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Chicago Dock and Canal Trust

REPORT

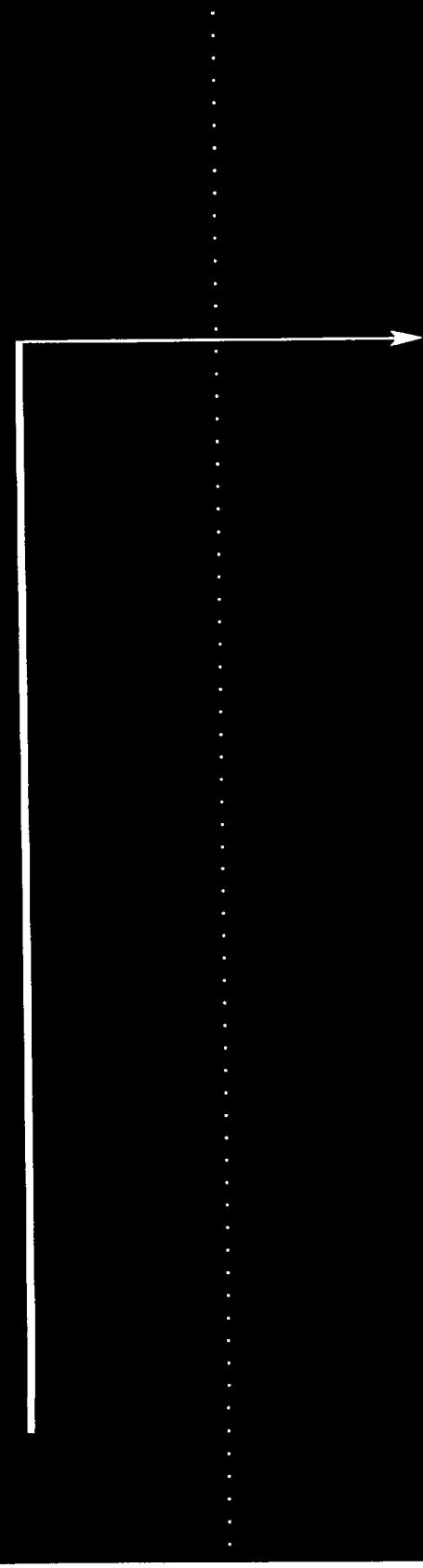
Work Plan for Characterization of Radioactive Contamination

Chicago, Illinois

STS Consultants Ltd

STS

D



D

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

APPENDIX D

QUALITY ASSURANCE PROJECT PLAN (QAPP)

316 EAST ILLINOIS PROJECT CHICAGO, ILLINOIS

Revision 01

Controlled Document No. ____

Approvals:

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QUALITY ASSURANCE PROJECT PLAN

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1.0 IDENTIFICATION OF SITE

This Quality Assurance Project Plan (QAPP) has been prepared as part of the investigation of elevated gamma radiation levels on portions of a property in downtown Chicago. The property has a street address of 316 East Illinois Street. The property is an at grade, paved parking lot which covers the block bounded on the north by East Grand Avenue, on the south by East Illinois Street, on the east by McClurg Court, and on the west by Columbus Drive. The site has a nominal size of 200 feet (ft.) north to south and 564 ft. east to west.

2.0 CONTENTS

The contents of this QAPP include the 16 plan elements specified in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," USEPA Document QAMS-005/80, dated December 29,1980. The 16 elements are listed below:

- Title Page with Provisions for Approvals
- Table of Contents
- Project Description
- Project Organization and Responsibility
- QA Objectives for Measurement of Data in Terms of Precision, Accuracy, Completeness, Representativeness and Comparability
- Sampling Procedures
- Sample Custody
- Calibration Procedures and Frequency
- Analytical Procedures
- Data Reduction, Validation, and Reporting
- Internal Quality Control Checks and Frequency
- Performance/System Audits and Frequency
- Preventative Maintenance Procedures and Schedules
- Specific Routine Procedures Used to Assess Data Precision, Accuracy and Completeness
- Corrective Action
- Quality Assurance Reports to Management

3.0 PROJECT DESCRIPTION AND BACKGROUND

The Chicago Dock and Canal Trust Property (Chicago Dock), at 316 East Illinois Street., generally extends between East Illinois on the south to Grand Avenue on the north. It is bounded by Columbus Avenue on the west and McClurg Court on the east. Figure 3-1 shows the general layout of the site. Figure 3-2 is a location map, indicating the location in the state of Illinois and the City of Chicago. The U.S. Environmental Protection Agency (EPA) has measured elevated gamma radiation levels on portions of the site and has designated the site as Lindsay Light II. The site, which was leased to Lindsay light prior to about 1933, is denoted herein as "the property." The property is presently undeveloped and has been used as a parking lot in recent years. The lot, operated by General Parking Company, is paved with asphalt with a crushed stone base and has steel guard rails which border the parking lot.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock," Chicago Dock records indicate that the property was leased to Lindsay Light from about 1915 to 1932. Chicago Dock records also indicate that the property from 216 to 322 East Illinois was rented by Cooper's Stable prior to 1913 until 1914 or later. A two-story building on the site housed a stable for horses and wagons and a blacksmith shop.

In 1914, the Cooper Stable was divided in half, from east to west. The south half, fronting on Illinois at 316-322 was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.

The activities covered by this QAPP focus on characterizing the radioactive materials that may be residuals from the Lindsay Light activities at the property. Review of property records indicates that Lindsay Light performed its primary manufacturing operations in this area of Chicago at 161 E. Grand Avenue, about one-quarter mile west of the property. The perception is that the manufacturing operations were performed at 161 E. Grand

Avenue and that the 316 E. Illinois site was used as a warehouse site and as a stable to provide support services for transporting material to and from the main site.

A site investigation by STS Consultants, Ltd. (STS92:STS Project No. 27313-XH), July 1992, indicates that prior to the presence of Cooper's Stable and Lindsay light, there were industrial and manufacturing activities at the property that date back to about 1900. These activities apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks.

The STS investigation included digging several test pits, installing four shallow groundwater monitoring wells, and drilling numerous borings to obtain soil samples. The results of the STS investigation indicated petroleum spread over an area of approximately 24,000 square feet of the general site. The presence of petroleum appeared to be vertically centered on the water table at a depth of about 13 ft. The petroleum appeared to extend about 4 ft. below and above the water table, but there was no measurable thickness of petroleum residue floating on the water table in the monitoring wells.

The following items summarize the results of the STS investigation:

- Radioactive residuals (e.g., Lindsay Light): There was no radiation monitoring and samples were not specifically analyzed for radioactivity.

- Petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PNA) were present in many samples. The detection of volatile organic compounds (e.g., xylene and/or ethylbenzene), indicates the presence of petroleum products; probably diesel, heating, or heavy lubricating oil. Benzene and toluene were not detected in the soil or water samples. The measured concentrations of total xylenes and ethylbenzene, the other constituents of BETX, were less than 1 ppm (parts per million or mg per kg).

- Trace levels of several chlorinated solvents compounds (e.g., tetrachloroethene, trichloroethene, and tetrachloromethane) were detected in three test pit samples. However, the concentrations were at the trace level, and were not present in boring or groundwater samples. The identified concentrations were less than 1 ppm.

- No detectable levels of PCB or heavy metals were observed in the soil or groundwater samples. However, total lead concentrations in water exceeded the EPA MCLs in three of the monitoring well samples and the chromium MCL was exceeded in one of four well samples.

- The concentrations of TPH and PNAs ranged from 22 ppm to over 15,000 ppm.

Investigations at the site indicate that there may be residuals of radioactive material from Lindsay operations and petroleum related contaminants from prior activities. Radiation surveys performed by EPA and Illinois Department of Nuclear Safety (IDNS) on June 3, 1993, indicated radiation readings as high as 280 µR/hr on localized areas of the property, compared to a natural background for the area of about 20 µR/hr. These elevated radiation measurements may be due to residuals, containing thorium and radium, from the Lindsay Light operations.

A detailed description of the approach that will be taken to complete this work is found in the site Work Plan, and will not be repeated herein. The Work Plan also provides the estimated work schedule. Data gathered during this characterization work will be used to better understand the nature and the extent of radiological contamination at the site which will allow for the proper planning and execution of any required remedial activities.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project management organization is given in Figure 4-1. The work will be performed under EPA oversight. Ms. Verneta Simon, of the EPA - Region 5 office, Emergency and Enforcement Response Branch - Response Section III, will be the EPA On-Scene Coordinator (OSC). The project team approved to complete the work set forth in the AOC consists of STS Consultants, Ltd. (STS) of Northbrook, Illinois for geotechnical and environmental work, M.J.W. Corporation, Inc. (MJW) of Williamsville, New York for the health physics work and International Technology Corporation (IT) of Knoxville, Tennessee for analytical work.

Richard Berggreen of STS is the Project Coordinator. After approval of the Work Plan, communications between the EPA and representatives of the property concerning this work plan will be coordinated by Ms. Simon and Mr. Berggreen. Any designation of alternates by these individuals will be authorized in writing.

4.1 Responsibilities and Functions

Richard Berggreen, the Project Coordinator is responsible for ensuring full implementation of the Work Plan. The following identifies the key individuals and their responsibilities.

Project Manager, Richard Berggreen (STS): Responsible for overall conduct of all project work, establish project schedules, budget, and priorities; approve the recommendations of Project QA Officer and the QA requirements for the project; provide oversight of Field Investigation; approve documents prior to their distribution and use. Responsible for the preparation and submittal of progress reports to the EPA.

Assistant Project Manager, Craig Rawlinson (STS): Responsible for supporting Project Coordinator in accomplishing his responsibilities. The Assistant Project Manager is authorized to act as the Project Coordinator when the Project Coordinator is not available. Will be in daily communication verbally or in writing with the OSC regarding project progress. Responsible for maintaining a site entry and exit log, and formally documenting other site activities.

Project Quality Assurance Officer, David Dooley (MJW): Responsible for ensuring the requirements, procedures, and practices for the project. Review, evaluate, interpret, and define the application of QA requirements, standards, and guidelines for the project; conduct or direct QA audits, surveillance, and other related activities; and certify the completion of all corrective actions.

Site Safety officer, David Dooley (MJW): Responsible for monitoring compliance with the Site Safety Plan, providing emergency first aid, setting up decontamination facilities, making sure adequate health and safety equipment and supplies are available on-site, operating and overseeing the operating of personal or environmental health hazard monitoring, and overseeing the use of Personal Protective Equipment.

Analytical Laboratory, Chemical and Radiological, Jackie Waddell (ITAS): Responsible for overall conduct of laboratory analytical work. Preparation of laboratory report package; coordination between ITAS facilities for various analysis requested.

Surveyors (Certified Construction Services, Inc.): Responsible for establishing coordinates and elevations for sample locations and grid points. Also responsible for layout of the stable building and utilities below the parking lot grade.

5.0 ~~DATA QUALITY OBJECTIVES~~QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESSS AND COMPARABILITY

Data quality is determined:

1. By its accuracy and precision against prescribed requirements or specifications and,

2. By its usefulness in assisting the user to make a decision or answer a question with confidence.

   (USEPA Document 540/G-90/004 Quality Assurance/Quality Control Guidance for Removal Activities, Interim Final)

The three quality assurance objectives specified by the USEPA refer to the intended data use and the reliability which must be placed on data quality. The following general descriptions apply to the ~~three~~ two data quality objectives which apply to this project.

QA1 is a screening objective to afford a quick preliminary assessment of site contamination. This objective for data quality is available for data collection activities that involve rapid, non-rigorous methods of analysis and quality assurance.

QA2 is a verification objective use to verify analytical (field or lab) results. This objective for data quality is available for data collection activities that require qualitative and/or quantitative verification of a "select portion of sample findings" (10% or more) that were acquired using non-rigorous methods of analysis and quality assurance.

~~QA3 is a definitive objective used to assess the accuracy of the concentration level as well as the identify of the analytes of interest. This objective of data quality is available for data collection activities that require a high degree of qualitative and quantitative accuracy using rigorous methods of analysis and quality assurance for critical samples, those samples for which the data are considered essential in making a decision.~~

For each of the data collection activities which comprise this site investigation, the data quality objective must be specified to correspond with the data use objective. The following table, Table 5-1, lists the data collection activity, the data use objective and the data quality objectives for the principal data collection efforts.

Completeness is defined (USEPA, QAMS-005/80, December 1980) as a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. The quality assurance measures for accuracy (degree of agreement between spike samples and the measured concentration in those spikes) and precision (measure of agreement between duplicate or split samples) will provide a measure of the completeness. It is anticipated that the measure of completeness, calculated by the accuracy percentage plus the percent of samples meeting the precision standard, will be equal to 95 percent of samples analyzed.

Representativenesss is defined as the degree to which data accurately and precisely represent characteristics of a population, parameter variations at a sampling point, a process condition, or an environment condition.

Comparability expresses the confidence with which one data set can be compared to another.

The representativeness of the sampling data and the comparability between the field data and laboratory data are founded on the number of data points where surface gamma measurements will be made (anticipated to be over 2000 data points), the vertical profiling at a minimum of 8 locations with vertical interval discretion on the order of 6 inches (15 cm) or less through the fill soils and into natural soils, and the chemical analysis of 10 samples from background levels, transitional locations and high gamma radiation levels.

The extensive surface and down hole gamma measurement data population supports a high level of confidence in the comparability of results between the gamma survey data and the chemical analysis of samples selected from

those locations selected as representing various levels of gamma emitting contaminants.

Table 5-1
Data Quality Objectives

Data Collection Activity	Data Use Objectives	Data Quality Objectives
Surface/Overland Gamma Survey	o Identify locations exhibiting elevated gamma radiation readings.	QA1/2
	o Select subsurface sampling points.	QA1
	o Assess potential health risk (dose).	QA2
Subsurface Gamma Radiation Survey	o Identify vertical zones of elevated gamma radiation.	QA1
	o Select subsurface sampling points.	QA1
Soil Sampling and Analysis	o Identify background concentrations.	QA2
	o Identify concentration of elevated radioactive compounds.	QA2
	o Identify concentration of RCRA hazardous constituents.	QA2
	o Identify location of contamination (vertical and horizontal).	QA2
	o Assess potential health risk from exposure.	QA2~~/3~~
	o Assess disposal options for contaminated soil.	QA3~~QA2~~
~~Groundwater Sampling and Analysis~~	~~o Identify concentration of contamination in groundwater.~~	~~QA2~~
	~~o Identify location of contaminated groundwater.~~	~~QA2~~

Table 5.2

TABLE OR-4-9
ITAS-OAK RIDGE LABORATORY
Radiological Methods

Analytical Parameters	Matrix	Method
Gross Alpha/Beta	Water	Direct Determination by Gas Flow Proportional Alpha/Beta Counting
	Soil	Direct Determination by Gas Flow Proportional Alpha/Beta Counting
	Filter	Direct Determination by Gas Flow Proportional Alpha/Beta Counting
Americium-241	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
Carbon-14	Water	Direct Determination by Liquid Scintillation Counting Sample Distillation and Liquid Scintillation Counting
	Soil	Combustion of Sample, Collection of CO_2 and Determination by Liquid Scintillation Counting
	Other Matrices	Combustion of Sample, Collection of CO_2 and Determination by Liquid Scintillation Counting
Calcium-45	Water	Direct Determination by Liquid Scintillation Counting Chemical Separation and Liquid Scintillation Counting
	Soil	Not Applicable
	Other Matrices	Not Applicable
Curium-242	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Sample Digestion, Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
Gamma Emitters Actinides, as applicable, Co-60, Cs-137, K-40, Mn-54, and other fission/activation products	Water	Direct Determination by Gamma Spectroscopy
	Soil	Direct Determination by Gamma Spectroscopy
	Vegetation	Direct Determination by Gamma Spectroscopy
Iodine 131	Water	Direct Determination by Gamma Spectroscopy or Separation by Ion Exchange and Determination by Gas Flow Proportional Bet Counting
	Soil	Direct Determination by Gamma Spectroscopy
	Other Matrices	Matrix Dependent

Table 5.2 (Cont.)

TABLE OR-4-9
ITAS-OAK RIDGE LABORATORY
Radiological Methods
Continued

Analytical Parameters	Matrix	Method
Iron-55	Water	Separation by Ion Exchange and Determination by Liquid Scintillation Counting
	Soil	Not Applicable
	Other Matrices	Not Applicable
Lead-210	Water	Separation by Ion Exchange and Determination by Gas Flow Proportional Beta Counting of the Bi-210 Daughter
	Soil	Direct Determination by Gamma Spectroscopy
	Other Matrices	Not Applicable
Neptunium-237	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Matrix Dependent
Promethium-147	Water	Organic Extraction and Determination by Gas Flow Proportional Beta Counting Organic Extraction and Determination by Liquid Scintillation Counting
	Soil	Not Applicable
	Other Matrices	Not Applicable
Plutonium-238,239/240	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Matrix Dependent
Radium-226	Water	Sequential Determination of Ra-226,228 by Co-precipitation and Determination by Alpha Spectrometry
	Soil	Determination by Gamma Spectroscopy of Lead-214 and Bismuth-214 Daughters
	Other Matrices	Matrix Dependent
Radium-228	Water	Sequential Determination of Ra-226,228 by Co-precipitation and Determination by Gas Flow Proportional Beta Counting
	Soil	Determination by Gamma Spectroscopy of the Actinium-228 Daughter
	Other Matrices	Matrix Dependent
Strontium-89,90 and Total Strontium	Water	Precipitation and Determination by Gas Flow Proportional Beta Counting
	Soil	Sample Digestion, Precipitation and Determination by Gas Flow Proportional Beta Counting
	Other Matrices	Not Applicable
Technetium-99	Water	Organic Extraction and Determination by Gas Flow Proportional Beta Counting
	Soil	Sample Leach or Digestion, Organic Extraction and Determination by Gas Flow Proportional Beta Counting
	Other Matrices	Not Applicable

Table 5.2 (Cont.)

