	1.48	2.18	1.53 - 2.83	N (4)
			U-234/233	Bq/sample	0.143	0.143	0.100 - 0.186	A
			U-238	Bq/sample	0.149	0.148	0.104 - 0.192	A
	15-GrF33	AP	Gr-A	Bq/sample	0.497	0.90	0.27 - 1.53	A
			Gr-B	Bq/sample	1.34	1.56	0.78 - 2.34	A
	15-RdV33	Vegetation	Cs-134	Bq/sample	6.10	5.80	4.06 - 7.54	A
			Cs-137	Bq/sample	0.0002		(1)	A
			Co-57	Bq/sample	8.01	6.62	4.63 - 8.61	W
			Co-60	Bq/sample	4.97	4.56	3.19 - 5.93	A
			Mn-54	Bq/sample	8.33	7.68	5.38 - 9.98	A
			Sr-90	Bq/sample	0.386	1.30	0.91 - 1.69	N (4)
			Zn-65	Bq/sample	6.07	5.46	3.82 - 7.10	A

(1) False positive test.

(2) Sensitivity evaluation.

(3) Soil Sr-90 - incomplete digestion of the sample resulted in low results; AP U-234/233 - extremely low activity was difficult to quantify AP Gr-A - the MAPEP filter has the activity embedded in the filter. To corrected the low bias, TBE will create an attenuated efficiency for MAPEP samples. NCR 15-13

(4) Water Ni-63 extremely low activity was difficult to quantify; AP & Vegetation Sr-90 was lost during separation. possiblely from substance added by MAPEP NCR 15-21.

(a) Teledyne Brown Engineering reported result.

(b) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(c) DOE/MAPEP evaluation: A=acceptable, W=acceptable with warning, N=not acceptable.

A.3

ERA Cross Check Program Results

ERA ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Limits	Evaluation (c)
May 2015	RAD-101	Water	Sr-89	pCi/L	45.2	63.2	51.1 - 71.2	N (1)
			Sr-90	pCi/L	28.0	41.9	30.8 - 48.1	N (1)
			Ba-133	pCi/L	80.6	82.5	63.9 - 90.8	A
			Cs-134	pCi/L	71.7	75.7	61.8 - 83.3	A
			Cs-137	pCi/L	187	189	170 - 210	A
			Co-60	pCi/L	85.7	84.5	76.0 - 95.3	A
			Zn-65	pCi/L	197	203	183 - 238	A
			Gr-A	pCi/L	26.1	42.6	22.1 - 54.0	A
			Gr-B	pCi/L	28.8	32.9	21.3 - 40.6	A
			I-131	pCi/L	23.5	23.8	19.7 - 28.3	A
			U-Nat	pCi/L	6.19	6.59	4.99 - 7.83	A
			H-3	pCi/L	3145	3280	2770 - 3620	A
	MRAD-22	Filter	Gr-A	pCi/filter	28.3	62.2	20.8 - 96.6	A
011/01/2015	RAD-103	Water	Sr-89	pCi/L	40.9	35.7	26.7 - 42.5	A
			Sr-90	pCi/L	29.3	31.1	22.7 - 36.1	A
			Ba-133	pCi/L	31.5	32.5	25.9 - 36.7	A
			Cs-134	pCi/L	59.65	62.3	50.6 - 68.5	A
			Cs-137	pCi/L	156	157	141 - 175	A
			Co-60	pCi/L	70.6	71.1	64.0 - 80.7	A
			Zn-65	pCi/L	145	126	113 - 149	A
			Gr-A	pCi/L	38.2	51.6	26.9 - 64.7	A
			Gr-B	pCi/L	42.0	36.6	24.1 - 44.2	A
			I-131	pCi/L	24.8	26.3	21.9 - 31.0	A
			U-Nat	pCi/L	146.90	56.2	45.7 - 62.4	N (2)
			H-3	pCi/L	21100	21300	18700 - 23400	A
	MRAD-23	Filter	Gr-A	pCi/filter	Lost during processing			N (3)

(1) Yield on the high side of our acceptance range indicates possibility of calcium interference. NCR 15-09

(2) Technician failed to dilute origanal sample. If dilulted, the result would have been 57.1, which fell within the acceptance limits. NCR 15-19

(3) Sample was lost during the digestion process. NCR 15-23

(a) Teledyne Brown Engineering reported result.

(b) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.

A.4

Analytics Cross Check Program Results – Client Supplied Samples

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
CLIENT PROVIDED SAMPLES
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 1 OF 4)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2015	E11139	Milk	I-131	pCi/L	97.0	98.1	0.99	A
			Ce-141	pCi/L	112	124	0.90	A
			Cr-51	pCi/L	296	327	0.91	A
			Cs-134	pCi/L	103	113	0.91	A
			Cs-137	pCi/L	141	149	0.95	A
			Co-58	pCi/L	139	161	0.86	A
			Mn-54	pCi/L	136	142	0.96	A
			Fe-59	pCi/L	161	174	0.93	A
			Zn-65	pCi/L	257	267	0.96	A
			Co-60	pCi/L	263	294	0.89	A
June 2015	E11209	Milk	I-131	pCi/L	95.0	98.2	0.97	A
			Ce-141	pCi/L	None provided for this study			
			Cr-51	pCi/L	3560	3560	1.00	A
			Cs-134	pCi/L	2030	2100	0.97	A
			Cs-137	pCi/L	1730	1620	1.07	A
			Co-58	pCi/L	919	882	1.04	A
			Mn-54	pCi/L	1400	1300	1.08	A
			Fe-59	pCi/L	2140	1950	1.10	A
			Zn-65	pCi/L	3390	3210	1.06	A
			Co-60	pCi/L	2540	2490	1.02	A
September 2015	E11267A	Milk	I-131	pCi/L	105	89	1.18	A
			Ce-141	pCi/L	123	190	0.65	N (1)
			Cr-51	pCi/L	503	481	1.05	A
			Cs-134	pCi/L	186	189	0.98	A
			Cs-137	pCi/L	246	228	1.08	A
			Co-58	pCi/L	228	235	0.97	A
			Mn-54	pCi/L	251	259	0.97	A
			Fe-59	pCi/L	209	202	1.03	A
			Zn-65	pCi/L	270	316	0.85	A
			Co-60	pCi/L	280	295	0.95	A
December 2015	E11399	Milk	I-131	pCi/L	99.8	93	1.07	A
			Ce-141	pCi/L	1790	1730	1.03	A
			Cr-51	pCi/L	3950	3790	1.04	A
			Cs-134	pCi/L	2100	2160	0.97	A
			Cs-137	pCi/L	1650	1540	1.07	A
			Co-58	pCi/L	1520	1480	1.03	A
			Mn-54	pCi/L	2090	1950	1.07	A
			Fe-59	pCi/L	1610	1450	1.11	A
			Zn-65	pCi/L	3650	3340	1.09	A
			Co-60	pCi/L	2980	2870	1.04	A
March 2015	E11140	AP	Ce-141	pCi	76.5	66.8	1.15	A
			Cr-51	pCi	190	176	1.08	A
			Cs-134	pCi	66	61	1.08	A
			Cs-137	pCi	77	80	0.96	A
			Co-58	pCi	92	86	1.07	A
			Mn-54	pCi	90	76.1	1.18	A
			Fe-59	pCi	88	94	0.94	A
			Zn-65	pCi	145	143	1.01	A
			Co-60	pCi	170	158	1.08	A

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
CLIENT PROVIDED SAMPLES
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 2 OF 4)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2015	E11141	AP	Ce-141	pCi	85	70.8	1.20	A
			Cr-51	pCi	214	186	1.15	A
			Cs-134	pCi	67	64	1.05	A
			Cs-137	pCi	88	85	1.04	A
			Co-58	pCi	93	91	1.02	A
			Mn-54	pCi	84	81	1.04	A
			Fe-59	pCi	109	99.1	1.10	A
			Zn-65	pCi	147	152	0.97	A
			Co-60	pCi	175	167	1.05	A
March 2015	E11142	AP	Ce-141	pCi	77	68.5	1.12	A
			Cr-51	pCi	196	180	1.09	A
			Cs-134	pCi	63	62	1.02	A
			Cs-137	pCi	84	82.1	1.02	A
			Co-58	pCi	95	88.5	1.07	A
			Mn-54	pCi	86	78.1	1.10	A
			Fe-59	pCi	82	95.9	0.86	A
			Zn-65	pCi	137	147	0.93	A
			Co-60	pCi	167	162	1.03	A
June 2015	E11210	AP	Ce-141	pCi	None provided for this study			
			Cr-51	pCi	317	245	1.29	N (1)
			Cs-134	pCi	156	144	1.08	A
			Cs-137	pCi	123	111	1.11	A
			Co-58	pCi	61	60.0	1.02	A
			Mn-54	pCi	91	89	1.02	A
			Fe-59	pCi	143	134	1.07	A
			Zn-65	pCi	225	220	1.02	A
			Co-60	pCi	173	172	1.01	A
June 2015	E11211	AP	Ce-141	pCi	None provided for this study			
			Cr-51	pCi	273	248	1.10	A
			Cs-134	pCi	162	146	1.11	A
			Cs-137	pCi	116	112	1.04	A
			Co-58	pCi	69	61.0	1.13	A
			Mn-54	pCi	89	90	0.99	A
			Fe-59	pCi	152	136	1.12	A
			Zn-65	pCi	208	223	0.93	A
			Co-60	pCi	191	173	1.10	A
June 2015	E11212	AP	Ce-141	pCi	None provided for this study			
			Cr-51	pCi	339	231	1.47	N (1)
			Cs-134	pCi	136	136	1.00	A
			Cs-137	pCi	106	105	1.01	A
			Co-58	pCi	54	57.2	0.94	A
			Mn-54	pCi	87	84	1.04	A
			Fe-59	pCi	100	127	0.79	W
			Zn-65	pCi	204	208	0.98	A
			Co-60	pCi	153	161	0.95	A

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
CLIENT PROVIDED SAMPLES
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 3 OF 4)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
December 2015	E11400	AP	Ce-141	pCi	97	94	1.03	A
			Cr-51	pCi	195	204	0.96	A
			Cs-134	pCi	116	116	1.00	A
			Cs-137	pCi	81	83	0.98	A
			Co-58	pCi	84	80	1.05	A
			Mn-54	pCi	102	105	0.97	A
			Fe-59	pCi	83	78	1.06	A
			Zn-65	pCi	181	180	1.01	A
			Co-60	pCi	160	155	1.03	A
December 2015	E11401	AP	Ce-141	pCi	92	85	1.08	A
			Cr-51	pCi	217	185	1.17	A
			Cs-134	pCi	102	105	0.97	A
			Cs-137	pCi	70	75	0.93	A
			Co-58	pCi	73	73	1.00	A
			Mn-54	pCi	92	95	0.97	A
			Fe-59	pCi	71	71	1.00	A
			Zn-65	pCi	159	163	0.98	A
			Co-60	pCi	144	140	1.03	A
December 2015	E11402	AP	Ce-141	pCi	96	83	1.16	A
			Cr-51	pCi	200	181	1.10	A
			Cs-134	pCi	110	103	1.07	A
			Cs-137	pCi	79	74	1.07	A
			Co-58	pCi	72	71	1.01	A
			Mn-54	pCi	100	93	1.08	A
			Fe-59	pCi	74	69	1.07	A
			Zn-65	pCi	169	160	1.06	A
			Co-60	pCi	145	138	1.05	A
September 2015	E11271	Soil	Ce-141	pCi/kg	258	222	1.16	A
			Cr-51	pCi/kg	753	560	1.34	N(1)
			Cs-134	pCi/kg	184	221	0.83	A
			Cs-137	pCi/kg	309	344	0.90	A
			Co-58	pCi/kg	255	274	0.93	A
			Mn-54	pCi/kg	314	302	1.04	A
			Fe-59	pCi/kg	246	235	1.05	A
			Zn-65	pCi/kg	353	368	0.96	A
			Co-60	pCi/kg	366	344	1.06	A
March 2015	E11146	Water	H-3	pCi/L	4980	4850	1.03	A
June 2015	E11213	Water	H-3	pCi/L	3980	4910	0.81	A
September 2015	E11272	Water	H-3	pCi/L	4450	4800	0.93	A
December 2015	E11406	Water	H-3	pCi/L	644	552	1.17	A

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
CLIENT PROVIDED SAMPLES
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES
(PAGE 4 OF 4)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
September 2015	E11268	C	I-131	pCi	76.0	81.6	0.93	A
September 2015	E11269	C	I-131	pCi	81.6	81.6	1.00	A
September 2015	E11270	C	I-131	pCi	77.8	81.7	0.95	A
December 2015	E11403A	C	I-131	pCi	75.3	75.5	1.00	A
December 2015	E11404A	C	I-131	pCi	73.7	75.3	0.98	A
December 2015	E11405A	C	I-131	pCi	76.3	75.2	1.01	A
August 2015	A30998	Liquid	Gr-A	uci/cc	4.84E-05	5.00E-05	0.97	A
		Liquid	Sr-89	uci/cc	4.58E-03	5.18E-03	0.88	A
			Sr-90	uci/cc	5.16E-04	5.92E-04	0.87	A
			Ni-63	uci/cc	2.69E-03	3.01E-03	0.89	A
		Liquid	Fe-55	uci/cc	1.12E-03	1.00E-03	1.12	A
		AP	Co-60	uCi	6.10E-04	7.55E-04	0.81	A

(1) NCR 16-06 was inititated to investigate the failure.
(a) Teledyne Brown Engineering reported result.
(b) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.
(c) Ratio of Teledyne Brown Engineering to Analytics results.
(d) Analytics evaluation based on the United States Nuclear Regulatory Commission Inspection and Enforcement Manual, Inspection Procedure 84725, section 0.3.03 c, Criteria for Accepting the Licensee's Measurements.