TABLE OR-4-9
ITAS-OAK RIDGE LABORATORY
Radiological Methods
Continued

Analytical Parameters	Matrix	Method
Thorium-227,228,230,232	Water	Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Not Applicable
Total Uranium	Water	ASTM:D5174-90; Determination by Pulsed-Laser Phosphorimetry
	Soil	Not Applicable
	Other Matrices	Not Applicable
Tritium	Water	Direct Determination by Liquid Scintillation Counting Cryogenic Distillation and Determination by Liquid Scintillation Counting Sample Distillation and Determination by Liquid Scintillation Counting
	Soil	Cryogenic Distillation and Determination By Liquid Scintillation Counting
	Other Matrices	Matrix Dependent
Uranium-233 234,235/236	Water	Separation by Anion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Separation by Anion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Matrix Dependent
Uranium-238	Water	Separation by Anion Exchange and Determination by Alpha Spectrometry
	Soil	Direct Determination by Gamma Spectroscopy of Thorium-234 (Assumes secular equilibrium between ^{238}U and ^{234}Th)
	Other Matrices	Matrix Dependent

6.0 SAMPLING PROCEDURES AND SAMPLE CUSTODY

6.1 Field Operations

Sampling ~~produces~~ procedures to support the field work are contained in Section 3.3 of the Work Plan. Procedures to perform this work include but are not limited to:

- ASTM D1452-80 (R 1990), Standard Practice for Soil Investigation and Sampling by Auger Borings.
- ASTM D1586-84 (R 1992), Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.
- ASTM D2488-90, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
- ASTM D4750-87, Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well).
- MJW RCP-40, Conduct of Overland Gamma Surveys.
- MJW RCP-41, Operating Instructions for the Bicron Micro Rem Tissue Equivalent Survey Meter.
- STS RCP-1, Gamma Logging Boreholes to Determine the Concentration of Ra-226 and Other Gamma Emitting Radionuclides.
- STS RCP-2, Calibration Procedure for Cone Penetrometer Test (CPT) Truck Gamma Logger

For completeness of radiological measurements the detector will have to be held in place a full 15 seconds to make the best possible measurement given the instrument response time at the most sensitive setting. Accuracy is predefined by the manufacturer as within 10% of reading for Cs-137 between 20% and 100% of full scale on any range, and measurement standard deviation will be calculated based on 1) several measurements at the same location over several days and 2) multiple (10) measurements at the same locations taken every 15 seconds or 2 seconds apart depending on the time constant of the associated measurement scale. The response time for the Bicron Micro Rem is optimized for each range, 0-90% of the final reading as follows:

Range	Time (Seconds)
X0.1	<15
X1	<15
X10	<5
X100	<2
X1000	<2

Acceptable field accuracy for a check source test for the Bicron instruments and all other radiological field instruments shall be within ± three(3) standard deviations of the mean value. All results shall be plotted on control charts. All soil samples requiring radiological analysis will be collected into IT Analytical Services approved containers. No preservations will be required for these samples for radiological analyses but may be required for other types of analyses. In addition, there are no restrictions with regard to hold times given that the half-life of the suspect radioactive material in the sample approximates the age of the earth.

Soil sample collection in the field will be tracked using the STS Field Sample Tracking Form shown as Figure QAPP 6.1-1. These data will be entered onto the ITAS Chain-of-Custody (COC) Record an example of which is shown in Figure QAPP 6.1-2. Instructions for completion of the COC are shown in Figure QAPP 6.1-3. ITAS sample custody requirements are found in Appendix E, Section 8.3.4 and 8.3.5 of the ITAS QAMP.
Refer to Table 3-1 of the Work Plan for the number and type of QA samples to be analzyed.

6.2 Lab Operations

ITAS lab operations are detailed in Appendices A through E and will not be repeated here.

Table 5.2 lists the radioanalytic methods that will be used to analyze samples for this project.

Table 6.1 lists radiological and chemical method detection limits.

ITAS St. Louis laboratory, which performs chemical and mixed waste analyses, currently participates in the CLP program. At this time the CLP program does not include radiochemical analyses, however, ITAS OakRidge laboratory, which performs radiochemical analyses, does participate in both the DOE EML Intercomparison Study Program and the EPA Cross Check Program.

Each batch of samples is analyzed with quality control samples to demonstrate performance of the method during analysis. A laboratory blank and laboratory control sample (spiked) is analyzed with each batch. Duplicates are analyzed at the frequency of 1 in 20 analyses. For gamma analyses, the same aliquot is counted on a different detector from the original. Acceptance criteria are prescribed in method ITAS-OR-7301 and are based on EPA method EPA-600/4-81-004.

6.3 Sample Shipment

All samples shipped to the ITAS laboratories will be shipped in accordance with U.S. DOT rules and regulations for radioactive materials as set forth in 49 CFR 171 through 177 and regulations of the State of Illinois (32 IAC 341). Illinois Administrative Code 341, Transportation of Radioactive Material, is included as Appendix I to this QAPP.

Table 6.1

TABLE SL-5-2
ST. LOUIS LABORATORY
ICAP Metals
Contract Required Detection Limits (CRDL)[1],
Method Detection Limits (MDL)[2],
and Practical Quantitation Limits (PQL)[3]

Element	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (mg/Kg)	Water MDL (ug/L)	Soil MDL[4] (mg/Kg)	Water PQL (ug/L)	Soil PQL[4] (mg/Kg)
Aluminum	7429-90-5	200	40	23.7	3.03	75	7.5
Antimony	7440-36-0	60	12	56.1	7.82	200	20
Arsenic	7440-38-2	10	2	222	44.9	500	50
Barium	7440-39-3	200	40	3.14	0.78	10	1
Beryllium	7440-41-7	5	1	4.42	0.57	10	1
Boron	7440-42-8			84.3	5.19	100	10
Bismuth	7440-69-9			48.7		500	50
Cadmium	7440-43-9	5	1	7.44	1.16	10	1
Calcium	7440-70-2	5000	1000	81.1	4.13	100	10
Chromium	7440-47-3	10	2	9.48	2.03	25	2.5
Cobalt	7440-48-4	50	10	7.23	0.91	20	2
Copper	7440-50-8	25	5	5.57	1.74	20	2
Iron	7439-89-6	100	20	41.6	6.16	50	5
Lead	7439-92-1	3	0.6	148	26.1	150	15
Lithium	7439-93-2			58.7	33.4	200	20
Magnesium	7439-95-4	5000	1000	17.2	2.43	100	10
Manganese	7439-96-5	15	3	4.01	1.22	10	1
Molybdenum	7439-98-7			22.7	9.16	50	5
Nickel	7440-02-0	40	8	72.4	16.9	75	7.5
Potassium	7440-09-7	5000	1000	1300	447	5000	500
Selenium	7782-49-2	5	1	315	43.5	500	50
Silicon	7440-21-3			448		450	45
Silver	7440-22-4	10	2	3.21	1.01	20	2
Sodium	7440-22-4	5000	1000	565	4.74	1000	100
Strontium	7440-24-6			1.61		50	5
Tellurium	13494-80-9			176	32.0	200	20
Thallium	7440-28-0	10	2	52.1	77.5	500	50
Thorium	7440-29-1			26.6	2.49	750	75
Tin	7440-31-5			224	12.9	2000	200

Table 6.1 (Cont.)

TABLE SL-5-2
ST. LOUIS LABORATORY
ICAP Metals
Contract Required Detection Limits (CRDL)[1],
Method Detection Limits (MDL)[2],
and Practical Quantitation Limits (PQL)[3]

Element	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (mg/Kg)	Water MDL (ug/L)	Soil MDL[4] (mg/Kg)	Water PQL (ug/L)	Soil PQL[4] (mg/Kg)
Titanium	7440-32-6			87.7		1000	100
Uranium	7440-62-2			88.4	27.0	500	50
Vanadium	7440-62-2	50	10	17.7	0.93	20	2
Zinc	7440-66-6	20	4	3.88	1.26	20	2

[1] CRDLs apply to work performed according to the USEPA Scope of Work ILM03.0 and its revisions.

[2] Method detection limits were performed using SW-846 Method 6010 on 9/2/92 and 3/24/93 for waters. Soil MDLs were run using Method 6010 on 9/2/92.

[3] PQLs were estimated from the results of water MDL determinations

[4] Soil detection limits are based on wet weight of sample, and will be higher when converted to a dry weight basis.

Table 6.1 (Cont.)

TABLE SL-5-3
ST. LOUIS LABORATORY
AA Metals
Contract Required Detection Limits (CRDL)[1],
Method Detection Limits (MDL)[2], and
Practical Quantitation Limits (PQL)[3]

Element	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (mg/Kg)	Water MDL (ug/L)	Soil MDL[4] (mg/Kg)	Water PQL (ug/L)	Soil PQL[4] (mg/Kg)
Arsenic	7440-38-2	10	2	1.7	0.091	3	0.3
Lead	7439-92-1	3	0.6	1.9	0.098	3	0.3
Selenium	7782-49-2	5	1	0.50	0.023	3	0.3
Thallium	7440-28-0	10	2	2.38	0.204	3	0.3
Antimony	7440-36-0	60	12	4.5	0.36	6	0.6
Silver	7440-22-4	10	2	6.4	0.64	8	0.8
Mercury[5]	7439-97-6	0.2	0.1	0.175	0.013	0.2	0.1

1 CRDLs apply to analyses performed under the Scope of Work of the USEPA Scope of work of Work ILM03.0 and its revisions.

2 Method detection limits for furnace metals were determined between 2/12/93 and 4/2/93. Water MDLs for mercury were determined on 9/9/92. Soil MDLs for mercury were determined on 6-22-93.

3 PQLs are estimated from the method detection limit studies for water samples.

4 Soil detection limits are based on wet weight of sample; detection limits will be higher when corrected for percent solids.

5 Mercury is performed by cold vapor atomic absorption. The other elements are performed by graphite furnace techniques.

Table 6.1 (Cont.)

TABLE SL-5-4
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Volatile Organics
with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/Kg)
Chloromethane	74-87-3	10	10	2.1	1.2	10	10
Bromomethane	74-83-9	10	10	1.6	1.7	10	10
Vinyl Chloride	75-01-4	10	10	2.1	1.2	10	10
Chloroethane	75-00-3	10	10	2.1	2.4	10	10
Methylene Chloride	75-09-2	10	10	0.50	0.44	5	5
Acetone	67-64-1	10	10	2.8	6.0	100	100
Carbon Disulfide	75-15-0	10	10	1.2	0.47	5	5
1,1-Dichloroethene	75-35-4	10	10	1.0	0.50	5	5
1,1-Dichloroethane	75-34-3	10	10	0.47	0.41	5	5
1,2-Dichloroethene (total)	540-59-0	10	10	0.82	0.82	5	5
Chloroform	67-66-3	10	10	0.44	0.28	5	5
1,2-Dichloroethane	107-06-2	10	10	0.19	0.19	5	5
2-Butanone	78-93-3	10	10	3.8	2.2	100	100
1,1,1-Trichloroethane	71-55-6	10	10	0.79	0.50	5	5
Carbon Tetrachloride	56-23-5	10	10	0.85	0.53	5	5
Vinyl Acetate		NA	NA	0.97	2.0	50	50
Bromodichloromethane	75-27-4	10	10	0.35	0.31	5	5
1,2-Dichloropropane	78-87-5	10	10	0.35	0.53	5	5
cis-1,3-Dichloropropene	10061-01-5	10	10	0.28	0.50	5	5
2-chloroethylvinylether	110-75-8	NA	NA	1.1	1.5	10	10
Trichloroethene	79-01-6	10	10	0.53	0.85	5	5
Dibromochloromethane	124-48-1	10	10	0.22	0.31	5	5
1,1,2-Trichloroethane	79-00-5	10	10	0.44	0.28	5	5
Benzene	71-43-2	10	10	0.31	0.22	5	5
trans-1,3-Dichloropropene	10061-02-6	10	10	0.44	0.38	5	5
Bromoform	75-25-2	10	10	0.31	0.44	5	5
4-Methyl-2-Pentanone	108-10-1	10	10	2.0	2.3	50	50
2-Hexanone	591-78-6	10	10	1.3	3.3	50	50
Tetrachloroethene	127-18-4	10	10	0.66	0.50	5	5

Table 6.1 (Cont.)

TABLE SL-5-4
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Volatile Organics
with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/Kg)
Toluene	108-88-3	10	10	0.50	0.57	5	5
1,1,2,2-Tetrachloroethane	79-34-5	10	10	0.53	1.2	5	5
Chlorobenzene	108-90-7	10	10	0.38	0.44	5	5
Ethylbenzene	100-41-4	10	10	0.47	0.47	5	5
Styrene	100-42-5	10	10	0.44	0.41	5	5
Xylene (total)	1330-20-7	10	10	0.72	0.38	5	5

[1] CRDLs apply to analyses performed under the USEPA CLP Scope of Work OLMO1.0 and its revisions only.

[2]The Method Detection Limit study for water was performed on 6-10-93 and 6-11-93. The MDL study for soil was performed on 6-10-93. Both studies were run by SW-846 Method 8240.

[3]Practical Quantitation Limits are taken from SW-846 Method 8240.

[4]Quantitation limits listed for soil are based on wet weight. The quantitation limits based on dry weight as required, will be higher.

Table 6.1 (Cont.)

TABLE SL-5-5
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/L)
Carbazole	86-74-8	10	330	NA	60	10	330
Di-n-Butylphthalate	84-74-2	10	330	1.4	263	10	330
Fluoranthene	206-44-0	10	330	1.4	181	10	330
Pyrene	129-00-0	10	330	1.2	160	10	330
Butylbenzylphthalate	85-68-7	10	330	1.7	192	10	330
3,3'-Dichlorobenzidine	91-94-1	10	330	1.6	175	20	670
Benzo(a)anthracene	56-55-3	10	330	2.8	19	10	330
Chrysene	218-01-9	10	330	2.1	31	10	330
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	3.3	92	10	330
Di-n-Octylphthalate	117-84-0	10	330	1.4	106	10	330
Benzo(b)fluoranthene	205-99-2	10	330	1.9	93	10	330
Benzo(k)fluoranthene	207-08-9	10	330	1.3	100	10	330
Benzo(a)pyrene	50-32-8	10	330	1.2	44	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	1.4	184	10	330
Dibenzo(a,h)anthracene	53-70-3	10	330	0.85	203	10	330
Benzo(g,h,i)perylene	191-24-2	10	330	1.8	167	10	330

[1] CRDLs apply to analyses performed under the USEPA CLP Scope of Work OLM01.0 and its revisions only.

[2] The Method Detection Limit for water was performed by SW-846 Method 8270 on 7-16-93. The MDL study for soil was performed by SW-846 Method 8270 on 1-20-93 and 2-3-93.

[3] Practical Quantitation Limits are taken from SW-846 Method 8270; soil detection limits are based on wet weight, and are the same with and without GPC cleanup.

[4] Quantitation limits listed are for low soil procedure, and are based on wet weight. The quantitation limits based on dry weight as required, will be higher. The quantitation limits for medium level soil procedures will be higher by a factor of 30 than the low soil limits.

Table 6.1 (Cont.)

TABLE SL-5-5
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/L)
Hexachlorocyclopentadiene	77-47-4	10	330	1.9	82	10	330
2,4,6-Trichlorophenol	88-06-2	10	330	7.2	87	10	330
2,4,5-Trichlorophenol	95-95-4	25	800	6.0	100	10	330
2-Chloronaphthalene	91-58-7	10	330	2.5	109	10	330
2-Nitroaniline	88-74-4	25	800	1.3	94	50	1600
Dimethyl Phthalate	131-11-3	10	330	3.6	74	10	330
Acenaphthylene	208-96-8	10	330	1.9	55	10	330
2,6-Dinitrotoluene	606-20-2	10	330	1.4	82	10	330
3-Nitroaniline	99-09-2	25	800	1.8	271	50	1600
Acenaphthene	83-32-9	10	330	2.4	32	10	330
2,4-Dinitrophenol	51-28-5	25	800	50	67	50	1600
4-Nitrophenol	100-02-7	25	800	31	158	50	1600
Dibenzofuran	132-64-9	10	330	1.9	89	10	330
2,4-Dinitrotoluene	121-14-2	10	330	0.92	133	10	330
Diethylphthalate	84-66-2	10	330	2.1	207	10	330
4-Chlorophenyl-phenylether	7005-72-36	10	330	2.2	176	10	330
Fluorene	86-73-7	10	330	2.0	188	10	330
4-Nitroaniline	100-01-6	25	800	2.2	94	50	1600
4,6-Dinitro-2-Methylphenol	534-52-1	25	800	23	86	50	1600
n-Nitrosodiphenylamine	86-30-6	10	330	1.4	74	10	330
4-Bromophenyl-phenylether	101-55-3	10	330	2.1	114	10	330
Hexachlorobenzene	118-74-1	10	330	2.0	208	10	330
Pentachlorophenol	87-86-5	25	800	11	77	50	1600
Phenanthrene	85-01-8	10	330	1.2	34	10	330
Anthracene	120-12-7	10	330	1.2	37	10	330

Table 6.1 (Cont.)