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A.5

Formal Interlaboratory Quality Control Program Results

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RESULTS OF ENVIRONMENTAL

CROSS CHECK PROGRAM

TELEDYNE BROWN ENGINEERING

First Quarter 2015

L. Tk 10 Sep 15

Levan Tkavadze, Nuclear Metrologist Date

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11181	Sr-89	8.89E+01 pCi/L	1.78E+00	9.72E+01 pCi/L	1.62E+00	0.91
Sr-89/90 w/maf*	Sr-90	1.22E+01 pCi/L	4.03E-01	1.74E+01 pCi/L	2.91E-01	0.70
Milk						
TBE Sample						
L62763-1						
Ref. Date						
8-Apr-15						

* with mixed activation/fission interferences

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11182	I-131	6.13E+01 pCi/L	2.39E+00	6.51E+01 pCi/L	1.09E+00	0.94
Gamma	Ce-141	1.04E+02 pCi/L	8.64E+00	1.13E+02 pCi/L	1.88E+00	0.92
Milk	Cr-51	2.65E+02 pCi/L	4.62E+01	2.76E+02 pCi/L	4.60E+00	0.96
	Cs-134	1.38E+02 pCi/L	5.12E+00	1.54E+02 pCi/L	2.57E+00	0.90
TBE Sample	Cs-137	2.05E+02 pCi/L	8.47E+00	2.07E+02 pCi/L	3.45E+00	0.99
L62763-3	Co-58	1.78E+02 pCi/L	8.61E+00	1.83E+02 pCi/L	3.06E+00	0.97
	Mn-54	1.87E+02 pCi/L	8.43E+00	1.88E+02 pCi/L	3.14E+00	0.99
Ref. Date	Fe-59	1.82E+02 pCi/L	1.21E+01	1.77E+02 pCi/L	2.96E+00	1.03
8-Apr-15	Zn-65	3.45E+02 pCi/L	1.83E+01	3.51E+02 pCi/L	5.86E+00	0.98
	Co-60	3.79E+02 pCi/L	7.60E+00	4.05E+02 pCi/L	6.76E+00	0.94
	K-40	1.27E+03 pCi/L	8.04E+01	Present - Not Measured		----

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11183 I-131 Cartridge TBE Sample L62763-5 Ref. Date 8-Apr-15	I-131	8.29E+01 pCi	7.55E+00	8.54E+01 pCi	1.43E+00	0.97
E11184	Ce-141	1.07E+02 pCi	2.63E+01	8.50E+01 pCi	1.42E+00	1.26
Gamma	Cr-51	2.61E+02 pCi	4.77E+01	2.24E+02 pCi	3.74E+00	1.17
Filter	Cs-134	7.46E+01 pCi	2.84E+00	7.70E+01 pCi	1.29E+00	0.97
	Cs-137	9.96E+01 pCi	1.21E+01	1.02E+02 pCi	1.70E+00	0.98
TBE Sample	Co-58	9.98E+01 pCi	1.59E+01	1.10E+02 pCi	1.83E+00	0.91
L62763-6	Mn-54	9.92E+01 pCi	1.37E+01	9.69E+01 pCi	1.62E+00	1.02
	Fe-59	1.09E+02 pCi	3.09E+01	1.19E+02 pCi	1.99E+00	0.92
Ref. Date	Zn-65	1.88E+02 pCi	2.35E+01	1.83E+02 pCi	3.05E+00	1.03
19-Mar-15	Co-60	2.00E+02 pCi	1.13E+01	2.01E+02 pCi	3.35E+00	1.00
E11185 Fe-55 Water TBE Sample L62763-7 Ref. Date 8-Apr-15	Fe-55	1.95E+03 pCi/L	2.05E+02	1.90E+03 pCi/L	3.17E+01	1.03

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RESULTS OF ENVIRONMENTAL

CROSS CHECK PROGRAM

TELEDYNE BROWN ENGINEERING

Second Quarter 2015
(Ref. Date 11-Jun-2015)

5 Nov 15

Levan Tkavadze, Nuclear Metrologist Date

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11234	Sr-89	9.49E+01 pCi/L	1.07E+00	9.26E+01 pCi/L	1.55E+00	1.02
Sr-89/90 w/maf*	Sr-90	1.43E+01 pCi/L	3.50E-01	1.27E+01 pCi/L	2.12E-01	1.13
Milk						
TBE Sample						
L63686-1						

* with mixed activation/fission interferences

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SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11235	I-131	9.32E+01 pCi/L	4.05E+00	9.59E+01 pCi/L	1.60E+00	0.97
Gamma	Cr-51	3.49E+02 pCi/L	4.53E+01	2.76E+02 pCi/L	4.61E+00	1.26
Milk	Cs-134	1.65E+02 pCi/L	2.93E+00	1.63E+02 pCi/L	2.72E+00	1.01
	Cs-137	1.43E+02 pCi/L	4.59E+00	1.25E+02 pCi/L	2.09E+00	1.14
TBE Sample	Co-58	8.20E+01 pCi/L	4.78E+00	6.84E+01 pCi/L	1.14E+00	1.20
L63686-3	Mn-54	1.13E+02 pCi/L	4.78E+00	1.01E+02 pCi/L	1.68E+00	1.12
	Fe-59	1.84E+02 pCi/L	8.78E+00	1.51E+02 pCi/L	2.53E+00	1.22
	Zn-65	2.69E+02 pCi/L	1.09E+01	2.48E+02 pCi/L	4.15E+00	1.08
	Co-60	2.08E+02 pCi/L	3.96E+00	1.93E+02 pCi/L	3.22E+00	1.08
	K-40	1.54E+03 pCi/L	5.00E+01	Present - Not Measured		----

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SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11236	I-131	9.39E+01 pCi	2.40E+01	8.00E+01 pCi	1.34E+00	1.17
I-131						
Cartridge						
TBE Sample						
L63686-5						