TABLE SL-5-5
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/L)
Phenol	108-95-2	10	330	3.4	115	10	330
bis(2-Chloroethyl)ether	111-44-4	10	330	1.3	117	10	330
2-Chlorophenol	95-57-8	10	330	6.2	102	10	330
1,3-Dichlorobenzene	541-73-1	10	330	2.4	64	10	330
1,4-Dichlorobenzene	106-46-7	10	330	2.6	44	10	330
Benzyl Alcohol	100-51-6	NA	NA	3.7	83	20	670
1,2-Dichlorobenzene	95-50-1	10	330	2.3	83	10	330
2-Methylphenol	95-48-7	10	330	6.0	78	10	330
bis(2-chloroisopropyl)ether	108-60-1	10	330	2.1	163	10	330
4-Methylphenol	106-44-5	10	330	5.4	171	10	330
n-Nitroso-di-n-Propylamine	621-64-7	10	330	1.6	166	10	330
Hexachloroethane	67-72-1	10	330	3.0	104	10	330
Nitrobenzene	98-95-1	10	330	1.1	181	10	330
Isophorone	78-59-1	10	330	1.2	204	10	330
2-Nitrophenol	88-75-5	10	330	1.6	98	10	330
2,4-Dimethylphenol	105-67-9	10	330	5.3	84	10	330
Benzoic Acid	65-85-0	NA	NA		345	50	1600
bis(2-Chloroethoxy) Methane	111-91-1	10	330	1.5	67	10	330
2,4-Dichlorophenol	120-83-2	10	330	6.1	34	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330	2.3	51	10	330
Naphthalene	91-20-3	10	330	2.3	49	10	330
4-Chloroaniline	106-47-8	10	330	1.6	232	20	670
Hexachlorobutadiene	87-68-3	10	330	2.8	106	10	330
4-Chloro-3-Methylphenol	59-50-7	10	330	5.6	151	20	670
2-Methylnaphthalene	91-57-6	10	330	3.7	122	10	330

Table 6.1 (Cont.)

FIGURE SL-5-12
ITAS-ST. LOUIS LABORATORY
Radiochemical Target Detection Limits

Analytical Parameters	Matrix	Detection Limit[1]
Total Uranium	Water	1 µg/L (KPA)
	Soil	20 µg/g (gamma)
Radium-228	Water	3 pCi/L
Tritium	Water	500 pCi/L
	Soil	500 pCi/L
Gross Alpha	Water	5 pCi/L[2]
	Soil, Vegetation	25 pCi/g
	Filter	1 pCi/filter
Gross Beta	Water	4 pCi/L
	Soil, Vegetation	25 pCi/g
	Filter	2 pCi/filter
Total Alpha Emitting Isotopes for Radium	Water, Vegetation	1 pCi/unit volume
Radium-226/228 by Gamma	Soil	1 pCi/g (Ra-226)
		3 pCi/g (Ra-228)
Isotopic Americium, Uranium, Plutonium, Thorium	Water	1 pCi/L
	Soil	1 pCi/g
	Vegetation	1 pCi/g
	Filter	1 pCi/filter
Technetium-99	Water, Filter	3 pCi/L
	Soil, Vegetation	2 pCi/g
Strontium-89/90	Water, Filter	1 pCi/L
	Soil, Vegetation	1 pCi/g
Polonium-210	Water	1 pCi/L
Lead-210	Water	1 pCi/L
Gamma	Water, Filter	20 pCi/L (based on Cs-137)[4]
	Soil, Vegetation	2 pCi/g (based on Cs-137)
Ra-226/Rn-222 by Emanation	Water	0.2 pCi/L

Table 6.1 (Cont.)

FIGURE SL-5-12
ITAS-ST. LOUIS LABORATORY
Radiochemical Target Detection Limits

Analytical Parameters	Matrix	Detection Limit[1]

[1]Count durations for all samples will be optimized so that client required detection limits can be achieved. Interferences, contaminants, and other matrix problems may cause the sample detection limit to exceed the desired detection limit.

[2]Achievable only when dissolved solids <500 ppm.

STS FIELD SAMPLE TRACKING FORM

Job Number: _____ Page _____ of _____

FIELD SAMPLE CODE (FSC)	BRIEF DESCRIPTION OF SAMPLE	DATE	TIME (MILITARY)	SAMPLER INITIALS

Figure QAPP 6.1-1

ITC Corporation, Inc.

INTERNATIONAL TECHNOLOGY CORPORATION

CHAIN-OF-CUSTODY RECORD

~~R/A Control No.~~

~~G/O Control No.~~ 132596

PROJECT NAME/NUMBER Tonawanda (109-91-015-01)

LAB DESTINATION BMR

SAMPLE TEAM MEMBERS D.A. Dooley / J.V. Wiernicki

CARRIER/WAYBILL NO. Hand Carried

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.
FS-21	Sewer Sludge from 30 gal drum	9/25/91 - 1425	Sludge	100ml poly		
FS-22	" "	9/25/91 - 1005	"	"		
FS-23	" "	9/25/91 - 1552	"	"		
FS-24	" "	9/25/91 - 1237	"	"		
FS-25	" "	9/25/91 - 1037	"	"		
FS-26	" "	9/25/91 - 1522	"	"		
FS-27	" "	9/25/91 - 1512	"	"		
FS-28	" "	9/25/91 - 1417	"	"		
FS-29	" "	9/25/91 - 1408	"	"		
FS-30	" "	9/25/91 - 1615	"	"		
FS-31	" "	9/25/91 - 1625	"	"		

RECEIVED DEC 4 1991

Special Instructions: Analyze for Am-241

Possible Sample Hazards: Bioactive, Radioactive

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: J. Wiernicki, MWCorp, 9/26/91, 10:00
   Received By: C. DiMartino, MWCorp, 9/26/91, 10:07
2. Relinquished By: C. DiMartino, MWCorp 9/26/91, 10:32
   Received By: Jim Wright MWCorp. 9/26/91 10:37
3. Relinquished By: Jim Wright MWCorp 9/26/91 11:40
   Received by: David R. Webb 9/26/91 11:48
4. Relinquished By:
   Received By:

WHITE - To accompany samples
YELLOW - Field copy

Figure 6.1-2

INSTRUCTIONS FOR COMPLETING CHAIN-OF-CUSTODY RECORD

The Chain-of-Custody record must be accurately completed and the original must accompany the sample(s). When sending samples to the laboratory, a Request for Analysis form must also be submitted.

R/A Control No.: Record the printed control number from the top right corner of the Request for Analysis form, if you are sending these samples to the laboratory.

Project Name/Number: Record the name of the project or client/site location, and the billing number of the project. (Example - 613215: X, Y, Z Chemical Co., WA).

Sample Team Members: List the names of all the members of the team taking these samples; team leader's name first.

Lab Destination: Indicate wo which laboratory you are sending the samples. Do not list more than one lab on a single chain-of-custody record. Be certain before sending the samples that the laboratory you are designating is aware of the shipment.

Carrier/Waybill No.: If you are sending these samples by a commercial carrier such as Airborne or Federal Express, record the courier company name and the waybill or airbill number under which these samples will be shipped. (Example - Federal Express #513631771).

Sample Number: List the complete identifying number of each of the samples you are sending. These numbers must correspond with the identifying labels on the sample containers.

Sample Location and Description: Briefly record where the sample was taken and provide a short physical description of the sample. Draw a sketch on the Sample Collection Log if necessary.

Date and Time Collected: Record date and exact time each sample was collected. Use a 24 hour clock; i.e., 1645 not 4:45 p.m.

Sample Type: Indicate the sample type such as soil, sediment, sludge, water, wipe, air or bulk.

Container Type: Indicate the volume, color and type of the sample container used (Examples - 1 gallon amber glass, 1 liter clear plastic, 40 ml clear glass).

Condition on Receipt: Before a custody transfer, the intended recipient should verify all samples are present and in good conditions. This column may be used by the recipient to record any abnormalities found at the time of the transfer. (Examples - jar lid cracked, sample label torn).

Special Instructions: Use this space to record any special instructions to the laboratory regarding the processing of these samples. Leave blank if there are no special instructions.

Possible Sample Hazards: Indicate if the samples are suspected to contain high concentrations of any hazardous materials, or if they may pose other hazards. If you are unaware of any possible hazards, leave this line blank.

Signatures: When releasing custody of these samples, use the "Relinquished By" space to sign your full name, company name, date and time of release. After verifying that all samples indicated are present, the person receiving the samples must sign in the "Received By" space to take custody of the samples.

FIGURE QAPP 6.1-3

7.0 CALIBRATION PROCEDURES AND FREQUENCY

The SOP for use of the Bicron Micro Rem survey meter is contained in the work plan. All Bicron instruments shall be calibrated by the manufacturer every six months using N.I.S.T. traceable sources. Calibration data shall include both the "as found" condition of the instrument and the "as left" calibration results. Examples of these two calibration certificates are shown in Figures QAPP 7.0-1 and 7.0-2.

All ancillary radiological equipment used by M.J.W. to access radiological conditions is also required to be calibrated every 6 months, using N.I.S.T. traceable sources. **Calibrations are performed in accordance with the manufacturers' recommendations and per MJW Radiological Control Procedures. Instruments which fail the daily field source check will be removed from service after verification of all instrument settings and a retest shows no change in the result.** The general procedure for radiological instrument calibration and operability checks is shown in Appendix F, and Appendix G contains the operating and calibration procedures for the most commonly used field instruments. An example of a calibration standard certificate for a standard used by MJW for instrument calibrations is shown in Figure QAPP 7.0-3.

HARSHAW BICRON RADIATION MEASUREMENT PRODUCTS

BICRON • 6801 Cochran Road • Solon, Ohio 44139

Phone: (216) 248-7400 • Fax: (216) 349-6581

CERTIFICATE OF INSTRUMENT CALIBRATION

CUSTOMER: MJW CORP. Q# RGR-4097

INSTRUMENT MODEL: micro rem SERIAL # B378A

CALIBRATION DATA AS FOUND

RANGE	EXPOSURE RATE	INST. READING	EXPOSURE RATE	INST. READING
X1000	160 mR/h	159	40 mR/h	39
X100	16 mR/h	16.1	4 mR/h	3.9
X10	1.6 mR/h	1.65	400 uR/h	400
X1	160 uR/h	185	40 uR/h	40
X0.1	16 uR/h	18		

ISOTOPIC CALIBRATION PERFORMED WITH A J.L. SHEPHERD & ASSOCIATES MODEL 28-6A CALIBRATOR, S/N 10081 AND IS TRACEABLE TO (N.I.S.T).

* INSTRUMENT CALIBRATED WITH A CS-137 GAMMA SOURCE USING A CONVERSION FACTOR OF $\frac{1 \text{ urem/h}}{1 \text{ uR/h}}$

OTHER CALIBRATIONS AVAILABLE UPON REQUEST.

CALIBRATED BY: Ray Compton DATE: 1-12-94

Figure 7.0-1

HARSHAW BICRON RADIATION MEASUREMENT PRODUCTS

BICRON • 6801 Cochran Road • Solon, Ohio 44139

Phone: (216) 248-7400 • Fax: (216) 349-6581

CERTIFICATE OF INSTRUMENT CALIBRATION

CUSTOMER: MJW CORP. Q# RGR-4097

INSTRUMENT MODEL: micro rem SERIAL # B378A

CALIBRATION DATA

RANGE	EXPOSURE RATE	INST. READING	EXPOSURE RATE	INST. READING
X1000	160 mR/h	160	40 mR/h	41
X100	16 mR/h	16	4 mR/h	4
X10	1.6 mR/h	1.6	400 uR/h	410
X1	160 uR/h	160	40 uR/h	40
X0.1	16 uR/h	16		

THE Cs-137 1 Ci SOURCE USED FOR THIS CALIBRATION HAS A CERTIFICATE STATING ITS TRACEABILITY TO N.B.S. (N.I.S.T.) STANDARDS.

* INSTRUMENT CALIBRATED WITH A CS-137 GAMMA SOURCE USING A CONVERSION FACTOR OF $\frac{1 \text{ urem/h}}{1 \text{ uR/h}}$

* CALIBRATOR : J.L.SHEPHERD / MODEL: 28-6A S.N.:10081

CALIBRATED BY: Roy Compton DATE: 1-12-94

Figure 7.0-2

CERTIFICATE OF CALIBRATION
BETA STANDARD SOURCE

Radionuclide:	Sr-90	Customer:	MJW CORPORATION INC.	
Half Life:	28.5 ± 0.2 years	P.O.No.:	VERBAL	
Catalog No.:	200-1	Reference Date:	January 1 1991	12:00 PST.
Source No.:	371-72-4	Contained Radioactivity:	0.01291	µCi.

Description of Source

a. Capsule type:	A
b. Nature of active deposit:	Distributed and evaporated metallic salts
c. Active diameter/volume:.	22 mm
d. Backing:	0.254 mm stainless steel
e. Cover:	0.9 mg/cm² aluminized mylar

Radioimpurities

None detected (Y-90 daughter in equilibrium)

Method of Calibration

The source was assayed using a windowless internal gas flow proportional counter.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration:	± 2.0%
b. Random uncertainty in assay:	± 1.0%
c. Random uncertainty in weighing(s):	± 0.0%
d. Total uncertainty at the 99% confidence level:	± 3.0%

NIST Traceability

This calibration is implicitly traceable to the National Institute of Standards and Technology.

Notes

1. Nuclear data were taken from "Table of Isotopes", Seventh Edition, edited by Virginia S. Shirley.
2. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials. (As in NRC Regulatory Guide 4.15)

QUALITY CONTROL

ISOTOPE PRODUCTS LABORATORIES
1800 No. Keystone Street.,
Burbank, California 91504
(818) 843 - 7000

IPL Ref. No.: N/A

Figure 7.0-3

8.0 ANALYTICAL PROCEDURES

The analytical procedures for the sample laboratory (ITAS) are provided in Appendices B, C and D and will not be discussed further. Radiological measurements and analyses performed to support the field work will be documented per M.J.W. RCP-4 shown in Appendix H.

9.0 DATA REDUCTION VALIDATION AND REPORTING

Data collected during the overland gamma survey on the 6x6 meter grid will be reduced using the computer program CorelDRAW!, Version 4.0 or equivalent to produce a 3-D graphic of the changes in exposure rate over the surface of the study area. A detailed plot will also be generated for measurements taken using the smaller 1x1 meter grid to provide better resolution for areas of elevated gamma readings. Data transcription from the field data sheets to the computer program will receive 100% validation. In addition, the Work Plan calls for a minimum of 10% validation of the original field measurements for the overland gamma survey activity using a different Bicron instrument and different surveyor. Validation records shall be maintained with the original data set and computer spreadsheet and graphics printouts.

Data reduction, validation, and reporting for analyses conducted at the ITAS laboratory will be in accordance with their standard practices per Appendices A through E and as accepted by STS. The laboratories will be required to report the basic QA/QC data specified by SW-846 for the pertinent methods. All sample analysis data generated by ITAS shall be reviewed for accuracy, precision, and completeness by the site Quality Assurance Officer or other qualified personnel as designated by the Project Manager. The data will be assessed for confirmation of compliance with QA/QC requirements by the site QA officer.

Data acceptance will be based upon the results of the analytical laboratory's ~~participation~~ participation and results of the Performance Evaluation Studies conducted with the EML laboratory of DOE and the EPA crosscheck program run out of Las Vegas. Apart from splits, duplicates and spikes, this is the only true measure of analytical accuracy for radiological sample analyses to be performed.

The laboratory deliverable packages provided by ITAS will be appended to applicable reports. Raw data from field measurement and sample collection activities will be documented on data sheets and in log books and retained as part of the project files. The use of field data and the reduction of such data used in project reports will be appropriately identified in project reports.

10.0 INTERNAL QUALITY CONTROL CHECKS

All radiological field instruments will undergo operability checks prior to each use per M.J.W. RCP-9 (Appendix F). Given time for breaks and lunch, operability checks may be performed 2-4 times per day.

All operability checks are documented per MJW RCP-9 and MJW RCP-41 as applicable. Completed operability check forms will be retained as part of the permanent record. All radiological QC data will be control charted to the extent possible, i.e., background and check source data collected during the field work.

Internal QC checks for soil samples will consist of at least one spiked sample (supplied by ITAS), four (4) replicates and two (2) split samples. Soil for split samples will be collected into a plastic bag and homogeneously mixed to assure a representative split. The replicate analyses will be ordered on 2 high activity samples and 2 moderate to low activity samples based on initial field screening.

11.0 PERFORMANCE AND SYSTEM AUDITS

Planned internal audits, surveillance, or checks are to be performed to provide comprehensive and independent verification and evaluation of the application of the QA/QC requirements throughout the duration of the characterization work as performed by STS. The scope of such audit, surveillance, or check activities shall encompass: (1) evaluation of QA/QC practices and procedures and the effectiveness of their implementation, monitoring, operations, or activities; and (2) review of pertinent documents and records, and the control and maintenance of such documents and records.

Periodic surveillance of subcontractors, suppliers, and laboratories are to be performed and documented when requested by the Project Manager or when required by Chicago Dock. Surveillance results shall be reviewed by the Project Manager and other appropriate personnel. Action will be taken to correct deficiencies and document their resolutions, or proposed resolutions as per QA Procedure P.3, "Corrective Actions." Observed deficient areas are to be re-examined to ensure corrections have been accomplished. Immediately upon completion of and reporting on a surveillance inspection or check made by Chicago Dock, actions are to be taken and documented to correct deficiencies reported in such surveillance.

A single audit, independent of surveillance or inspection activities, shall be conducted toward the end of the activities. The audit will consist of planned and documented activities performed to determine, by investigation, examination, and evaluation of objective evidence, the adequacy of and compliance with the established procedures. It will also determine the effectiveness of implementation of the project Work Plan. A single audit will be performed unless otherwise requested by Chicago Dock. Audit results shall be documented and reviewed by management personnel who have responsibility in the area audited.

The planned periodic surveillance and the audit shall be performed in accordance with QA Procedure P.4, "Quality Assurance Audit Procedures."

12.0 PREVENTATIVE MAINTENANCE

Specific preventative maintenance procedures for sampling and field measurement equipment are referenced in or are part of the standard operating procedures applicable to the equipment. The Field Investigation Manager or designate is responsible for implementing and documenting these procedures during the period of their use. Any instrument or piece of equipment which is defective shall be tagged "out of service" pending repair. Any repair radiological equipment shall be recalibrated before further use.

13.0 PROCEDURES TO ASSESS DQOs

The data quality objectives for the overland gamma survey only involve calculation of the mean and standard deviation of the original and the 10% validation measurements taken at similar grid point locations. The equations used to calculate the arithmetic mean and standard deviation are:

Mean: $\bar{X} = \Sigma_{i=1}^{n} X_i$

Standard Deviation: $\sigma = \sqrt{S^2}$ WHERE $S^2 = \dfrac{\Sigma_{i=1}^{n} (X_i - \bar{X})^2}{n-1}$

Accuracy of field measurements will be assessed by reviewing control charts maintained for daily instrument calibrations, checks, repeat measurements and analysis of blanks, as applicable. Precision will be assessed by examining the reproducibility of multiple measurements of a single sample, as applicable for the measurement.

Laboratory precision will be measured using replicate sample analysis. Interlaboratory comparisons will not be made. ITAS will be required to submit sample data results which describe the accuracy of the result and any bias encountered.

The analytical results for samples will be evaluated for precision, accuracy, and completeness, as identified in the Work Plan. These evaluations will generally only be applicable to the analyses of samples for analytes, because there are no applicable procedures for geotechnical and other physical test procedures for soils and sludge. Given the heterogeneous nature of the subject materials, assessments for precision and accuracy are not appropriate to the physical test procedures and results.

Precision of laboratory analyses will be assessed by comparing the analytical results of matrix spike/matrix spike duplicate analyses for organic analysis and laboratory duplicate analyses or matrix spikes for inorganic analysis. The relative percent difference will be calculated for pairs of duplicate analysis. The relative percent difference will be calculated for pairs of duplicate analysis or for deviations from the known value of the spiked samples.

Accuracy of laboratory results will be assessed for compliance with the established QC criteria (Appendices A and E) using the analytical results of method blanks, reagent/preparation blanks, matrix spike/matrix spike duplicate samples, field blanks, field equipment blanks, and trip blanks.

The completeness of data resulting from laboratory analyses will be assessed for compliance with the amount of data required for decision making. Laboratory and field data will also be reviewed for completeness. Completeness reviews are the responsibility of the Site QA Officer for the activity which produced the measurement or the sample from which the data were obtained.

The achievement of method detection limits depends on instrumental sensitivities and matrix effects or interferences. The project contract with the analytical laboratory and oversight by the Site QA Officer will be used to ensure that proper procedures are employed to obtain adequate detection or quantitative limits.

The Project Manager, Field Investigation Manager, or the Task Leaders will perform daily reviews of field activities and collected information. The reviews shall confirm that proper measurements were taken, data were properly recorded, and, to the extent possible at that time of the review, that the collected data satisfy the applicable DQOs.

14.0 CORRECTIVE ACTION

Conditions adverse to quality (e.g., nonconformances, failures, malfunctions, errors, deficiencies, derivations, defective materials, etc.) shall be identified and evaluated to determine the need for corrective action in accordance with QA Procedure P.3, "Corrective Actions." Corrective actions are to be promptly initiated by the Project Manager when it is determined that corrective actions are needed.

Corrective actions include determination of the cause of conditions adverse to quality, the actions to prevent recurrence of those conditions, verification of acceptable completion of actions taken to resolve or rectify the conditions, and documentation of associated activities. Deficiencies and nonconformances identified through audits, surveillances, and inspections shall be reported to the Project manager in accordance with QA Procedure P.3. The cause of the nonconformance or deficiency shall be documented and actions taken for resolution. If corrective actions taken in response to nonconformance reports, audits, and surveillances are not adequately performed, the Project Manager and Site QA Officer will evaluate the conditions and determine if quality affecting activities shall be stopped in accordance with QA Procedure P.3.

15.0 QUALITY ASSURANCE RECORDS AND REPORTS

The 316 East Illinois Project QA records are defined as the QAPP, its associated procedures, standard technical procedures, and supporting and implementing documentation. Included are all changes to the QAPP and standard technical procedures, and all documentation of QA audits, surveillances, checks, and corrective actions.

Originals of all QA records for the 316 East Illinois Project are maintained by the Site QA Officer or designate. Copies are maintained as part of the project file. All project-specific QA records are retained for the duration of the project. Such records are to be transferred to Chicago Dock at the same time as the project files. Any deficiencies in the project-specific QA activities will be corrected before final closeout of the project QA record is approved by the Site QA Officer.

The 316 East Illinois Project QA records shall be stored as part of the Project file and shall be protected against damage, deterioration, vandalism, or loss. Duplicate records may be maintained at separate locations, as appropriate. Project QA records are reviewed for content and correctness in accordance with QA Procedure P.3, "Quality Assurance Records," and appropriate standard technical procedures are reviewed for legibility and reproducibility prior to turnover of the project files. Reduction or transcription of original data records are completed within an interval defined by the Project Manager.

The identification, storage, and retrieval of project documents identified as QA records are in accordance with Quality Assurance Procedure P.5.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROJECT PLAN

APPENDIX D.1

QUALITY ASSURANCE PROCEDURES

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

APPENDIX D.1-1

PROCEDURE NO. 1 - PREPARATION OF PROCEDURES

Revision No. _____

Approval:

Technical:		**Quality Assurance:**	
Signature:	_____	Signature:	_____
Name:	Craig Rawlinson	Name:	David A. Dooley
Title:	Project Manager	Title:	Quality Assurance Officer
Date:	_____	Date:	_____

PREPARATION OF PROCEDURES

Technical and other activities affecting project quality or health and/or safety shall be conducted using approved procedures. Procedures shall be prepared for activities which are not covered by existing STS or subcontractor procedures. New 316 East Illinois project specific procedures should be prepared to the extent necessary according to the following format:

1.0 Purpose: Describe the specific purpose of the procedure.

2.0 Applicability: Identify the applicability of the procedure.

3.0 Definitions: Define words and phrases having special meaning within the procedure, if necessary.

4.0 References: Identify pertinent literature utilized in the preparation of the procedure, if necessary.

5.0 Discussion: If necessary, a discussion may be included to make the application or execution of the procedure more understandable.

6.0 Responsibility: Identify the organizational positions and responsibilites of the individuals charged with implementing the procedure.

7.0 Equipment or Materials: Identify equipment or materials necessary to support the procedure, if necessary.

8.0 Procedure: Identify the specific step-by-step process to be implemented.

9.0 Records: List QA records and controlled documents generated as a result of the procedure, as necessary.

The above subject headings are an example format and are not required to be used for all procedures.

IDENTIFICATION

Procedures prepared in accordance with 316 East Illinois Project QA requirements are to be dated and assigned unique letter-number designations. Each page of the procedure is to be numbered with the most current revision number.

The author who prepares procedures, addenda, or revisions to these documents shall obtain the required reviews and approvals. The 316 East Illinois Project procedures, addenda, or revisions thereto are reviewed and approved by the Project Manager or designee and the Project QA Officer or designee, as appropriate. Any revision deemed necessary shall be submitted for the same review and approval process as the original procedure.

Field revisions to procedures may be made by personnel using the procedure if following the process described above will impact project costs or schedule to a degree determined to be unacceptable by the Project Manager or his designee. In such instances, implementation personnel shall make pen and ink changes to the procedure and perform an independent check of the change. The persons making the change and the check of the change shall each initial and date the change. At the first opportunity after a field change is made, the change shall be formally documented as outlined above.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

APPENDIX D.1-2

PROCEDURE NO. 2 - PROJECT FILES

Revision No. _____

Approval:

Technical:

Signature: _____

Name: Craig Rawlinson

Title: Project Manager

Date: _____

Quality Assurance:

Signature: _____

Name: David A. Dooley

Title: Quality Assurance Officer

Date: _____

PROJECT FILES

The Project Manager shall be responsible for the maintenance of all project files. The project files consist of the information necessary to document the planning, implementation, analysis, design and quality of the activities conducted to produce the information contained in all final documents prepared for external distribution and all QA activities conducted in support of the 316 East Illinois Project. Separate technical and QA project files will be maintained.

The project file consists of an organized set of files and log sheets which allows the easy and rapid location of project information. At a minimum, the project file must contain all incoming and outgoing correspondence and copies of all internal working logs, calculation sheets, computer codes and other project-related supporting documents.

Project files are retained by STS as directed by Chicago Dock or for a minimum of three years, whichever is longer.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

APPENDIX D.1-3

PROCEDURE NO 3 - CORRECTIVE ACTIONS

Revision No. _____

Approval:

Technical:

Signature: _____

Name: Craig Rawlinson

Title: Project Manager

Date: _____

Quality Assurance:

Signature: _____

Name: David A. Dooley

Title: Quality Assurance Officer

Date: _____

CORRECTIVE ACTIONS

Conditions adverse to quality in equipment or in design activities, upon discovery, shall be promptly brought to the attention of the Project Manager (PM). Before proceeding further with the equipment use or design activity, the PM shall determine if corrective action is needed. If corrective action is determined to be not necessary, the PM shall include in the project files a written explanation of the nonconformity and the reasons for not taking corrective action.

If corrective action is determined to be necessary, the Project Manager shall:

- At his own discretion, determine whether to involve Chicago Dock in the selection of corrective actions.
- Ascertain the cause of the conditions adverse to quality.
- Determine appropriate corrective actions to preclude recurrence.
- Implement designated corrective actions.
- Verify that the designated corrective actions have been satisfactorily completed.
- Document all deliberations, decisions and activities taken as corrective action.
- Notify Chicago Dock of corrective actions taken, if he judges it to be of significance to Chicago Dock.

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

APPENDIX D.1-4

PROCEDURE NO. 4 - QUALITY ASSURANCE AUDITS PROCEDURES

Revision No. _____

Approval:

Technical:		**Quality Assurance:**	
Signature:	_____	Signature:	_____
Name:	Craig Rawlinson	Name:	David A. Dooley
Title:	Project Manager	Title:	Quality Assurance Officer
Date:	_____	Date:	_____

QUALITY ASSURANCE AUDITS PROCEDURES

The Project QA Officer (designated as the QAO) or designate shall perform project-specific audits to provide comprehensive and independent verification and evaluation of the proper application of QA requirements.

Each audit shall ensure that project-specific QA requirements, as specified in the 316 East Illinois Project QAPP, are being properly applied. The date, results and closure of each project audit shall be recorded on Form P.4-1. Form P.4-1 is used to document the actual activities performed in completing each audit.

Findings reported on Form P.4-1 are to be promptly corrected by the Project Manager or designee. The Project QA Officer is responsible to ensure that outstanding findings are corrected according to the schedule documented on Form P.4-1. The person who performed the audit verifies that the corrective action taken has resolved the intended finding. The auditor acknowledges resolution of each finding by initials and date on Form P.4-1. Audits are considered closed only after all outstanding findings are resolved to the satisfaction of the Project QA Officer. Closure of the audit is acknowledged by the Project QA Officer by signature on Form P.4-1. The original of each completed Form P.4-1 shall be retained by the Project QA Officer as part of the project QA record. A copy of each completed Form P.4-1 shall be retained by the Project Manager or designee as part of the project records.

STS CONSULTANTS, LTD.
QUALITY ASSURANCE PROGRAM PROJECT AUDIT
FORM P.4-1

1. Project Audited (Project Manager and STS Contract _____

2. Assigned Project Auditor (QAO Completes) _____

3. Scope and Focus of Audit (QAO Completes) _____

Assigned Auditor understands the purpose, scope and focus of the audit.

Name: _____ Date: _____

4. Applicable Documentation (Completed by Auditor): List documents (manuals, procedures, etc.) used to implement QA requirements for this project.

STS QAM dated: _____ STS QAP-1.1 dated: _____

STS Quality Assurance Procedures and Dates: (list each Procedure applicable to the project being audited.)

Procedure Name or Number	Effective Date

Other Applicable Documents (list titles and effective dates)

Title	Effective Date

STS CONSULTANTS, LTD.
QUALITY ASSURANCE PROGRAM PROJECT AUDIT (continued)
FORM P.4-1

5. Audit Record (Completed by Auditor)

a. Project Files and Other Materials reviewed (list and date when reviewed)

b. Interviews conducted (Individuals interviewed and interview date)

c. Other Audit Activities (Specify activity conducted)

6. Audit Observations and Conclusions

STS CONSULTANTS, LTD.
QUALITY ASSURANCE PROGRAM PROJECT AUDIT (continued)
FORM P.4-1

7. Specific Audit Findings	Non-Conformance		Non-Conformance Time Period	Client Data, Reports, Conclusions Affected			Corrective Action	
	Yes	No	____ to ____	Yes	No	Uncertain	Yes	No
a.								
b.								
c.								
d.								
e.								
f.								
g.								
h.								
i.								

STS CONSULTANTS, LTD.
QUALITY ASSURANCE PROGRAM PROJECT AUDIT (continued)
FORM P.4-1

8. Audit Completed By (Date): _____

9. Audit Accepted By QAO: _____ Date: _____

10. Audit observations and findings presented and discussed with Project Manager:

Date: _____ QAO Signature: _____

11. Planned Corrective Actions (Columns 1-3 completed by Project Manager; Column 4 completed by Auditor)

(1) Finding (Refer to Item 7)	(2) Planned Corrective Action	(3) Date Corrective Action to be Complete	(4) Corrective Action Complete	
			Initials	Date
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				

12. Planned Corrective Actions Approved:

Auditor: _____ Date: _____

QAO: _____ Date: _____

13. Audit Closure

All Corrective Actions Completed, no further action required. Audit Satisfactory.

QAO Signature: _____ Date: _____

PM Signature: _____ Date: _____

14. Date the Project Audit from filed in Project Files: _____

316 EAST ILLINOIS PROJECT

QUALITY ASSURANCE PROCEDURES

APPENDIX D.1-5

PROCEDURE NO. 5 - PROJECT QUALITY ASSURANCE RECORDS

Revision No. _____

Approval:

Technical:

Signature: _____

Name: Craig Rawlinson

Title: Project Manager

Date: _____

Quality Assurance:

Signature: _____

Name: David A. Dooley

Title: Quality Assurance Officer

Date: _____

PROJECT QUALITY ASSURANCE RECORDS

At a minimum, the QA records for the 316 East Illinois Project consist of the 316 East Illinois Project QAPP, all procedures designated in the QAPP, and all required forms and records necessary to demonstrate the proper implementation of the 316 East Illinois Project QA requirements. All project QA records are maintained by the Project QA Officer as part of the Project QA file. Once a project is completed, the Project Manager shall ensure the project file is complete and obtain Project QA Officer approval of the final Project QA audit. Once the final project audit is approved by the Project QA Officer, the project file is disposed of as directed by Chicago Dock.

All project QA records are classified as non-permanent records and shall be maintained as part of the project file. Project file QA records shall be retained for three years following completion of the project or as specifically directed by Chicago Dock.

APPENDIX A

OPERATION-SPECIFIC
QUALITY ASSURANCE MANAGEMENT PLAN -
IT ANALYTICAL SERVICES DIVISION

Operation-Specific

Quality Assurance Management Plan

IT ANALYTICAL SERVICES DIVISION

Revision 0

September 1, 1993

Operation-Specific
QUALITY ASSURANCE MANAGEMENT PLAN
IT ANALYTICAL SERVICES DIVISION

OAK RIDGE LABORATORY

Prepared by:

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LIST OF ACRONYMS

AA	Atomic Absorption
ANSI	American National Standards Institute
AR/COC	Analysis Request/Chain-of-Custody
AS	Analytical Spike
ASTM	American Society for Testing and Materials
BFB	Bromofluorobenzene
BLK	Blank
BS	Blank Spike
BSD	Blank Spike Duplicate
CCC	Continuing Calibration Compounds
CCS	Continuing Calibration Standard
CEO	Chief Executive Officer
CF	Calibration Factor
CHP	Chemical Hygiene Plan
CLP	Contract Laboratory Program
COC	Chain-of-Custody
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CS	Check Standard
CUR	Condition Upon Receipt
CVAA	Cold Vapor Atomic Absorption
DFTPP	Decafluorotriphenylphosphine
DOC	Dissolved Organic Carbon
DOT	Department of Transportation
DQO	Data Quality Objective
DRC	Data Review Checklist
EDT	Electronic Data Transfer
EMSL-LV	Environmental Monitoring Laboratory-Las Vegas
EPA	U. S. Environmental Protection Agency
FAS	Field Analytical Services
FB	Field Blank
FD	Field Duplicate
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption Spectroscopy
HDPE	High Density Polyethylene
HPLC	High Performance Liquid Chromatography
HRGC	High Resolution Gas Chromatography
HRMS	High Resolution Mass Spectrometry

LIST OF ACRONYMS (continued)

HTV	Holding Time Violation
IATA	International Air Transportation Association
ICAO	International Civil Aviation Organization
ICP	Inductively Coupled Argon Plasma Spectroscopy
ID	Identification
IR	Infrared Spectroscopy
IS	Internal Standard
ISO	International Standard Organization
IT	IT Corporation
ITAS	IT Analytical Services
JPR	Job Performance Review
LCL	Lower Control Limit
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LRMS	Low Resolution Gas Chromatography
LST	Laboratory Safety Training
LWL	Lower Warning Limit
MB	Method Blank
MBAS	Methylene Blue Active Substance
MDA	Minimum Detectable Activity
MDL	Method Detection Limit
MOP	Manual of Practice
MS	Matrix Spike
MSA	Method of Standard Additions
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
NBS	National Bureau of Standards
NCM	Nonconformance Memo
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards Technology
NMOC	Non-Methane Organic Compounds
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OS-QAMP	Operation-Specific Quality Assurance Management Plan
PAH	Polynuclear Aromatic Hydrocarbons (or PNA)
PCB	Polychlorinated Biphenyls
PE	Performance Evaluation
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit

LIST OF ACRONYMS (continued)

PUF	Polyurethane Foam
QA	Quality Assurance
QAMP	Quality Assurance Management Plan
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
QA/QCC	Quality Assurance/Quality Control Coordinator
QAS	Quality Assurance Summary
QC	Quality Control
RB	Reagent Blank
RCRA	Resource Conservation Recovery Act
RF	Response Factor
RPD	Relative Percent Difference
RRF	Relative Response Factor
RSD	Relative Standard Deviation
RSO	Radiation Safety Officer
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SPCC	System Performance Check Compounds
SRM	Standard Reference Material
SS	Surrogate Standard
TAT	Turnaround Time
TB	Trip Blank
TCLP	Toxicity Characteristic Leaching Procedure
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TQM	Total Quality Management
UCL	Upper Control Limit
UN	United Nations
USEPA	United States Environmental Protection Agency
UWL	Upper Warning Limit
VOA	Volatile Organic Analytes
VOST	Volatile Organic Sampling Train
WS	Water Supply
WP	Water Pollution

APPENDIX LIST

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1.0 MANAGEMENT COMMITMENT AND ORGANIZATION

1.1 Statement of Management Position on Quality

IT Corporation (IT) is committed to providing quality services for environmental management: services which meet the needs of our clients, satisfy regulatory requirements, and are commensurate with the current state of the art. To satisfy our clients' quality objectives, to meet regulatory requirements, and to comply with IT corporate-wide requirements, IT Analytical Services (ITAS) Division has adopted a comprehensive Quality Assurance (QA) Program. The principles and practices of the Program apply to every Associate at every level within ITAS: they are fundamental to the way we do business and to the services we provide.