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SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11237	Cr-51	3.23E+02 pCi	4.55E+01	2.33E+02 pCi	3.90E+00	1.38
Gamma	Cs-134	1.39E+02 pCi	2.12E+00	1.38E+02 pCi	2.30E+00	1.01
Filter	Cs-137	1.11E+02 pCi	7.85E+00	1.06E+02 pCi	1.77E+00	1.05
	Co-58	5.40E+01 pCi	1.35E+01	5.78E+01 pCi	9.64E-01	0.94
TBE Sample	Mn-54	9.68E+01 pCi	7.30E+00	8.49E+01 pCi	1.42E+00	1.14
L63686-6	Fe-59	1.62E+02 pCi	2.17E+01	1.28E+02 pCi	2.14E+00	1.27
	Zn-65	1.98E+02 pCi	1.73E+01	2.10E+02 pCi	3.51E+00	0.94
	Co-60	1.78E+02 pCi	7.15E+00	1.63E+02 pCi	2.72E+00	1.09
E11238	Fe-55	1.89E+03 pCi/L	3.29E+02	1.79E+03 pCi/L	3.00E+01	1.05
Fe-55						
Water						
TBE Sample						
L63686-7						

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RESULTS OF ENVIRONMENTAL

CROSS CHECK PROGRAM

TELEDYNE BROWN ENGINEERING

Third Quarter 2015
(Ref. Date 10-Sep-2015)

[illegible] 21 Dec 15

Levan Tkavadze, Nuclear Metrologist **Date**

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11289	Sr-89	9.57E+01 pCi/L	1.80E+00	9.91E+01 pCi/L	1.65E+00	0.97
Sr-89/90 w/maf*	Sr-90	1.54E+01 pCi/L	4.44E-01	1.64E+01 pCi/L	2.73E-01	0.94
Milk						
TBE Sample						
L64862-1						
* with mixed activation/fission interferences						
E11290	I-131	9.49E+01 pCi/L	5.60E+00	9.99E+01 pCi/L	1.67E+00	0.95
Gamma	Ce-141	2.28E+02 pCi/L	6.65E+00	2.13E+02 pCi/L	3.56E+00	1.07
Milk	Cr-51	4.99E+02 pCi/L	2.93E+01	5.38E+02 pCi/L	8.99E+00	0.93
	Cs-134	2.08E+02 pCi/L	3.48E+00	2.12E+02 pCi/L	3.54E+00	0.98
TBE Sample	Cs-137	2.70E+02 pCi/L	5.70E+00	2.55E+02 pCi/L	4.26E+00	1.06
L64862-3	Co-58	2.75E+02 pCi/L	5.93E+00	2.63E+02 pCi/L	4.40E+00	1.04
	Mn-54	3.20E+02 pCi/L	5.85E+00	2.90E+02 pCi/L	4.85E+00	1.10
	Fe-59	2.55E+02 pCi/L	7.83E+00	2.26E+02 pCi/L	3.77E+00	1.13
	Zn-65	3.92E+02 pCi/L	1.09E+01	3.53E+02 pCi/L	5.90E+00	1.11
	Co-60	3.50E+02 pCi/L	4.40E+00	3.30E+02 pCi/L	5.51E+00	1.06
	K-40	1.45E+03 pCi/L	4.59E+01	Present - Not Measured		----
E11291	I-131	8.59E+01 pCi	3.14E+00	8.17E+01 pCi	1.36E+00	1.05
I-131						
Cartridge						
TBE Sample						
L64862-5						

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11292	Ce-141	1.04E+02 pCi	2.04E+00	8.51E+01 pCi	1.42E+00	1.22
Gamma	Cr-51	2.62E+02 pCi	1.45E+01	2.15E+02 pCi	3.59E+00	1.22
Filter	Cs-134	8.61E+01 pCi	3.67E+00	8.46E+01 pCi	1.41E+00	1.02
	Cs-137	9.30E+01 pCi	6.50E+00	1.02E+02 pCi	1.70E+00	0.91
TBE Sample	Co-58	1.06E+02 pCi	7.70E+00	1.05E+02 pCi	1.76E+00	1.01
L64862-6	Mn-54	1.17E+02 pCi	5.20E+00	1.16E+02 pCi	1.94E+00	1.01
	Fe-59	9.48E+01 pCi	9.60E+00	9.02E+01 pCi	1.51E+00	1.05
	Zn-65	1.60E+02 pCi	1.53E+01	1.41E+02 pCi	2.36E+00	1.13
	Co-60	1.46E+02 pCi	4.85E+00	1.32E+02 pCi	2.20E+00	1.11
	K-40	2.79E+02 pCi/L	7.15E+01	Present - Not Measured		----
E11293	Fe-55	2.09E+03 pCi/L	2.22E+02	1.80E+03 pCi/L	3.01E+01	1.16
Fe-55						
Water						
TBE Sample						
L64862-7						
E11294	Ce-141	2.09E-01 pCi/g	1.35E-02	2.22E-01 pCi/g	3.71E-03	0.94
Gamma	Cr-51	4.63E-01 pCi/g	6.35E-02	5.60E-01 pCi/g	9.36E-03	0.83
Soil	Cs-134	2.31E-01 pCi/g	9.05E-03	2.21E-01 pCi/g	3.68E-03	1.05
	Cs-137	3.11E-01 pCi/g	8.70E-03	3.44E-01 pCi/g	5.74E-03	0.90
TBE Sample	Co-58	2.45E-01 pCi/g	7.60E-03	2.74E-01 pCi/g	4.58E-03	0.89
L64862-8	Mn-54	2.97E-01 pCi/g	8.10E-03	3.02E-01 pCi/g	5.05E-03	0.98
	Fe-59	2.48E-01 pCi/g	1.19E-02	2.35E-01 pCi/g	3.92E-03	1.06
	Zn-65	3.47E-01 pCi/g	1.38E-02	3.68E-01 pCi/g	6.14E-03	0.94
	Co-60	3.28E-01 pCi/g	6.65E-03	3.44E-01 pCi/g	5.74E-03	0.95
	K-40	9.34E-01 pCi/L	7.45E-02	Present - Not Measured		----

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RESULTS OF ENVIRONMENTAL

CROSS CHECK PROGRAM

TELEDYNE BROWN ENGINEERING

Fourth Quarter 2015

(Ref. Date 03-Dec-2015)

26 Feb 16

Levan Tkavadze, Nuclear Metrologist **Date**

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11354	Sr-89	9.62E+01 pCi/L	3.89E+00	8.68E+01 pCi/L	1.45E+00	1.11
Sr-89/90 w/maf*	Sr-90	1.48E+01 pCi/L	8.52E-01	1.25E+01 pCi/L	2.09E-01	1.18
Milk						
TBE Sample L66009-1						