The Quality Assurance Management Plan (QAMP) is an overall statement of Program policy. This Plan provides guidance to ITAS Associates in fulfilling their responsibilities and serves as a statement to external parties of ITAS' commitment to quality.

The ITAS QAMP recognizes that some QA activities must be detailed and adopted on an operation-specific basis. To document individual laboratory QA practices, the *ITAS QAMP requires the preparation of* this Operation-Specific QAMP.

Implementation of the QA Program is the responsibility of all ITAS Associates. *Management at every level has the* commitment, duty, and authority to lead the development and implementation of a structured management system that provides the framework to support the QA Program. Management will assure that the principles and practices of the QA Program are implemented and followed.

A Quality Assurance/Quality Control Coordinator (QA/QCC) is assigned to each ITAS operating unit to verify that the QA Program is implemented as intended by the Associates performing the work on a daily basis. The QA/QCC has the authority and duty to stop work if and when necessary to satisfy QA Program requirements.

To verify that the QA Program is successfully implemented at each ITAS operating unit, independent assessments are directed or conducted by the Division Director, Quality Assurance/Quality Control. In addition, operating units are subject to assessments by the Vice President, Quality and Health Services, and by various regulatory authorities and other

outside agencies.

1.2 IT Analytical Services (ITAS) Division Organizational Structure

1.2.1 ITAS Operating Units

The ITAS Division consists of twelve operating units at the following locations:

- ITAS-Austin Laboratory (Austin, Texas)
- ITAS-Cerritos Laboratory (Cerritos, California)
- ITAS-Cincinnati Laboratory (Cincinnati, Ohio)
- ITAS-Edison Laboratory (Edison, New Jersey)
- ITAS-Knoxville Laboratory (Knoxville, Tennessee)
- ITAS-Oak Ridge Laboratory (Oak Ridge, Tennessee)
- ITAS-Pittsburgh Laboratory (Pittsburgh, Pennsylvania)
- ITAS-Special Analysis Laboratory (Knoxville, Tennessee)
- ITAS-St. Louis Laboratory (St. Louis, Missouri)
- ITAS-Richland Laboratory (Richland, Washington)
- ITAS-Field Analytical Services-West (Martinez, California)
- ITAS-Field Analytical Services-East (Knoxville, Tennessee)

ITAS is a laboratory network dedicated to the analysis of hazardous, radioactive, and mixed waste material. Radiochemical analyses are performed at the ITAS laboratories located in Oak Ridge, Richland, and St. Louis. Field Analytical Services (FAS) groups, located in California and Tennessee, serve as a key link between field operations and the analytical laboratories.

1.2.2 Organization Charts

The organizational structure for the ITAS Division is displayed in Figure 1.2-1. The organizational structure for each ITAS operating unit is displayed in Appendix Section 1. The quality-related responsibilities of the members of the ITAS Division and of the ITAS operating units are outlined in Section 1.3.

1.2.3 Equipment

A listing of instrumentation used by each ITAS operating unit is shown in Appendix Section 2.

1.2.4 Facility Security

Each ITAS laboratory is a limited access, secure facility. To ensure that only authorized personnel are able to enter the building from an entrance that is not

monitored, entry into each building is limited in one or more of the following ways at a minimum:

- The use of key pads or electronic locks activated by swipe or magnetic cards which are issued only to authorized personnel
- Locking doors and issuing keys only to authorized personnel
- During business hours, entry is possible only through the main entrance. This entrance is monitored at all times by the receptionist. All guests are required to sign in using the visitor logbook and obtain a visitors badge.
- Alarm systems to detect unauthorized entrance

1.3 Quality Organization

The achievement of quality in all activities is the responsibility of each ITAS Associate. Quality related responsibilities within the operational unit provide for the implementation of the QA Program and completion of quality control (QC) activities.

The quality related responsibilities in IT and the ITAS Division are described in the following sections. The quality-related responsibilities may be reassigned by dividing the activities among different individuals or enhanced by adding activities, but they may not be eliminated.

1.3.1 Vice President, Quality and Health Services, IT Corporation

- Reports directly to the Chief Executive Officer (CEO), IT Corporation
- Approves the ITAS QAMP and the ITAS Operation-Specific QAMP
- Provides independent QA review by participating in or conducting assessments of ITAS operations
- Participates in finding solutions to quality problems not readily resolved within ITAS

1.3.2 Vice President, IT Analytical Services, IT Corporation

- Reports directly to the CEO, IT Corporation
- Approves the ITAS QAMP, the ITAS Operation-Specific QAMP, and ITAS Manuals of Practice (MOP)
- Assumes the ultimate responsibility for the QA Program within ITAS operations
- Assigns specific quality-related responsibilities within the operating units to the ITAS Laboratory and FAS Directors
- Periodically determines the effectiveness of the QA Program, recommending changes to the

Division Director, QA/QC

1.3.3 Division Technical Director, IT Analytical Services

- Reports directly to the Vice President, IT Analytical Services
- Maintains and disseminates as appropriate to the laboratories current information on regulations and approved methodologies performed by ITAS laboratories
- Acts as a technical consultant, interfacing with the Division Director, QA/QC for quality related issues to assure uniform technical excellence across ITAS operations
- Provides guidance and training to all Laboratory Technical Directors
- Approves the ITAS QAMP, the ITAS Operation-Specific QAMP and appendices, and ITAS MOPs. Also reviews other quality and technical documents produced by ITAS for accuracy, completeness, and applicability to relevant technical goals, regulations, and methodologies
- Guides implementation of the QA Program through training programs

1.3.4 Division Director, Quality Assurance/Quality Control, IT Analytical Services

- Reports directly to the Division Technical Director with a QA "dotted line" responsibility to both the Vice President, IT Analytical Services and the Vice President, Quality and Health Services, IT
- Reviews and approves ITAS QA documents
- Approves the ITAS QAMP, the ITAS Operation-Specific QAMP and appendices, and ITAS MOPs
- Provides guidance and training to all laboratory QA/QCCs
- Oversees independent assessments (audits) of ITAS laboratories to identify areas where improvement is needed to comply with the QA Program
- Verifies completion of corrective actions required to correct nonconformances identified during assessments
- Acts as the focal point for improvements and changes to the QA Program, approves and initiates these changes
- Discusses unresolved nonconformances identified during assessments or brought to the Director's attention by the QA staff for resolution with the ITAS Operational Directors, Vice President, IT Analytical Services and/or Vice President, Quality and Health Services, IT
- Suspends further processing in operational units that are out-of-control until the nonconformance is

corrected

1.3.5 Division Operations Director, IT Analytical Services

- Reports directly to the Vice President, IT Analytical Services
- Approves the ITAS Operation-Specific QAMP
- Assumes responsibility and provides resources for implementation of the QA Program within the operational units
- Assigns specific quality-related responsibilities within the operational units to resolve problems
- Periodically determines the effectiveness of the QA program

1.3.6 Field Analytical Services Director

- Reports directly to the Vice President, IT Analytical Services with operational responsibility to the Division Operations Director
- Implements the QA Program within the operation
- Approves quality related documents
- Periodically determines the effectiveness of the QA Program within the operation
- Responsible for the issuance of analysis reports for the operation
- Maintains adequate staffing documented on organization charts

1.3.6.1 Field Analytical Services Business Unit/Office Manager

- Reports directly to the FAS Director
- Implements the QA Program within the business unit/office
- Reviews and approves quality related documents
- Conducts project reviews to assure compliance with QA Programs
- Chairs the business unit/office Quality Team
- Coordinates performance of client satisfaction surveys with client QA Officer
- Approves the ITAS Operation-Specific QAMP and the applicable appendix

1.3.6.2 FAS Project Manager

- Directs preparation of quality related documents for projects
- Designs project QA programs to meet project objectives
- Establishes analytical project data quality objectives
- Coordinates with the laboratory to ensure that quality issues are addressed at all stages of a project

- Assures that project quality requirements are met

1.3.6.3 FAS Field Analytical Specialist

- Prepares project quality documents
- Implements project quality requirements for task performance and documentation
- Prepares and maintains records documenting quality control problems implemented for a project
- Adheres to the ITAS QA Program for governing project activities unless superceded by a project/program-specific plan

1.3.7 Laboratory Director (Operating Unit Director)

- Reports directly to the Vice President, IT Analytical Services with operational responsibility to the Division Operations Director
- Implements the QA Program within the laboratory
- Approves quality related documents
- Approves the ITAS Operation-Specific QAMP and the appropriate appendix
- Periodically determines the effectiveness of the QA Program within the operation
- Maintains adequate staffing documented on organization charts

1.3.7.1 Systems Manager

- Reports directly to the Laboratory Director
- Supervises daily activities of the Project Management, Laboratory Information Management System (LIMS) Operation, Sample Control, Administrative, and Report/Proposal Production Groups
- Oversees the log-in of all samples received, completion of chain-of-custody records, and initiation of project records
- Supervises sample storage facilities
- Works with Operations Manager and/or Group Leaders to assure the requirements of the project are met in a timely manner
- Supervises the verification of software for data processing
- Ensures compliance with QA Program within the laboratory

1.3.7.2 Operations Manager

- Reports directly to the Laboratory Director
- Supervises daily activities of the Operational Groups
- Supervises QC activities performed as a part of routine analytical operations

- Supervises the preparation and maintenance of laboratory records
- Oversees the preventive maintenance program
- Supervises laboratory participation in interlaboratory accreditation and proficiency programs
- Ensures compliance with QA Program within the laboratory
- In the absence of a Group Leader, assumes their quality responsibilities

1.3.7.3 Quality Assurance/Quality Control Coordinator

- Reports directly to the Laboratory Director or the Laboratory Technical Director as defined by the organizational chart
- Develops and defines the Total Quality Program for the laboratory within Division and Corporate guidelines
- Monitors laboratory practices to ensure conformance with the ITAS QA Program, regulatory requirements and client specified contractual obligations
- Recommends resolutions for ongoing or recurrent nonconformances within the laboratory
- Shuts down out-of-control analyses or laboratory groups if necessary until the nonconformance is corrected and notifies the appropriate Laboratory Director and/or the Division Director, QA/QC
- Reviews data quality measures, including statistical data to verify that the laboratory is meeting stated quality goals
- Closes findings and observations of QA audits
- Performs two QA Systems Audits per year (one full systems audit and one follow-up audit)
- Establishes and supervises laboratory QA training programs
- Assists in the preparation of and approves Quality Assurance Project Plans (QAPjPs)
- Serves as the focal point for the reporting and disposition of nonconformances
- Performs monthly surveillances of the laboratory (except during months when a systems audit or follow-up audit is performed)
- Maintains certification and accreditation programs
- Arranges for insertion of QC samples into the laboratory sample stream and reviews the results
- Performs statistical analyses utilizing results of the QC sample analyses and reviews the data to assure

compliance with stated quality objectives

- Assists in the performance of QA Systems Audits
- Maintains controlled documents
- Prepares monthly quality report to management
- Performs Client Satisfaction Surveys

1.3.7.4 Technical Director

- Reports directly to the Laboratory Director
- Provides technical overview of laboratory activities
- Establishes and supervises the training of analysts in good laboratory practices and analytical methodologies
- Writes and reviews Standard Operating Procedures (SOPs), assuring compliance with regulations and approved methodology
- Serves as technical consultant to Project Management and analytical staff in choosing the correct methods, QC and analytical techniques
- Evaluates analytical techniques, procedures, and instrumentation and provides recommendations for improvement to the Laboratory Director
- Recommends standards for purchasing instrumentation, equipment, reagents, gases, and chemicals in accordance with SOPs and approved methodologies
- Defines the calibration and preventive maintenance programs
- Approves customer requested variances to methods
- Responsible for specific Division SOPs and method improvement variances
- In some laboratories, supervises the QA/QCC as defined by the organizational chart
- Ensures compliance with QA/QC Program within the laboratory

1.3.7.5 Group Leader/Team Leader

- Reports directly to the Operations Manager or the Laboratory Director in the absence of an Operations Manager
- Serves as the lead analyst within the group (e.g. GC/MS, GC, AA/ICP, General Chemistry, etc.) and supervises daily activities of all other analysts within their group
- Organizes and schedules the analytical testing program with consideration for sample holding times
- Supervises QC activities performed as a part of routine analytical

operations

- Implements data verification procedures
- Supervises the preparation and maintenance of laboratory records
- Evaluates instrument performance and supervises the calibration and preventive maintenance programs
- Oversees or performs review and approval of all analytical data and submits it to the Project Manager for reporting
- Reports out-of-control or nonconforming situations to the appropriate managers (e.g. Operations Manager, Laboratory Director, Technical Director, and/or Project Manager) and the QA/QCC.
- Supervises maintenance of instruments and scheduling of repairs
- Ensures compliance with QA Program within the laboratory

1.3.7.6 Project Manager

- Monitors analytical and QA project requirements
- Assists the Systems Manager, QA/QCC, and Technical Director with interpretation of work plans or QAPjP requirements
- Assists the Systems Manager in establishing goals, priorities, schedules, and work assignments
- Keeps the laboratory and the client informed of project status
- Approves customer requested variances to methods
- Monitors, reviews, and evaluates the progress and performance of projects
- Reviews data packages for completeness and compliance to client needs
- Prepares Quality Assurance Summaries (QASs)
- Generates and signs analytical reports (or designee)

1.3.7.7 Analyst

- Implements the QA Program within the laboratory
- Performs analytical procedures and data recording in accordance with accepted methods
- Performs and documents calibration and preventive maintenance (may also be performed by a calibration control group)
- Performs data processing and data verification
- Immediately reports out-of-control or nonconforming situations to the Group Leader and QA/QCC

- Maintains control charts or tables

1.3.7.8 Sample Custodian

- Ensures implementation of proper sample receipt procedures, including maintenance of chain-of-custody
- Logs samples into the LIMS system
- Ensures that all samples are stored in the proper environment
- Assists Waste Management staff with sample disposal

1.3.7.9 Document Control Coordinator

- Receives and initiates chain-of-custody for data packages received from the laboratory
- Maintains custody of data packages

1.3.7.10 Data Reporting Staff

- Accurately transfers data from verified laboratory data packages or laboratory report forms to Certificates of Analyses or other deliverables
- Performs a thorough QA review of all Certificates of Analysis or final reports to verify the accurate transcription of data
- Prepares electronic data transfers (EDTs)

2.0 QUALITY ASSURANCE PROGRAM DESCRIPTION

2.1 Introduction

IT has defined Quality as "meeting the requirements of our clients, both internal and external". To achieve Quality, a Total Quality Management (TQM) process has been established and is being implemented throughout the company. Part of this implementation is through Division QA Programs.

It is the purpose of the ITAS QA Program, as expressed in the QAMP, to provide data which are of known and acceptable quality. To achieve this, a system is described which controls the following:

- Preservation of samples
- Receipt and handling of samples
- Processing and analysis of samples
- Analytical equipment
- Data verification
- Data reporting
- Records management
- Management review

ITAS recognizes that all laboratory and field Associates affect data quality. This Plan has been prepared so that all IT Associates will be cognizant of the policies adopted by ITAS for the production of analytical data and will be aware of their responsibilities. Specific implementation instructions for quality practices are documented in SOPs for each ITAS operating unit.

As cross referenced in Table 2.1-1, the ITAS QA Program meets the basic requirements of the following references:

- Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80, Office of Monitoring Systems and Quality Assurance, Office of Research and Development, United States Environmental Protection Agency, EPA 600/4-83-004, February 1983
- Quality Assurance Program Requirements for Environmental Programs, American Society for Quality Control, Energy Division, Environmental Waste Management Committee, ANSI/ASQC-E4-19xx (Formerly EQA-1), July 1992
- Quality Assurance Program Requirements for Nuclear Facilities, The American Society of Mechanical Engineers, ANSI/ASME NQA-1-1989 edition

- Quality Assurance, Office of Nuclear Energy & Office of Environmental Safety and Health, United States Department of Energy, DOE ORDER 5700.6C, August 1991

- Performance Criteria for Radiobioassay, ANSI N 13.30, September 1989

- Measurement Quality Assurance for Radioassay Laboratories, ANSI N 42.2, Revised May 21, 1992, Revision 10A

- Quality Systems-Model for Quality Assurance in Design/Development, Production, Installation, and Servicing, ISO 9001 (ANSI/ASQC Q91-1987)

Additional guides utilized by the radiochemistry laboratories include:

- USNRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operation) - Effluent Streams and the Environment

- ASTM Standard Guide C 1009 - 83. Establishing a Quality Assurance Program for Analytical Chemistry Laboratories within the Nuclear Industry

For the purposes of this Plan, the ITAS Quality System is composed of QA and QC activities. The terms are defined and used as follows:

- Quality System - "The collective plans, activities, and events that are provided to ensure a product, process, or device will satisfy given needs." ***ANSI/ASQC Standard A3***

- Quality Assurance - "All those planned or systematic actions necessary to provide confidence that a product or service will satisfy given needs."***ANSI/ASQC Standard A3***

- Quality Control - "A process which measures actual quality performance, compares with standards, and acts on the difference!" ***Juran, 1974***

2.2 Objectives of the QA Program

The overall objective of the QA Program for ITAS operations is to provide data of known quality that meet client requirements. In general, to accomplish this, each laboratory must:

- Maintain an effective, ongoing QC Program to measure and verify laboratory performance

- Meet data requirements for accuracy, precision, and completeness through the use of proven methodologies

- Provide sufficient flexibility to allow controlled changes in routine methodology to meet specific data requirements

- Monitor operational performance of the laboratory on a routine basis and provide corrective action as needed

- Recognize and promptly correct for any

factors which adversely affect quality

- Maintain complete records from sample submittal through laboratory analysis, data verification, reporting, and sample disposal

In order to meet these objectives, two levels of management controls are required. Controls at the organizational level include all activities that support common or standardized functions such as Associate qualifications and training, document control, and material procurement. Controls at a project level consist of the project-specific QA program activities necessary to produce the desired type and quality of product.

2.3 Quality Assurance Documents

Table 2.3-1 summarizes the ITAS QA documents, the purpose of each, and the required approvals for each. Document control, distribution, and revision is discussed in Section 5.

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3.0 ASSOCIATE TRAINING AND QUALIFICATION

All quality related activities performed by ITAS shall be accomplished by Associates qualified on the basis of education, experience, and training. The following definitions are relevant to the discussion of training in this section:

- Training - In-depth instruction to develop proficiency in the application of requirements, methods, and procedures. Such instruction may be internal or external classroom sessions, courses, or on-the-job assignments.

- Indoctrination - To instruct in fundamentals so as to provide understanding of principles involved.

- Qualification (Personnel) - The characteristics or abilities gained through training or experience or both, that enable an individual to perform a required function.

- Certification - The action of determining, verifying, and attesting, in writing, to the qualifications of personnel (Associates) or material.

- Orientation - The act or process of acquainting individuals with the existing situation, environment, or condition.

3.1 Associate Qualifications

Each operating unit shall have job descriptions for all positions. These job descriptions shall specify the minimum qualifications in terms of education and experience, knowledge, and skills necessary for an Associate to carry out work. The operational supervisors shall compare each Associate's performance with the qualifications established in his/her job description at least annually. This should be done in conjunction with the Associate's Job Performance Review (JPR).

ITAS normally expects necessary knowledge and fundamental chemical laboratory skills to have been demonstrated by formal academic training to include course work in general chemistry, qualitative analysis, quantitative analysis, and instrumental analysis. Qualifications of all professional Associates shall be documented by resumes which include academic credentials, employment history, experience, and professional registrations. A copy of a current resume shall be included in each Associate's training file. When applicable, each professional Associate shall be formally qualified to perform their lab functions by their supervisor. Applicability is dependent upon the Associate's job function. Associates must be formally qualified if their work involves sample management, sample preparation, clean-up, or analysis

procedures, or project management. Record of personnel qualification must be documented in the Associate's training file. An example form is shown in Figure 3.1-1.

3.2 Orientation and Training of Laboratory Staff

Training is performed to maintain proficiency, promote improvement, and to stimulate professional development. ITAS staffs include professional Associates who are scientists. Such Associates shall be assigned duties within the capabilities of their education and experience by the appropriate supervisor and shall be qualified to perform and train others on specified procedures based on this experience.

ITAS Associates are qualified through indoctrination and experience which is documented in resumes and training files. Each new Associate shall be supervised in their activities by experienced Associates until, in the opinion of the supervisor, they are capable of independently performing their duties. This authorization to perform independently shall be documented in the training files on a personnel qualification form. In addition, training for management Associates shall include professional, managerial, communication, and interpersonal skills. On-going or periodic assessments will be performed to determine training needs and effectiveness of instruction.

An individual training record (example shown in Figure 3.2-1) shall be maintained for each Associate. This form must be reviewed and updated, as necessary, by the Associate on an annual basis.

3.2.1 Quality Assurance Orientation

Each newly hired ITAS Associate is required to go through QA orientation. The QA/QCC shall conduct this orientation in accordance with SOPs within two weeks of the Associate's report-to-work date. The QA/QCC shall review the following topics (at a minimum) with the new Associate:

- Overview of ITAS QA Program
- ITAS philosophy on data integrity and meeting client requirements
- ITAS QA documents
- Pertinent regulatory QA requirements
- Data recording practices
- Nonconformance and corrective action
- Chain-of-Custody procedures

An example form used for documenting QA orientation is shown in Figure 3.2-2.

Following QA orientation, the Associate is required to take a written QA examination

to demonstrate an understanding of the laboratory QA program and to determine if any areas covered require further training.

3.2.2 Quality Assurance Training

Training in the nature and goals of the QA Program shall be provided at least once a year to all laboratory Associates. Formal training sessions will be conducted and documented by the QA/QCC. The training program shall address regulatory requirements as appropriate, basic QC practices, responsibilities of the technical staff, responsibilities of the QA/QCC, the reporting of nonconformances, and the performance of audits. In addition, each laboratory Associate shall become familiar with the laboratory QA Program by reading pertinent sections of the ITAS QAMP and the Operation-Specific QAMP, and QC procedures appropriate to his/her position.

3.2.3 Health and Safety Orientation

Each newly hired ITAS Associate, contract worker, or working visitor is required to go through a health and safety orientation before they are allowed to work in the laboratory (as per the laboratory Chemical Hygiene Plan). This orientation is to be performed as soon as possible after or within one week of the Associate's report-to-work date. The Associate's immediate supervisor or the laboratory Health and Safety Coordinator should perform this orientation, which includes viewing videotapes on the OSHA Laboratory Standards and "basic" laboratory safety. The Associate will receive information on the following:

- Safety Policy and Program
- Laboratory Emergency (Contingency) Plan
- Safety Equipment
- Material Safety Data Sheets (MSDSs) (content and location)

The supervisor will supply basic job-related information on:

- Chemical Safety
- Electrical Safety
- Thermal Safety
- Mechanical Safety
- Waste Disposal

All health and safety orientations will be documented.

3.2.4 Health and Safety Training

Health and safety training at ITAS is required for all Associates, contracted workers, and temporary help. This training is to be given within 90 days of the start-to-work date and will be provided by Division Health and Safety or by qualified instructors in the laboratories.

Documentation is maintained in the Associate's training records.

ITAS health and safety training includes the following:

- Laboratory Safety Training (LST)-required for each Associate every two years, at a minimum
- Chemical Hygiene Plan (CHP) Training-each Associate is required to attend an annual refresher

3.2.5 QA/QCC Training

All QA/QCCs shall receive training from the Division Director, QA/QC, so that they are proficient in the requirements of the ITAS QA Program and it's application. Formal training, directed by the Division Director, QA/QC, is performed on an annual basis. Continued proficiency of QA/QCCs shall be maintained through active participation in QA audits and the preparation and review of QA documents. Evaluation of QA/QCC proficiency shall be conducted on an annual basis by the Division Director, QA/QC, as secondary reviewer of the QA/QCC's JPR.

3.2.6 Lead Auditor Certification

ITAS has developed a program for certifying Lead Auditors. QA/QCCs are the primary participants in this program which is described in the ITAS System Procedure No. 8907-QAC-04, "Standard Operating Procedure for Auditors Certification at ITAS Laboratories." All internal ITAS systems audits are lead by an ITAS certified Lead Auditor. Lead Auditor certification is documented with an example form shown in Figure 3.2-3 and with a certificate signed by the Division Director, QA/QC.

3.3 Training Records

Each ITAS Associate has an individual training file maintained by the QA/QCC. The documents included in the training file are the following:

- Associate's resume (current and in ITAS format)
- Individual training record
- Reference to qualifying sample sets
- QA examinations
- Professional certificates (copies)
- Attendance records of training courses
- Personnel qualification records

Each Associate shall review their training file annually, at a minimum, to ensure completeness and correctness of contained information.

4.0 PROCUREMENT OF ITEMS AND SERVICES

This chapter defines the ITAS requirements for the procurement of items and services. This program will provide for:

- Assurance that purchased items and services meet established requirements and perform as expected
- Evaluation and selection of vendors
- Inclusion of applicable technical and administrative requirements in procurement documents

4.1 Selection of Vendors

Prospective vendors will be evaluated and selected based on the following criteria as appropriate:

- Evaluation of the vendor's history of providing an identical or similar product which performs satisfactorily in actual use
- Objective evaluation of the vendor's current quality records supported by documentation
- Direct audit of the vendor's technical and quality capability

The QA/QCC shall determine the needed level of qualification based on the importance of the item or service being purchased. Vendors which provide test and measuring equipment, standards, quality related service contracts, or subcontracted laboratory services (quality related items) shall be subject to the more rigorous controls below.

For the procurement of test and measuring equipment it is recognized that the environment in which the measurement system is placed may have a bearing on its performance. Therefore, the QA/QCC may substitute an acceptance testing plan to assure that the measurement system is able to meet specifications in the laboratory environment, in lieu of other supplier qualification activities.

4.2 Procurement of Quality Related Items

The quality of instruments, equipment, standards, reagents, solvents, other chemicals, gases, water, and laboratory containers used in analyses must be known so that their effect upon analytical results can be defined. Items purchased by an ITAS operating unit shall meet the requirements and specifications of client contracts or analytical methods, as detailed in laboratory-specific SOPs. At a minimum, all reagents shall meet the specifications established by the Committee on Analytical Reagents of the American

Chemical Society. If these are not available, a comparable or next best grade shall be used.

Quality specifications shall be included or referenced in the purchasing documents for the procurement of applicable items. The QA/QCC shall approve vendors or items purchased. This approval will be maintained by purchasing from a "QA Approved" list of vendors and items. If items which may affect laboratory quality are requested from non-preapproved vendors, QA approval must be obtained prior to placing the order.

When ordering such items, a system shall be put in place in each laboratory to assure the quality of the item received. Each laboratory shall assign individuals responsible for purchasing materials and controlling them in the laboratory. Duties of the responsible individuals include:

- Specifying in purchase orders or requisitions, suitable grades of materials (grade shall be defined by the QA/QCC or responsible manager)
- Verifying upon receipt that materials meet requirements and that, as applicable, material certificates are provided and maintained in the laboratory Quality/Operations records system
- Identifying and storing materials
- Verifying that material storage is properly maintained, and removing materials from use when shelf life has expired

4.2.1 Role of ITAS Division Purchasing

ITAS Division Purchasing supports the ITAS operations by:

- Maintaining contractual requirements of materials contracts
- Negotiating new contracts
- Identifying potential vendors and subcontractors
- Identifying vendors for unique or scarce materials

In order to enhance standardization of the product within the laboratory network, ITAS Division Purchasing shall pursue National Contracts for:

- Laboratory supplies of known quality and proven reliability
- Instrumentation
- Standards from traceable, certified sources

4.2.2 Procurement Procedures

The specifications for standards, chemical reagents, solvents, gases, water, and other items specified in approved analytical methods shall be met by the laboratory and

written in method SOPs. In addition, each laboratory must have the following items included in SOPs that cover:

- Checking the purity of standards, reagents, solvents, other chemicals, and water versus intended use
- Storage and expiration of standards, reagents, solvents, and other chemicals
- Requirements for laboratory containers (e.g. volumetric glassware, sample containers)
- Cleaning of glassware prior to use

Corrective actions for failure of an item to meet required specifications are:

- Review current supplies and eliminate from use
- Return to vendor
- Evaluate a new lot or alternate supplier

The Division Technical Director or the Division Director, QA/QC shall be immediately notified of any quality problems with national vendors.

4.2.3 Radioactive Reference Materials

ITAS shall procure only radioactive reference materials which are traceable to the National Institute of Standards and Technology (NIST). If the NIST traceability is not commercially accessible, the best available standard for that isotope shall be used. Certification of traceability shall be procured from the supplier. Documentation received with each standard shall include, at a minimum, the following information:

- Traceability to NIST or other certificate of analysis
- Radionuclide identification with activity and error
- Source identification or traceability number
- Date of assay
- Half-life of radionuclide(s)
- Mass and volume of standards
- Percent of impurities

Receipt, storage, use, control, and disposal of radioactive standards, as well as documentation of these activities, are described in operation-specific SOPs. Sources used to verify continuing calibration shall meet the requirements of this section.

4.3 Procuring Services

Subcontract Laboratory Services - A subcontract laboratory is defined, for the purposes of this QAMP, as a laboratory

external to the ITAS laboratory network. A subcontract laboratory will be used only in the event that an ITAS laboratory does not have the capability or capacity to perform the requested testing, or the customer so directs (in which case the customer then assumes responsibility for subcontractor performance). A subcontract laboratory will be used only after approval is obtained from the client and the quality of the laboratory is determined to be acceptable by ITAS QA/QC staff.

Once it is determined that a subcontract laboratory is required and approval is obtained from the client to use a laboratory external to the ITAS network, the QA/QCC must perform a quality systems audit of the selected subcontract laboratory. This audit must be approved by the Division Director, QA/QC and documented in both the Quality/Operations records at the laboratory and in division subcontract laboratory files. The procedure for the approval to use a subcontract laboratory is detailed in ITAS Division SOP No. IT-QC-0002.

4.4 Internal QC Requirements

4.4.1 Water

ASTM Type II grade or equivalent water at a minimum will be used in all metals, radiological, wet chemistry, and organic analyses. Type II water is obtained by the use of commercial ion-exchange deionizing units including an appropriate polishing unit. The resulting water has a maximum conductivity of 1.0 umho-cm at 25° C, minimum resistivity of 1.0 Mohm at 25° C, maximum total matter of 0.1 mg/L, a minimum color retention time of potassium permanganate of 60.0 minutes, and no detectable soluble silica. Conductivity and/or resistivity will be documented daily in a logbook or file. Maintenance documentation will be kept for both the deionizing units and the polishing unit.

For volatile analyses the water may be further purified by purging with an inert gas before use to remove traces of organic solvents.

Water monitoring procedures used by ITAS operating units are detailed in operation-specific SOPs.

4.4.2 Compressed Air and Gases

Ultra high purity compressed gases from preapproved vendors will be used when required for instrumentation. Compressed air and gasses must meet the requirements and specifications of the analytical methods performed. In-line filters will be used when appropriate to minimize contamination and moisture from the gases.

4.4.3 Glassware Preparation

Glassware preparation procedures instituted at ITAS operating units are designed to ensure that no contaminants are introduced during sample analysis. Procedures describing glassware preparation are detailed in operation-specific SOPs.

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5.0 DOCUMENT CONTROL AND RECORDS

ITAS has designed and implemented a system to control, distribute, and revise documents affecting quality. These documents are approved by the appropriate positions (see Table 2.3-1). Controlled documents are required to be reviewed and revised, if necessary, on a scheduled basis. The frequency of this review is dependent on regulations and client requirements, but it should occur at least annually. Interim changes to controlled documents may be instituted by the use of a Procedure Change Form (example shown in Figure 5.0-1). Procedure Change Forms require the approval of the laboratory QA/QCC, the Operating Unit Director, and the Division Director, QA/QC. Procedure Change Forms remain in effect until the next revision of the document. They are described in the ITAS System Procedure No. 8906-QAC-03, "Standard Operating Procedure for Preparation and Control of Procedures and Manuals". Controlled documents include but are not limited to this Operation-Specific QAMP, the ITAS QAMP, SOPs, and internally-generated QAPjPs and QAPPs.

5.1 Quality Assurance Management Plan (QAMP)

The ITAS QAMP provides ITAS Quality Assurance policy. It is applicable to and provides direction for all ITAS operations. The Plan discusses both the administrative and technical aspects of Quality Assurance and Quality Control. It is not however, intended that the Plan provide in-depth technical discussion. The Operation-Specific QAMP and SOPs supplement the ITAS QAMP to provide the details of implementation. The QAMP has precedence in policy matters over all other ITAS quality-related documents.

5.2 Operation-Specific QAMP (OS-QAMP)

The OS-QAMP supplements and enhances the ITAS-QAMP (Section 5.1). While the ITAS-QAMP serves as an over-view document and provides ITAS QA policy, the OS-QAMP further provides detailed technical discussions and information that is common to all ITAS operating units. An appendix for each operating unit supplements the OS-QAMP. Each appendix contains information that is specific to that operating unit only.

5.3 Manuals of Practice (MOP)

MOPs are developed to provide in-depth technical discussions of specific topics. For example, a MOP for the field collection, preservation, and shipment of samples to ITAS laboratories provides specific uniform

direction to IT Associates. The ITAS Chemical Hygiene Plan and Safety Manual are also considered MOPs. MOPs are usable across ITAS operations.

5.4 Standard Operating Procedures (SOPs)

SOPs are the foundation of the documented QA Program within ITAS. There are two levels of SOPs, division and operation-specific. Division SOPs specify methods that are common to all operating units and are standard across the network. Operation-specific SOPs detail procedures that pertain to a particular operating unit. All SOPs are written, detailed instructions describing specific laboratory operations and performance of routine laboratory tasks. They specify what is done, whose responsibility it is to perform tasks, and whose responsibility it is to verify their correctness. SOPs are sufficiently detailed to provide data of acceptable quality and integrity with a minimum loss of data due to out-of-control situations. They also provide for documentation to record the performance of all tasks and their results, and demonstrate the verification of the data each time the data are recorded, calculated, or transcribed. SOPs are written to address the major elements upon which analytical quality depends. ITAS has adopted a standard SOP format for use within the Division. The ITAS standard format for administrative SOPs is shown in Figure 5.4-1. The ITAS standard format for technical SOPs is shown in Figure 5.4-2.