* with mixed activation/fission interferences

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11355	I-131	9.51E+01 pCi/L	4.23E+00	9.12E+01 pCi/L	1.52E+00	1.04
Gamma	Ce-141	1.17E+02 pCi/L	1.17E+01	1.29E+02 pCi/L	2.15E+00	0.91
Milk	Cr-51	2.65E+02 pCi/L	6.03E+01	2.81E+02 pCi/L	4.69E+00	0.94
	Cs-134	1.53E+02 pCi/L	5.63E+00	1.60E+02 pCi/L	2.68E+00	0.96
51	Cs-137	1.19E+02 pCi/L	7.21E+00	1.15E+02 pCi/L	1.91E+00	1.04
	Co-58	1.07E+02 pCi/L	7.80E+00	1.10E+02 pCi/L	1.84E+00	0.97
TBE Sample	Mn-54	1.53E+02 pCi/L	8.27E+00	1.45E+02 pCi/L	2.42E+00	1.06
L66009-3	Fe-59	1.17E+02 pCi/L	1.22E+01	1.08E+02 pCi/L	1.80E+00	1.09
	Zn-65	2.61E+02 pCi/L	1.70E+01	2.48E+02 pCi/L	4.14E+00	1.05
	Co-60	2.12E+02 pCi/L	6.41E+00	2.13E+02 pCi/L	3.56E+00	0.99
	K-40	1.40E+03 pCi/L	8.34E+01	Present - Not Measured		----
E11356	I-131	7.49E+01 pCi	6.04E+00	7.52E+01 pCi	1.26E+00	1.00
I-131						
Cartridge						
TBE Sample L66009-5						

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11357	Ce-141	8.99E+01 pCi	1.34E+01	8.40E+01 pCi	1.40E+00	1.07
Gamma	Cr-51	2.15E+02 pCi	8.80E+01	1.84E+02 pCi	3.06E+00	1.17
Filter	Cs-134	1.03E+02 pCi	7.24E+00	1.05E+02 pCi	1.75E+00	0.99
	Cs-137	7.66E+01 pCi	1.05E+01	7.48E+01 pCi	1.25E+00	1.02
	Co-58	7.62E+01 pCi	1.20E+01	7.19E+01 pCi	1.20E+00	1.06
TBE Sample	Mn-54	9.14E+01 pCi	1.24E+01	9.44E+01 pCi	1.58E+00	0.97
L66009-6	Fe-59	7.86E+01 pCi	1.87E+01	7.03E+01 pCi	1.17E+00	1.12
	Zn-65	1.73E+02 pCi	2.12E+01	1.62E+02 pCi	2.71E+00	1.07
	Co-60	1.38E+02 pCi	9.95E+00	1.39E+02 pCi	2.33E+00	0.99
E11358	Fe-55	2.16E+03 pCi/L	8.88E+01	1.71E+03 pCi/L	2.86E+01	1.26
Fe-55						
Water						
TBE Sample						
L66009-7						
E11353	Ce-141	2.52E-01 pCi/g	3.38E-02	2.22E-01 pCi/g	3.71E-03	1.13
Gamma	Cr-51	4.85E-01 pCi/g	1.36E-01	4.85E-01 pCi/g	8.11E-03	1.00
Soil	Cs-134	3.19E-01 pCi/g	2.03E-02	2.77E-01 pCi/g	4.62E-03	1.15
	Cs-137	2.92E-01 pCi/g	1.70E-02	2.76E-01 pCi/g	4.61E-03	1.06
	Co-58	1.93E-01 pCi/g	1.69E-02	1.90E-01 pCi/g	3.18E-03	1.01
TBE Sample	Mn-54	2.58E-01 pCi/g	1.89E-02	2.50E-01 pCi/g	4.17E-03	1.03
L66009-8	Fe-59	2.18E-01 pCi/g	2.38E-02	1.86E-01 pCi/g	3.10E-03	1.17
	Zn-65	4.57E-01 pCi/g	3.24E-02	4.29E-01 pCi/g	7.16E-03	1.07
	Co-60	3.81E-01 pCi/g	1.37E-02	3.68E-01 pCi/g	6.15E-03	1.03
	K-40	1.04E+00 pCi/L	1.65E-01	Present - Not Measured		----

SAMPLE	ANALYSIS	TBE VALUE	UNCERTAINTY (1 Sigma)	EZA VALUE	UNCERTAINTY (1 Sigma)	RATIO TBE: EZA
E11422	Sr-89	9.80E+01 pCi	1.13E+01	9.69E+01 pCi	1.62E+00	1.01
Sr-89/90	Sr-90	1.00E+01 pCi	1.14E+00	1.40E+01 pCi	2.34E-01	0.71
Filter						
TBE Sample						
L66009-9						

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP Series 32

(TELE01) TELEDYNE BROWN ENGINEERING - ENVIRONMENTAL SERVICES
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-15-MaS32: Radiological and inorganic combined soil standard

Inorganic Units: (mg/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	120				84 - 156		
Arsenic	NR	55.6				38.9 - 72.3		
Barium	NR	485				340 - 631		
Beryllium	NR	39.3				27.5 - 51.1		
Cadmium	NR	18.9				13.2 - 24.6		
Chromium	NR	98.0				68.6 - 127.4		
Cobalt	NR	109				76 - 142		
Copper	NR	183				128 - 238		
Lead	NR	71.0				49.7 - 92.3		
Mercury	NR	0.416				0.291 - 0.541		
Nickel	NR	135				95 - 176		
Selenium	NR	12.3				8.6 - 16.0		
Silver	NR	99.7				69.8 - 129.6		
Technetium-99	NR	0.00138				0.00097 - 0.00179		
Thallium	NR	202				141 - 263		
Uranium-235	NR	0.0459				0.0321 - 0.0597		
Uranium-238	NR	16.2				11.3 - 21.1		
Uranium-Total	NR	16.2				11.3 - 21.1		
Vanadium	NR	98				69 - 127		
Zinc	NR	161				113 - 209		

Radiological Units: (Bq/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	97				68 - 126		
Cesium-134	NR	678				475 - 881		
Cesium-137	NR					False Positive Test		
Cobalt-57	NR					False Positive Test		
Cobalt-60	NR	817				572 - 1062		
Iron-55	NR	205				Sensitivity Evaluation		
Manganese-54	NR	1198				839 - 1557		
Nickel-63	392	448	A		-12.5	314 - 582	23	A
Plutonium-238	NR	83.9				58.7 - 109.1		
Plutonium-239/240	NR	70.8				49.6 - 92.0		
Potassium-40	NR	622				435 - 809		
Strontium-90	286	653	N		-56.2	457 - 849	10.1	A

Radiological								Units: (Bq/kg)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Technetium-99	NR	867				607 - 1127		
Uranium-234/233	NR	52.5				36.8 - 68.3		
Uranium-238	NR	201				141 - 261		
Zinc-65	NR	1064				745 - 1383		