5.5 Quality Assurance Project Plans (QAPjP)

Contractual and regulatory demands, or uniqueness of the scope of work of a project, may require the preparation and implementation of a project-specific QAPjP or QAPP. If a specific project requires a unique QA program, that program with full documentation must be provided to the ITAS operation for implementation. Full documentation will be provided in a QAPjP. The requirements of the project will take precedence over conventional ITAS QA practices for that work. The requirements of the project may not be less stringent than minimum ITAS QA/QC requirements unless requested by the client in writing or approved by the ITAS Division Director, QA/QC. Typical project requirements are as follows:

- The development and/or use of new or modified testing methods
- Special requirements for equipment calibration and maintenance
- Specific contract required detection limits (CRDLs)
- Defined data quality objectives (DQOs) such as accuracy and precision limits or the statistical treatment of data
- Additional or unique documentation or

records management requirements

5.6 Project and Quality/Operations Records Management

The ITAS QA Program has been developed to provide analytical results of known quality that meet client requirements. To demonstrate that quality has been achieved, each ITAS laboratory maintains a system of records management that includes documents which demonstrate the analytical performance of the laboratory. Laboratory records are identified as either Quality/Operations records or Project records.

All operating unit records, from time of sample receipt through reporting and disposal, shall be available and stored in a manner that safeguards their integrity from tampering, physical damage, and/or loss. For ITAS, this will be separate files in file cabinets in a 24 hour per day secure area at a minimum. Any documentation that directly bears on the reported results must be retrievable if requested by the client or legally compelled by an authorized regulatory agency or court of law. This includes operational and project-specific data. Data may be stored in "real-time" as it is produced, or filed in a manner to allow prompt retrieval and assembly into a complete project file. Operation-specific SOPs shall describe how the complete set of documentation is compiled, including the flow of data forms, locations, responsibilities, and checks on the records management system implemented.

5.6.1 Project Records

Project records are documents which are specific to a project or a group of samples within an ongoing project, such as chain-of-custody and raw analytical data. Project records are stored separately in project files. Each project file shall be indexed, properly labeled, and current.

ITAS will maintain records associated with specific projects as nonpermanent records for the following time periods after completion of a project:

- Analysis performed as part of site mitigation activities - 10 years
- Records associated with facilities governed by the Resource Conservation Recovery Act (RCRA) - 5 years after closure if the analysis was performed prior to closure or for the 30-year monitoring period following closure if the analysis was performed for the purpose of closure monitoring
- Conventional analysis - 7 years

If a special contractual requirement, project requirement, or government regulation requires that records be maintained for a longer period of time, project files will be

kept as required. For projects that must be kept beyond the periods stated above, the project index shall be marked to indicate the required retention period.

Prior to scheduled record destruction, records shall be reviewed to determine if the holding period should be extended.

5.6.2 Quality/Operations Records

Quality/Operations records are permanent (lifetime) documents which demonstrate overall laboratory operation, such as instrument logbooks, calibration data, and control charts. These records will directly affect the data for a specific project, but in general their applicability is not limited to one project. Quality/Operations files must be indexed, properly labeled, and current.

5.6.3 Record Validation

When records are transferred to a records storage area, they shall be verified by comparing the contents of the container against an inventory sheet listing the contents of the container. If there are any discrepancies, the container and inventory sheet shall be returned to the Associate submitting the records for resolution. When the document container and the inventory sheet are found to be acceptable, the responsible records custodian shall indicate approval by signature and date on the inventory sheet. Records shall be considered valid when the inventory sheet is signed by the custodian[1].

[1] NQA-1, Supplement 17S-1, Section 2.3.

6.0 USE OF COMPUTER HARDWARE AND SOFTWARE

The purpose of defining controls for computer hardware and software is to protect the integrity of computer-resident data in the laboratory. SOPs are in place in each location so that computer resident data are accurate and defensible. The following references shall be used as guidance for implementation of this system of controls:

- Good Automated Laboratory Practices: US Environmental Protection Agency, (draft), December 28, 1990
- Quality Management and Quality Assurance Standards ISO 9000, Part 3: "Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software"
- ASTM Method E3140-1 (draft): "New Standard Guide for Laboratory Information Management Systems (LIMS)"
- ANSI N413: "Guidelines for the Documentation of Digital Computer Programs"

6.1 Use of Hardware

Computer equipment used in the generation, measurement, or assessment of client data shall be appropriately designed, be of adequate capacity to function according to specifications, and shall be suitably located for operation, inspection, cleaning, and maintenance. There shall be a written description of the computer system(s) hardware. The computer shall be installed in accordance with manufacturer's recommendations and undergo validation which demonstrates the computer equipment correctly performs its stated capabilities and functions. Changes to computer hardware shall be made only after review and approval of the LIMS Manager and Laboratory Director.

Computer hardware shall be inspected, cleaned, and maintained on a regular basis at a minimum of annually. Each laboratory shall:

- Have SOPs for the maintenance and security of hardware
- Designate an Associate (usually the LIMS Manager) to be responsible for system performance

6.2 Security

Each operating unit shall have procedures in place which secure computer hardware and software systems if that system:

- Contains confidential information that requires protection from unauthorized disclosure
- Contains data in which the integrity must be protected against unintentional error or intentional fraud

- Is used to acquire, process, or report data

When the computer system(s) contains data that must be secured, each operating unit shall ensure the system is physically secured. Physical and functional access to the system is limited to authorized Associates and introduction of unauthorized external programs or software is prohibited.

The LIMs Manager, or designee, is responsible for maintaining a list of secure, licensed software, and software not on that list is considered unauthorized.

All original software must be stored in a locked, secure area.

6.3 Use of Software

If computer software is used to acquire, process, or report client data, it is necessary to demonstrate that the software correctly performs its intended function. The following definitions are important to this discussion:

- Validation - establishing documented evidence which provides a high degree of assurance that a specific process will consistently produce a product meeting its predetermined specifications and quality attributes. This process demonstrates that the mathematical or statistical model embodied in the computer program is an acceptable representation of the process or system for which it is intended and meets all specified requirements.

- Verification - the process of checking the accuracy of manually or automatically (electronically) entered information.

In general, software is verified by comparing its performance against known results. Verification may be done in several ways (see Sections 6.3.1 and 6.3.2). Each operating unit shall have a software SOP(s) describing the following:

- Software verification and validation
- Data entry and verification
- Changing data
- Data analysis, processing, storage and retrieval
- Backup and recovery of data and software
- Electronic reporting of data
- Definition and storage times for data and software

6.3.1 Industry Standard Software

Industry standard programs are defined as programs which are widely used throughout the profession. These standard programs are brought into ITAS and used without modification. If the program has been prepared external to IT, independent validation is not required. However, the

program must be verified prior to first use on an ITAS system. To verify the software, example problems must be processed to demonstrate that the program is fully operational. Example problems must fully test the utilized capabilities of the software.

6.3.2 ITAS Developed Software

For programs developed within ITAS and externally prepared programs which are modified by ITAS, complete validation and verification must be performed. Validation must be performed in accordance with an approved reference (Section 6.0) and IT Standard Quality Practice, ITC0010 "Software Development and Usage". The verification process is dependent upon the function of the software and should include:

- For software which only performs numerical manipulation, sample sets of numbers for which results are known should be processed and compared. In this case, known results are usually generated by performing hand calculations using the same equations and procedures as the software. Verification of the software must test the software production of the intended results. Problems must test both the theory, or basis for computation, and the ability of the software to store and manage data.

- Software which performs as part of instrument operation should be verified by processing reference materials through the instrument system. Processed instrument response shall be compared against the standards used. Verification shall be performed annually, at a minimum.

6.3.3 Control of Software Changes

Changes to software shall be controlled. Detailed software control procedures must be available in each ITAS laboratory. Standard forms are used to document and track changes. An ITAS Associate in each laboratory must be assigned to maintain software control, usually the LIMS Manager or programmer. Whenever a program is changed, reverification is necessary. If the software has had features added, previous test problems should be rerun to demonstrate their function has not been affected. New test problems should be processed as discussed above to verify added performance. If software revision changes the basic operation of the program, complete revalidation and reverification of the program is required. All changes must be completely documented.

6.3.4 Software Review and Reverification

Spreadsheets and unprotected software shall be reverified on an annual basis at a minimum. The test problems used to provide initial verification shall be reprocessed and the results compared to demonstrate that performance of the software is unchanged. If software performance has changed, the effect of the change upon intended function and usage

since last verification shall be assessed. "Effect" must be determined on a case-by-case basis for the scope and impact of incorrectly reported results. If necessary, the data shall be reprocessed and recipients of affected data reports notified. Software programs must be validated upon creation or change and verified annually.

6.3.5 Software Validation and Verification Documentation

Software validation and verification shall be documented by the Associate performing the work, by signing and dating in indelible ink the computer output and supporting calculations. When test problems are used, the input shall be marked to indicate correct usage and the output checked to indicate acceptable comparison. If reference materials are used as the basis for validating and verifying instrument software, the "true" values or certificates for the materials shall be included with the output to demonstrate performance. The verification documentation must be reviewed and approved by the Associate's immediate supervisor, the LIMS Manager or computer programmer, and QA/QCC.

All software validations and all software verifications, whether for initial or subsequent reverification, shall be maintained in the Quality/Operations records management system. A historical file shall be maintained for each program. The file shall include the basis for the verification, such as the test problems or hand calculations, results of the software performance, the results of subsequent reverifications, applicable program code, user manuals, technical documentation and a copy of the program.

6.4 Computer Viruses

ITAS operating units shall employ the use of anti-virus software to detect and remove viruses from secure computer hardware. Any suspicion of a software virus must be immediately reported to the LIMS Manager, the Division Technical Director, and the Division Director, QA/QC.

7.0 WORK PROCESSES AND OPERATIONS

Much of the environmental project activity is planned and designed external to the laboratory or field operation and presented in the form of a contract, work plan, or QAPjP. Laboratory and field activities are planned, implemented, and assessed to meet client requirements according to approved procedures and methodologies. Many QA systems have been put in place to document the implementation of planned activities. The planning and design of operational systems to accomplish documented implementation are detailed in operation-specific SOPs. The entire process is assessed on a regular basis for conformance to prescribed requirements.

7.1 Standard Operating Procedures

SOPs are in place in all ITAS operating units for analytical and administrative procedures from the receipt of samples in the laboratory through analysis, reporting, and subsequent sample disposal. This includes auxiliary functions as well, such as training, QA/QC, and Health and Safety procedures. The ITAS standard SOP formats are shown in Figure 5.4-1 (administrative) and Figure 5.4-2 (technical). A list of ITAS operating unit SOPs is given in Appendix Section 3.

ITAS operations prepare and maintain, in addition to the Operation-Specific QAMP, a Standard Operating Procedure Manual. The requirements of this OS QAMP for activities such as calibration, field procedures, material procurement and control, preventive maintenance, training, and QC sample analysis shall be incorporated into the SOPs as appropriate.

7.2 Analytical Methods

Whenever possible, ITAS operations utilize industry and regulatory agency recognized analytical methods from source documents published by agencies such as the U.S. Environmental Protection Agency (USEPA), American Society for Testing and Materials (ASTM), and the National Institute for Occupational Safety and Health (NIOSH). Analytical methods used by each ITAS operation are listed in Appendix Section 4.

7.3 Detection Limits

All chemical analytical methodologies have an associated detection limit below which an analyte present in the sample cannot be accurately determined. A detection limit value may be reported in one of three ways:

- As a less than (<) value
- As not detected (ND)

- As an undetected (U) value

In all cases, the detection limit will also be reported for reference.

Detection limits indicated in methods are highly matrix dependent and are provided for guidance. Depending upon the exact sample composition, stated detection limits may not always be achievable.

The method detection limit (MDL) is defined by the USEPA as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. ITAS uses USEPA Procedure CFR 40 Part 36, Appendix B to determine detection limits. MDLs are determined annually.

For radiochemistry, whether the net result is negative, zero, or positive, the actual calculated result is reported with its associated propagated uncertainty. The detection limit is affected by many factors, such as the length of count, chemical yield, half-life, background of the instrument, counting efficiency, and the matrix interference. The minimum detection limit for radiochemical analyses is defined as the smallest activity of material that yields a net count above background with a 95 percent probability and no greater than a 5 percent probability of calling a blank a true signal. Detection limit calculations, frequency determined, and exact procedures for specific analytical methods are documented in operation-specific SOPs.

Method Detection Limits (MDLs), Practical Quantitation Limits (PQLs), and CRDLs (when applicable) are listed in Appendix Section 5.

7.4 Variance from Stated Methods

Work processes will be performed in accordance with SOPs derived from the methods referenced unless specific project requirements or needs dictate adoption of an alternate method or modification of the cited methods. For example, GC/MS procedures may be "USEPA CLP-modified" if specified by a client.

For some matrices and analytes, ITAS has developed in-house SOPs based on regulatory methods which may include modifications to improve reproducibility and/or accuracy. If an operation is performed in an alternate manner, the method shall be documented in the project records.

7.5 Assessment of Work Processes

All work processes or operations are subject to assessment as described in Section 9.4.

8.0 DATA COLLECTION AND PRODUCTION OPERATIONS

Laboratory analyses are designed to produce data that are representative of existing conditions present at the time the sample was obtained. The data collection design includes field sampling events, sample handling and custody, analytical operations, data verification, techniques to assess limitations of data use, and data reporting requirements.

In order to provide a sample that most accurately represents the test matrix, field sample collection personnel must abide by the sample collection guidelines and procedures established by involved regulatory agencies. A significant part of the efforts of regulatory agencies include the use of "approved" sample containers, chemical and physical preservation techniques, and observance of specified holding times. Although at times the sampling may be performed by non-ITAS Associates, the importance of sampling and transportation of the sample to the laboratory is understood and must be considered during data validation. Figure 8.0-1 is a flow chart showing the data collection process. The steps presented are described in detail in the following sections.

8.1 Field Collection and Shipment

In order for data to be representative of existing conditions present at the time the sample was collected, it is imperative that all samples be collected and preserved according to the appropriate analytical method specified in the QAPjP or QAPP (if one exists). Sampling requirements must be communicated to the sampling team prior to field collection.

Field personnel are responsible for labeling each individual sample collected with the following information:

- Project number
- Unique sample number
- Sample location (including as appropriate: borehole and depth or grid coordinates)
- Sampling date and time
- Person(s) obtaining the sample
- Sample preservation
- Analysis required

An overriding consideration for the resulting analytical data is the ability to demonstrate that the samples have been obtained from the locations stated and that they have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, laboratory custody, and disposal must be documented

to accomplish this. Figure 8.1-1 shows the Analysis Request/Chain-of-Custody (AR/COC) form that is used by the ITAS laboratory network.

Field personnel are responsible for initiating the AR/COC form. In addition, they are responsible for uniquely identifying and labeling samples, providing proper sample preservation, and packaging samples to preclude breakage during shipment.

The prompt shipment of samples to the laboratory is required to ensure that required holding times are met. Samples should be shipped by an overnight carrier, be hand-delivered, or transported in a manner that assures prompt delivery to the laboratory.

Some sites require an extensive radioactive screening process before a sample may be shipped. In these cases, it is imperative for the project manager to maintain good communications with the client to assure proper staffing of the laboratory in response to a decreased holding time.

Radioactive samples that are shipped to ITAS operations must be screened and found not to contain radioactivity that exceeds the level stated in the operation license of the laboratory. Samples received by an ITAS operation that contain radioactivity exceeding their license limit will immediately be returned to the project site.

8.2 Sample Containers, Shipping Containers, Preservatives, and Holding Times

8.2.1 Sample Containers

A sample container is defined as the sealed enclosure, usually made of borosilicate glass or plastic, that the sample is collected in and stored in until analysis. All sample bottles provided by ITAS operations for environmental sampling are purchased new and are certified precleaned following appropriate USEPA procedures by the manufacturer. The bottles to be supplied for inorganic analyses are listed in Table 8.2-1. The bottles to be supplied for organic analyses are listed in Table 8.2-2. Radiological sample bottles are listed in Table 8.2-3. All documentation certifying bottle cleanliness must be maintained in the operation's Quality/Operation files.

8.2.2 Shipping Containers

Shipping containers are defined as the sealed enclosure in which the sample containers are stored during shipment from the sample collection site to the analytical laboratory. Shipping containers must be of sufficient number and size to accommodate the samples in an upright condition. Shipping containers must also meet all Department of Transportation (DOT),

International Air Transportation Association (IATA), International Civil Aviation Organization (ICAO), United Nations (UN), USEPA, and Nuclear Regulatory Commission (NRC) requirements for the shipment of environmental and/or radioactive samples.

Packaged samples must be shipped to the analytical laboratory in a safe manner that preserves the integrity of the samples. The most common method of sample shipment employs coolers or ice chests that are sealed with custody tape and shipping tape. These coolers must be durable and resistant to crushing during shipment. All coolers must be well maintained and cleaned to prevent cross contamination of the samples. It is the ultimate responsibility of the person collecting and packaging the sample for shipment to ensure that the shipping containers are clean and functional. To help prevent sample breakage during shipment, additional consideration must be given to providing shock absorbency to all samples packaged inside the shipping container. Use of bubble-wrap around each sample container is the best way to provide this protection, followed by foam packing materials and vermiculite which are also commonly used.

8.2.3 Sample Preservatives

Most analytes have a finite holding time in a given sample matrix. Sample preservation is the chemical or physical means by which samples are treated during and/or following sample collection to aid in the stability of the analytes of interest for a given sample matrix. The preservation of samples at the time of sample collection will follow the requirements of the analytical methods used. This preservation includes the addition of reagents to deter chemical degradation and the maintenance of refrigeration during transit and ultimate storage in the laboratory. The required preservatives for the analysis to be performed on each matrix are included in Table 8.2-1 for all inorganic analyses and Table 8.2-2 for all organic analyses. Radiological sample preservatives are listed in Table 8.2-3.