Radiological Reference Date: February 1, 2015

MAPEP-15-MaW32: Radiological and inorganic combined water standard

Inorganic								Units: (mg/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	5.15e-9				3.60E-9 - 6.70E-9		
Antimony	NR					False Positive Test		
Arsenic	NR	2.48				1.74 - 3.22		
Barium	NR	2.72				1.90 - 3.54		
Beryllium	NR					False Positive Test		
Cadmium	NR	0.93				0.65 - 1.21		
Chromium	NR	1.96				1.37 - 2.55		
Cobalt	NR	0.035				Sensitivity Evaluation		
Copper	NR	6.34				4.44 - 8.24		
Lead	NR	1.22				0.85 - 1.59		
Mercury	NR	0.092				0.064 - 0.120		
Nickel	NR	4.18				2.93 - 5.43		
Plutonium-239	NR	3.37e-7				2.36E-7 - 4.38E-7		
Selenium	NR	0.778				0.545 - 1.011		
Technetium-99	NR	5.07E-6				3.55E-6 - 6.59E-6		
Thallium	NR	3.51				2.46 - 4.56		
Uranium-235	NR	1.52e-4				1.06E-4 - 1.98E-4		
Uranium-238	NR	0.078				0.055 - 0.101		
Uranium-Total	NR	0.078				0.055 - 0.101		
Vanadium	NR	5.48				3.84 - 7.12		
Zinc	NR	0.0113				Sensitivity Evaluation		

Radiological								Units: (Bq/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	0.632	0.654	A		-3.4	0.458 - 0.850	0.072	A
Cesium-134	NR	23.5				16.5 - 30.6		
Cesium-137	NR	19.1				13.4 - 24.8		
Cobalt-57	NR	29.9				20.9 - 38.9		
Cobalt-60	NR					False Positive Test		
Hydrogen-3	NR	563				394 - 732		
Iron-55	NR	6.88				4.82 - 8.94		
Manganese-54	NR					False Positive Test		
Nickel-63	2.47		A			False Positive Test	2.65	
Plutonium-238	0.0204	0.0089	A	(17)		Sensitivity Evaluation	0.023	
Plutonium-239/240	0.861	0.832	A		3.5	0.582 - 1.082	0.161	W

Radiological — Units: (Bq/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Potassium-40	NR					False Positive Test		
Strontium-90	NR	9.48				6.64 - 12.32		
Technetium-99	NR	3.18				2.23 - 4.13		
Uranium-234/233	NR	0.148				0.104 - 0.192		
Uranium-238	NR	0.97				0.68 - 1.26		
Zinc-65	NR	18.3				12.8 - 23.8		

Radiological Reference Date: February 1, 2015

MAPEP-15-RdF32: Radiological air filter

Inorganic — Units: (ug/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.0147				0.0103 - 0.0191		
Uranium-238	NR	7.96				5.57 - 10.35		
Uranium-Total	NR	7.97				5.58 - 10.36		

Radiological — Units: (Bq/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.0681				0.0477 - 0.0885		
Cesium-134	NR	1.15				0.81 - 1.50		
Cesium-137	NR					False Positive Test		
Cobalt-57	NR	1.51				1.06 - 1.96		
Cobalt-60	NR					False Positive Test		
Manganese-54	NR	1.02				0.71 - 1.33		
Plutonium-238	NR					False Positive Test		
Plutonium-239/240	NR	0.0847				0.0593 - 0.1101		
Strontium-90	-0.0991		A			False Positive Test	0.153	
Uranium-234/233	0.0211	0.0155	N		36.1	0.0109 - 0.0202	0.012	N
Uranium-238	0.0947	0.099	A		-4.3	0.069 - 0.129	0.0279	W
Zinc-65	NR	0.83				0.58 - 1.08		

Radiological Reference Date: February 1, 2015

MAPEP-15-GrF32: Gross alpha/beta air filter

Radiological — Units: (Bq/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Gross alpha	0.448	1.77	N		-74.7	0.53 - 3.01	0.049	A
Gross beta	0.758	0.75	A		1.1	0.38 - 1.13	0.052	A

Radiological Reference Date: February 1, 2015

MAPEP-15-RdV32: Radiological vegetation

Inorganic							Units: (ug/sample)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.0223				0.0156 - 0.0290		
Uranium-238	NR	10.3				7.2 - 13.4		
Uranium-Total	NR	10.3				7.2 - 13.4		

Radiological							Units: (Bq/sample)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.108				0.076 - 0.140		
Cesium-134	8.08	7.32	A		10.4	5.12 - 9.52	0.22	A
Cesium-137	11.6	9.18	W		26.4	6.43 - 11.93	0.36	A
Cobalt-57	-0.0096		A			False Positive Test	0.0818	
Cobalt-60	6.53	5.55	A		17.7	3.89 - 7.22	0.23	A
Manganese-54	0.0058		A			False Positive Test	0.122	
Plutonium-238	NR	0.085				0.060 - 0.111		
Plutonium-239/240	NR	0.094				0.066 - 0.122		
Strontium-90	0.999	1.08	A		-7.5	0.76 - 1.40	0.0456	A
Uranium-234/233	NR	0.0218				0.0153 - 0.0283		
Uranium-238	NR	0.128				0.090 - 0.166		
Zinc-65	-0.108		A			False Positive Test	0.339	

Radiological Reference Date: February 1, 2015

Notes:

(17) = NOT DETECTED - reported a statistically zero result

Department of Energy RESL - 1955 Fremont Ave. MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP Series 33

(TELE01) TELEDYNE BROWN ENGINEERING - ENVIRONMENTAL SERVICES
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-15-MaS33: Radiological and inorganic combined soil standard

Inorganic — Units: (mg/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	0.31				Sensitivity Evaluation		
Arsenic	NR	6.2				Sensitivity Evaluation		
Barium	NR	561				393 - 729		
Beryllium	NR	60.3				42.2 - 78.4		
Cadmium	NR	11.1				7.8 - 14.4		
Chromium	NR	59.1				41.4 - 76.8		
Cobalt	NR	257				180 - 334		
Copper	NR	88				62 - 114		
Lead	NR	90.9				63.6 - 118.2		
Mercury	NR	0.933				0.653 - 1.213		
Nickel	NR	163				114 - 212		
Selenium	NR	14.14				9.90 - 18.38		
Silver	NR	48.7				34.1 - 63.3		
Technetium-99	NR	1.01E-3				0.00071 - 0.00131		
Thallium	NR	108				76 - 140		
Uranium-235	NR	0.0480				0.0336 - 0.0624		
Uranium-238	NR	17.69				12.38 - 23.00		
Uranium-Total	NR	17.69				12.38 - 23.00		
Vanadium	NR	195				137 - 254		
Zinc	NR	406				284 - 528		

Radiological — Units: (Bq/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	49.5				34.7 - 64.4		
Cesium-134	NR	1010				707 - 1313		
Cesium-137	NR	809				566 - 1052		
Cobalt-57	NR	1180				826 - 1534		
Cobalt-60	NR	1.30				Sensitivity Evaluation		
Iron-55	NR	555				389 - 722		
Manganese-54	NR	1340				938 - 1742		
Nickel-63	635	682	A		-6.9	477 - 887	30.2	A
Plutonium-238	NR	97.5				68.3 - 126.8		
Plutonium-239/240	NR	80.4				56.3 - 104.5		
Potassium-40	NR	599				419 - 779		
Strontium-90	429	425	A		0.9	298 - 553	8.13	N

Radiological								Units: (Bq/kg)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Technetium-99	NR	631				442 - 820		
Uranium-234/233	NR	56				39 - 73		
Uranium-238	NR	220				154 - 286		
Zinc-65	NR	662				463 - 861		

Radiological Reference Date: August 1, 2015

MAPEP-15-MaW33: Radiological and inorganic combined water standard

Inorganic								Units: (mg/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	13.6				9.5 - 17.7		
Arsenic	NR	4.07				2.85 - 5.29		
Barium	NR	8.02				5.61 - 10.43		
Beryllium	NR	2.27				1.59 - 2.95		
Cadmium	NR	0.739				0.517 - 0.961		
Chromium	NR	3.83				2.68 - 4.98		
Cobalt	NR	14.8				10.4 - 19.2		
Copper	NR	4.40				3.08 - 5.72		
Lead	NR	3.98				2.79 - 5.17		
Mercury	NR	0.127				0.089 - 0.165		
Nickel	NR	16.8				11.8 - 21.8		
Selenium	NR	0.537				0.376 - 0.698		
Technetium-99	NR	1.15e-5				8.10E-6 - 1.50E-5		
Thallium	NR	2.32				1.62 - 3.02		
Uranium-235	NR	6.59e-4				4.61E-4 - 8.57E-4		
Uranium-238	NR	0.095				0.067 - 0.124		
Uranium-Total	NR	0.095				0.067 - 0.124		
Vanadium	NR	10.3				7.2 - 13.4		
Zinc	NR	15.8				11.1 - 20.5		

Radiological								Units: (Bq/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	1.012	1.055	A		-4.1	0.739 - 1.372	0.148	A
Cesium-134	NR	23.1				16.2 - 30.0		
Cesium-137	NR					False Positive Test		
Cobalt-57	NR	20.8				14.6 - 27.0		
Cobalt-60	NR	17.1				12.0 - 22.2		
Hydrogen-3	NR	216				151 - 281		
Iron-55	NR	13.1				9.2 - 17.0		
Manganese-54	NR	15.6				10.9 - 20.3		
Nickel-63	11.8	8.55	N		38.0	5.99 - 11.12	10.8	N
Plutonium-238	0.727	0.681	A		6.8	0.477 - 0.885	0.190	W
Plutonium-239/240	0.830	0.900	A		-7.8	0.630 - 1.170	0.260	N
Potassium-40	NR	214				150 - 278		
Strontium-90	NR	4.80				3.36 - 6.24		

Radiological

Units: (Bq/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Technetium-99	NR	7.19				5.03 - 9.35		
Uranium-234/233	NR	1.14				0.80 - 1.48		
Uranium-238	NR	1.18				0.83 - 1.53		
Zinc-65	NR	13.9				9.7 - 18.1		

Radiological Reference Date: August 1, 2015

MAPEP-15-RdF33: Radiological air filter

Inorganic

Units: (ug/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.086				0.060 - 0.112		
Uranium-238	NR	11.9				8.3 - 15.5		
Uranium-Total	NR	12.0				8.4 - 15.6		

Radiological

Units: (Bq/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.147				0.103 - 0.191		
Cesium-134	NR	2.45				1.72 - 3.19		
Cesium-137	NR	1.96				1.37 - 2.55		
Cobalt-57	NR	2.74				1.92 - 3.56		
Cobalt-60	NR	1.71				1.20 - 2.22		
Manganese-54	NR	2.11				1.48 - 2.74		
Plutonium-238	NR	0.104				0.073 - 0.135		
Plutonium-239/240	NR	0.0025				Sensitivity Evaluation		
Strontium-90	1.48	2.18	N		-32.1	1.53 - 2.83	0.135	A
Uranium-234/233	0.143	0.143	A		0.0	0.100 - 0.186	0.023	W
Uranium-238	0.149	0.148	A		0.7	0.104 - 0.192	0.024	W
Zinc-65	NR	1.32				0.92 - 1.72		

Radiological Reference Date: August 1. 2015

MAPEP-15-GrF33: Gross alpha/beta air filter

Radiological

Units: (Bq/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Gross alpha	0.497	0.90	A		-44.8	0.27 - 1.53	0.039	A
Gross beta	1.34	1.56	A		-14.1	0.78 - 2.34	0.068	A

Radiological Reference Date: August 1. 2015

MAPEP-15-RdV33: Radiological vegetation

Inorganic

Units: (ug/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.098				0.069 - 0.127		

Inorganic								Units: (ug/sample)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-238	NR	13.5				9.5 - 17.6		
Uranium-Total	NR	13.6				9.5 - 17.7		

Radiological								Units: (Bq/sample)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.108				0.076 - 0.140		
Cesium-134	6.10	5.80	A		5.2	4.06 - 7.54	0.189	A
Cesium-137	0.0002		A			False Positive Test	0.128	
Cobalt-57	8.01	6.62	W		21.0	4.63 - 8.61	0.228	A
Cobalt-60	4.97	4.56	A		9.0	3.19 - 5.93	0.206	A
Manganese-54	8.33	7.68	A		8.5	5.38 - 9.98	0.331	A
Plutonium-238	NR	0.0007				Sensitivity Evaluation		
Plutonium-239/240	NR	0.077				0.054 - 0.100		
Strontium-90	0.386	1.30	[redacted]		-70.3	0.91 - 1.69	0.055	A
Uranium-234/233	NR	0.162				0.113 - 0.211		
Uranium-238	NR	0.168				0.118 - 0.218		
Zinc-65	6.07	5.46	A		11.2	3.82 - 7.10	0.549	A

Radiological Reference Date: August 1, 2015

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A Waters Company

2003 NELAC Evaluation Report

Study: **RAD-101**

ERA Customer Number: **T200801**

Laboratory Name: **Teledyne Brown Engineering**

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RAD Results

RAD-101 2003 NELAC Evaluation Final Complete Report

ERA
A Waters Company

Keith Jeter
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EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 05/26/15
Study Dates: 04/06/15 - 05/21/15

NELAC Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808)												
2765	Barium-133	pCi/L	80.6	82.5	69.3 - 90.8	Acceptable	EPA 901.1 1980	5/2/2015	-0.0700	81.0	5.03	
2800	Cesium-134	pCi/L	71.7	75.7	61.8 - 83.3	Acceptable	EPA 901.1 1980	5/2/2015	0.551	69.7	3.54	
2805	Cesium-137	pCi/L	187	189	170 - 210	Acceptable	EPA 901.1 1980	5/2/2015	-0.271	189	7.40	
2815	Cobalt-60	pCi/L	85.7	84.5	76.0 - 95.3	Acceptable	EPA 901.1 1980	5/2/2015	-0.0100	85.7	4.61	
3070	Zinc-65	pCi/L	197	203	183 - 238	Acceptable	EPA 901.1 1980	5/2/2015	-0.977	213	16.2	
RAD GroSS™ Alpha/Beta (cat# 809)												
2830	Gross Alpha	pCi/L	26.1	42.6	22.1 - 54.0	Acceptable	EPA 900.0 GPC 1980	5/7/2015	-1.41	39.1	9.24	
2840	Gross Beta	pCi/L	28.8	32.9	21.3 - 40.6	Acceptable	EPA 900.0 GPC 1980	5/7/2015	0.0308	28.6	5.13	
RAD NaturalS™ (cat# 811)												
2965	Radium-226	pCi/L		8.43	6.33 - 9.90	Not Reported				8.02	0.752	
2970	Radium-228	pCi/L		4.39	2.56 - 6.01	Not Reported				4.30	0.972	
3055	Uranium (Nat)	pCi/L	6.19	6.59	4.99 - 7.83	Acceptable	EPA 908.0 GPC 1980	4/29/2015	-0.658	6.57	0.574	
3055	Uranium (Nat) mass	µg/L		9.61	7.26 - 11.4	Not Reported				9.41	0.587	
RAD TritiuM™ (cat# 812)												
3030	Tritium	pCi/L	3145	3280	2770 - 3620	Acceptable	EPA 906.0 1980	5/9/2015	-0.927	3330	199	
RAD Strontium-89/90 (cat# 807)												
2995	Strontium-89	pCi/L	45.2	63.2	51.1 - 71.2	Not Acceptable	EPA 905.0 1980	5/19/2015	-1.88	61.7	8.76	
3005	Strontium-90	pCi/L	28.0	41.9	30.8 - 48.1	Not Acceptable	EPA 905.0 1980	5/19/2015	-3.28	40.2	3.73	
RAD Iodine-131 (cat# 810)												
2875	Iodine-131	pCi/L	23.5	23.8	19.7 - 28.3	Acceptable	EPA 902.0 GPC 1980	5/7/2015	-0.472	24.0	1.07	

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2003 NELAC Evaluation Report

Study: **RAD-103**

ERA Customer Number: **T200801**

Laboratory Name: **Teledyne Brown Engineering**

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RAD Results

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RAD-103 2003 NELAC Evaluation Final Complete Report

Keith Jeter
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EPA ID:	TN11387
ERA Customer Number:	T200801
Report Issued:	11/23/15
Study Dates:	10/05/15 - 11/19/15

NELAC Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808, lot# R103-758)												
2765	Barium-133	pCi/L	31.5	32.5	25.9 - 36.7	Acceptable	EPA 901.1 1980	11/11/2015	-0.111	31.7	2.11	
2800	Cesium-134	pCi/L	59.65	62.3	50.6 - 68.5	Acceptable	EPA 901.1 1980	11/11/2015	0.112	59.2	3.91	
2805	Cesium-137	pCi/L	155.5	157	141 - 175	Acceptable	EPA 901.1 1980	11/11/2015	-0.387	158	5.33	
2815	Cobalt-60	pCi/L	70.55	71.1	64.0 - 80.7	Acceptable	EPA 901.1 1980	11/11/2015	-0.413	72.0	3.60	
3070	Zinc-65	pCi/L	145	126	113 - 149	Acceptable	EPA 901.1 1980	11/11/2015	1.30	135	7.52	
RAD GroSS™ Alpha/Beta (cat# 809, lot# R103-759)												
2830	Gross Alpha	pCi/L	38.2	51.6	26.9 - 64.7	Acceptable	EPA 900.0 GPC 1980		-1.25	49.9	9.36	
2840	Gross Beta	pCi/L	42.0	36.6	24.1 - 44.2	Acceptable	EPA 900.0 GPC 1980		1.07	34.7	6.84	
RAD NaturalS™ (cat# 811, lot# R103-751)												
2965	Radium-226	pCi/L		7.29	5.49 - 8.63	Not Reported				7.33	0.861	
2970	Radium-228	pCi/L		4.25	2.46 - 5.85	Not Reported				4.39	0.784	
3055	Uranium (Nat)	pCi/L	146.9	56.2	45.7 - 62.4	Not Acceptable	EPA 908.0 1980	11/15/2015	21.6	54.8	4.26	
3055	Uranium (Nat) mass	µg/L		82.0	66.6 - 91.1	Not Reported				81.1	3.73	
RAD TritiuM™ (cat# 812, lot# R103-752)												
3030	Tritium	pCi/L	21100	21300	18700 - 23400	Acceptable	EPA 906.0 1980	11/8/2015	-0.0477	21100	695	
RAD Strontium-89/90 (cat# 807, lot# R103-757)												
2995	Strontium-89	pCi/L	40.9	35.7	28.7 - 42.5	Acceptable	EPA 905.0 1980	11/17/2015	0.459	38.1	6.15	
3005	Strontium-90	pCi/L	29.3	31.1	22.7 - 36.1	Acceptable	EPA 905.0 1980	11/17/2015	-0.00374	29.3	2.86	
RAD Iodine-131 (cat# 810, lot# R103-750)												
2875	Iodine-131	pCi/L	24.8	26.3	21.9 - 31.0	Acceptable	EPA 901.1 1980	10/29/2015	-0.917	26.7	2.05	

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A Waters Company

2003 NELAC Evaluation Report

Study: **MRAD-22**

ERA Customer Number: **T200801**

Laboratory Name: **Teledyne Brown Engineering**

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RAD Results

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A Waters Company

MRAD-22 2003 NELAC Evaluation Final Complete Report

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EPA ID:	**TN11387**
ERA Customer Number:	**T200801**
Report Issued:	**05/19/15**
Study Dates:	**03/16/15 - 05/15/15**

NELAC Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Air Filter Gross Alpha/Beta (cat# 801)												
2830	Gross Alpha	pCi/Filter	28.3	62.2	20.8 - 96.6	Acceptable			-2.95	63.8	12.0	
2840	Gross Beta	pCi/Filter		58.4	36.9 - 85.1	Not Reported				59.9	7.99	

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