8.2.4 Sample Holding Times

Holding time is defined as the maximum allowable time between sample collection (or laboratory receipt for CLP) and extraction or analysis. ITAS has developed a commitment to meeting sample holding times that extends throughout each ITAS operating unit. Each operation has a system in place to ensure that holding times are monitored by each group within the operating unit. It is the responsibility of each ITAS Associate processing the sample to assure that holding times are met. ITAS laboratories are responsible for meeting all

holding times for samples received within 24 hours of collection.

The holding times for inorganic analyses are listed in Table 8.2-1. The holding times for organic analyses are listed in Table 8.2-2. Radiological sample holding times are listed in Table 8.2-3.

8.2.5 Turnaround-Time (TAT)

TAT is defined as the maximum number of days from sample collection to the date Certificates of Analysis or other deliverables are received by the client. Sample collection personnel must be aware of the holding time and TAT requirements so that they can determine the best method of sample transport and can communicate that information to the laboratory Project Manager.

8.3 Sample Receipt and Initiation of Testing Program

Each ITAS laboratory has a SOP describing this program in detail. The following sections describe the general program followed by all ITAS operating units.

8.3.1 Sample Receipt

Samples shall be received and logged in at ITAS operations by a designated sample custodian or properly trained designee back-up. Upon sample receipt, the sample custodian shall, as appropriate:

- Wear appropriate personal protective equipment (PPE). At a minimum, this consists of gloves, a lab coat, safety glasses, and in some cases a respirator
- Examine the shipping containers to verify that the custody tape is intact
- Examine all sample containers and determine if the temperature required by the requested testing program (normally 4°C ± 2°C) has been maintained during shipment. Document shipping container temperature on the AR/COC
- Examine all sample containers for damage
- Compare samples received against those listed on the AR/COC
- Verify that sample holding times have not been exceeded
- Examine all sample paperwork for correctness and completeness
- Determine sample pH (if required for the scheduled analysis) and record on the AR/COC
- Sign and date the AR/COC immediately (only after shipment is accepted) and attach the waybill
- Note any problems associated with the samples on the AR/COC, immediately initiate a Condition Upon Receipt Variance Report (CUR), and notify the Project Manager who in turn notifies the client
- Attach appropriate laboratory sample container labels with laboratory ID, test, and preservative information

- Place the samples in proper laboratory storage

8.3.2 Sample Log-in

Sample log-in activities at ITAS operating units are fully documented in operation-specific SOPs. The following is a general description of the log-in process:

- Enter the samples in the laboratory sample log-in book, and/or the sample management computer system (LIMS) which contains the following information at a minimum:
  - Project identification number
  - Sample numbers (both client and laboratory)
  - Type of samples
  - Required tests
  - Date received in laboratory
- Notify the Project Manager and appropriate Group Leader(s) of sample arrival
- Place the completed AR/COCs, waybills, and any additional documentation in the project file

8.3.3 Sample Storage

The primary considerations for sample storage are:

- Maintenance at prescribed temperature, if required, which is typically 4°C ± 2°C
- Processing samples within the prescribed holding time for the parameters of interest
- Maintenance of sample integrity through adequate protection from contamination from outside sources or from cross-contamination of samples. Low-level and high-level samples, when known, must be stored separately. When applicable, samples and standards must be stored in separate refrigerators or freezers.

The requirements listed on Tables 8.2-1, 8.2-2, and 8.2-3 for temperatures and holding times shall be used. Placing of samples in the proper storage environment is the responsibility of sample control personnel who shall notify the Operations Manager and Group Leaders if there are any samples which must be analyzed immediately because of holding time requirements.

8.3.4 Internal Sample Chain-of-Custody

Internal sample custody is tracked and documented in ITAS laboratories as described in operation-specific SOPs. The sample custody documentation shall include, but is not limited to the following:

- Signatures for relinquishing and receiving samples or sample extracts
- Listing of all procedures (sample preparation and analysis) performed on the sample and sample extract

- Laboratory and project identification
- Sample matrix
- Laboratory sample numbers

8.3.5 Sample Disposal and Return Chain-of-Custody

After the requested analyses on the samples have been completed, any remaining portions of the samples will be maintained by the sample custodian until the samples are disposed of or returned to the client. The disposal of each sample is recorded on the client's Chain-of-Custody (COC) form or referenced in the project file. Sample disposal procedures and documentation are described in operation-specific SOPs.

For NRC or state licensed laboratories, a real time inventory of all radioactive isotopes contained in the laboratory (including radioactive samples), as required by the NRC or state, is maintained by the Radiation Safety Officer (RSO). If the quantities of radioactive materials in-house approach the limits of the laboratory NRC license, appropriate action will be taken to ensure the license is not exceeded. This may involve returning samples to clients immediately.

The original copy of the client's COC form will be maintained in the appropriate laboratory project file unless the entire sample is physically transferred off-site. In that case, the original COC record will be signed off as relinquished by the sample custodian or designee and will accompany the sample in shipment. A copy of the completed COC form will be retained in the laboratory project file. In the case where an aliquot of a sample is shipped from the laboratory, a new COC will be generated by the laboratory and shipped with the sample aliquot and the original COC will be retained in the project file.

8.4 Calibration Procedures and Criteria

8.4.1 Calibration System

All equipment and instruments used at ITAS operations for quantitative measurements are controlled by a formal calibration program. Two types of calibration are discussed in this section. These are operational and periodic calibrations. Operational and periodic calibration procedures are described in operation-specific SOPs. At a minimum, these procedures shall include:

- Equipment to be calibrated
- Reference standards used for calibration
- Calibration technique and sequential actions
- Acceptable performance tolerances
- Frequency of calibration

- Calibration documentation requirements

Whenever possible, recognized procedures, such as those published by ASTM or the USEPA, or procedures provided by manufacturers shall be adopted. If established procedures are not available, a procedure shall be developed considering the type of equipment, stability characteristics of the equipment, required accuracy, and the effect of operational error on the quantities measured.

8.4.2 Reference Standards

Two types of reference standards are used within ITAS operations for calibration: physical reference standards and chemical reference standards.

8.4.2.1 Physical Reference Standards

Physical reference standards include weights for calibrating balances and certified thermometers for calibrating working thermometers. These are generally associated with periodic calibrations. Whenever possible, physical reference standards shall have known relationships to nationally recognized standards such as the National Institute of Standards Technology (NIST), formerly the National Bureau of Standards (NBS). If national standards do not exist, the basis for the reference standard shall be documented.

Physical reference standards shall be used only for calibration procedures and shall be stored separately from equipment used for analysis.

8.4.2.2 Chemical Reference Standards

These standards are generally associated with operational calibration. Chemical reference standards include Standard Reference Materials (SRMs) provided by NIST, the USEPA, or other recognized standards agency. This may include vendor-certified materials traceable to NIST or USEPA SRMs. Radioactive reference materials are discussed in Section 4.2.3.

8.4.2.3 Standard Verification

Standard verification is performed at all ITAS laboratories by comparison of a standard with a SRM or second-source standard. For chemical analyses, ITAS operating units shall use purchased standard mixes, when possible, from two different sources. The response factors of the two shall be compared. Neat standards shall be used only when standard mixes are not available. If only one standard source is available, the laboratory shall have two different analysts prepare the stock solution and dilutions of the stock solution. The laboratory shall then compare the response factors of these two separately prepared standards. In the rare cases, such as dioxin standards where costs are significant, new

standards shall be compared to previous standards for verification. Operation-specific SOPs shall define the specific requirements and process of standard preparation and verification.

8.4.3 Operational Calibration

Operational calibration is routinely performed as part of instrument usage, such as the development of a standard calibration curve. Operational calibration is generally performed for instrument systems.

A summary of the various operational calibrations performed at ITAS operations is shown in Tables 8.4-1 for inorganic method calibrations, and 8.4-2 for organic method calibrations.

8.4.4 Periodic Calibration

Periodic calibration is performed at prescribed intervals. In general, equipment which can be calibrated periodically is a distinct, singular purpose unit and is relatively stable in performance. ITAS operations perform this type of calibration on balances, micropipettors, and thermometers.

Each ITAS operating unit has SOPs in place for the calibration of equipment requiring periodic calibration. Periodic equipment calibrations employed at ITAS operations are listed along with their respective calibration criteria in Table 8.4-3.

8.4.5 Calibration Failure

Equipment that fails calibration or becomes inoperable during use shall be removed from service and segregated to prevent inadvertent use, or shall be tagged to indicate it is out of calibration. Such equipment shall be repaired and recalibrated before reuse.

Recalibration may occur more frequently than scheduled. At any time, if equipment calibration becomes suspect, it shall undergo a calibration check to determine whether the current calibration is still acceptable or if recalibration is required.

8.4.6 Calibration Records

Calibration records shall be prepared for each piece of equipment subject to calibration and shall be maintained according to operation-specific SOPs.

All calibration records (operational and periodic) directly affect data and may not be limited to one project. These records shall be stored in the operating unit Quality/Operations files unless it is required for a project that they be stored in the project file.

8.5 QC Sample Analysis

QC samples are routinely added to the

normal laboratory sample stream to demonstrate that the laboratory is operating within prescribed requirements for accuracy and precision. Statistical evaluation of QC sample data is discussed in Section 9.2. It is mandatory that all types of QC samples be handled and treated in the field and in all areas of the laboratory in the same manner as actual client samples.

QC levels and types of QC samples are described in the following sections. Laboratory QC samples are also listed per type of analysis in Table 8.5-1 for inorganic analyses and Table 8.5-2 for organic analyses. These tables also list the required frequency, acceptance criteria, and corrective actions. Radiochemistry QC samples are listed in Appendix Section 8 where applicable.

ITAS requires a minimum QC sample analysis frequency of 15%. When QC sample analysis requirements are not specified by a method, the following minimum will be used:

- Method blank
- Laboratory Control Sample
- Matrix Spike sample <u>or</u> Duplicate sample

8.5.1 QC Levels

Following are definitions of the ITAS QC levels:

Level I: ITAS Standard Practice. Use available analytical procedures. Fifteen percent QC samples (blank/spike/duplicate or duplicate spike) for every 20 samples of a given matrix. QC samples may not be performed for a specific project, but as part of compiled sets of samples. QC data are not reported with the analytical results.

Level II: ITAS Standard Practice/Project Specific. Use available analytical procedures. Fifteen percent QC samples minimum (blank/spike/duplicate or duplicate spike) for every 20 samples of a given matrix. QC samples are client or project specific. QC summary report is included with the analytical results. No raw data are included.

Level III: CLP or Equivalent. Use referenced regulatory procedures and/or established/verified procedures using confirmatory techniques. Method blank plus two QC samples minimum per each matrix. QC summary report is supplied with supporting data. Where applicable, this is the USEPA CLP package.

Level IV: Project Specific. QC requirements are defined in a QAPjP, Work Plan, Contract or other specific plan or procedure. Project documentation must be submitted to the laboratory prior to sample submittal.

8.5.2 Field QC Samples

When field QC sample collection and analysis are required for a project, it is the responsibility of the project sampling supervisor to ensure that this sampling is performed correctly and at the project-required frequencies. Field QC samples may or may not be identified as such to the laboratory and will undergo sample preparation and analysis procedures identical to the actual field samples. Field QC sample results are reported in the Certificate of Analysis or other project-required deliverable. The results are stored in the project file with which they are associated.

Field QC sample types, applicability to organic and inorganic analyses, precision and accuracy applications, and persons they are introduced by are summarized in Table 8.5-3. The following sections provide descriptions of field QC samples.

8.5.2.1 Trip (Travel) Blank (TB)

Volatile organics samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-lined, silicone, rubber septum of the sample vial. Therefore, Trip Blanks, also referred to as Travel Blanks, shall be analyzed to monitor for possible sample contamination during shipment. TBs will be prepared by filling two VOA vials (40 ml) with organic-free water and shipping the blanks with the field kit. TBs accompany the sample bottles during collection and shipment to the laboratory and are stored with the samples.

8.5.2.2 Field Blank (FB)

A FB is a volume of water (or soil) that is provided by the sample collectors to demonstrate the absence of contamination during sampling. Deionized, distilled laboratory water, or previously-prepared solid materials (i.e. lab sand) is placed into sample containers by the sample collection crew, packaged, and shipped with the other field samples.

8.5.2.3 Rinsate Blank

A rinsate blank is a volume of rinse solution (deionized, distilled lab water or organic solvent) used to rinse a sampling tool which contacts multiple samples. The rinse solution is collected after the tool has collected a sample and has been cleaned, to demonstrate that there is no residual contamination remaining on the tool to carry over into the next sample.

8.5.2.4 Field Duplicate (FD)

A FD sample is a duplicate sample which has been introduced as a separate sample by the sample collection personnel. Results of FD samples provide a measure of field precision.

8.5.2.5 *Field Matrix Spike Analyses*

A field MS sample is created by spiking target analytes into a portion of a sample in the field at the point of sample acquisition. This sample provides information on the target analyte stability after collection and during transport and storage.

8.5.2.6 *Collocated Samples*

Collocated samples are independent samples collected in such a manner that they are equally representative of the variable(s) of interest at a given point in space and time. Examples of collocated samples include: samples from two air quality analyzers sampling from a common sample manifold or two water samples collected at essentially the same time and from the same point in a lake.

Collocated samples processed and analyzed by the <u>same</u> organization provide intralaboratory precision information for the entire measurement system including sample acquisition, handling, shipping, storage, preparation, and analysis. Both samples can be carried through the steps in the measurement process together to provide an estimate of short-term precision for the entire measurement system. Likewise, the two samples, if separated and processed at different times or by different people, and/or analyzed using different instruments, provide an estimate of long-term precision of the entire measurement system.

Collocated samples processed and analyzed by <u>different</u> organizations provide interlaboratory precision information for the entire measurement system.

8.5.2.7 *Replicated Sample Analyses*

A replicated sample is a sample that has been divided into two or more portions at some step in the measurement process. Each portion is then carried through the remaining steps in the measurement process.

8.5.2.8 *Split Sample*

A split sample is a sample divided into two portions. One portion is sent to a different organization or laboratory and subjected to the same environmental conditions and steps in the measurement process as the portion retained.

A split sample can be divided into portions at different points in the sampling and analysis process to obtain precision information on the various components of the measurement system. For example, a field split sample provides precision information about all steps <u>after</u> sample acquisition including the effects of storage, shipment, analysis, and data processing; whereas, information on the intra- and

interlaboratory precision of sample preparation and analysis steps of the measurement system is provided by samples split once they are received in the laboratory.

8.5.3 Laboratory QC Samples

Laboratory QC samples, when successfully analyzed, demonstrate that the functions which are under laboratory control are within acceptable limits. Any laboratory QC sample results that are outside of acceptable limits must be documented on a nonconformance memo. Laboratory QC sample types, applicability to organic and inorganic analyses, precision and accuracy applications, and persons they are introduced by are summarized in Table 8.5-5. In addition, Tables 8.5.1 (inorganic) and 8.5-2 (organic) list laboratory QC samples, acceptance criteria, and corrective actions per analytical method. The following sections provide descriptions of laboratory QC samples.

8.5.3.1 Method Blank (MB)

A MB is a volume of deionized, distilled laboratory water for water samples, or a purified solid matrix for soil/sediment samples carried through the entire analytical procedure. The volume or weight of the blank must be approximately equal to the sample volume or sample weight processed. A MB shall be performed with each group of samples. Analysis of the blank verifies that method interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Optimally, a MB should contain no greater than the reporting limit for the parameter. Results of MB analyses shall be maintained with or referenced to the corresponding analytical data in the project file.

8.5.3.2 Reagent Blank (RB)

A reagent blank is composed of the materials which will be added to client samples during preparation, and analyzed for specific parameters. It is analyzed to verify that no laboratory contaminants are present at levels which would affect sample results. RBs must be successfully analyzed prior to sample analysis. Records of associated solvent lots and column absorbent test results are stored in Quality/Operation files.

8.5.3.3 Duplicate Sample Analyses

Duplicate analyses are performed to evaluate the precision of an analysis. Results of the duplicate analyses are used to determine relative percent - difference. Criteria for evaluating duplicate sample results are provided in Section 9.2.

8.5.3.4 Continuing Calibration Standard (CCS)

Because standards and calibration curves

are subject to change and can vary from day to day, a midpoint standard or check standard should be analyzed during each time period required by the analytical method. Analysis of this standard is necessary to verify the standard curve and may serve in some cases as sufficient for calibration.

8.5.3.5 Surrogate Standard (SS)

A SS determination should be performed on all samples and blanks for methods requiring surrogate usage. Surrogates should be similar to the target analytes in chemical composition and behavior in the analytical process, but not normally found in environmental samples. All samples and blanks are fortified with surrogate spiking compounds before purging or extraction to monitor preparation and analysis of samples.

8.5.3.6 Laboratory Matrix Spike (MS)

To evaluate the effect of the sample matrix on analytical methodology, a separate aliquot sample should be spiked with the analyte(s) of interest and analyzed with the sample. The percent recovery for the respective compound will then be calculated. If the percent recovery falls outside established QC limits, the data and other associated QC sample results should be evaluated and the sample may require reanalysis if criteria are not met. This type of MS does not necessarily reflect the behavior of the field-collected target analyte, especially if the target analyte is not stable during shipping or storage.

8.5.3.7 Laboratory Matrix Spike Duplicate (MSD)

Similar in concept to the MS sample, a MSD is a separate aliquot sample that is spiked with the analyte(s) of interest and analyzed with the associated sample and sample matrix spike. If the percent recovery falls outside established QC limits, the data and other QC sample results should be evaluated and the sample may require reanalysis if criteria are not met. The comparison of the recoveries of the spiked compounds in the MS and MSD samples is made to determine the relative percent difference (RPD) between the MS/MSD samples.

8.5.3.8 Laboratory Control Sample (LCS), Blank Spike (BS), or QC Check Standard

A LCS is a blank sample spiked with the parameters of interest or is a matrix of known parameter concentrations that is carried through the entire analytical procedure. Analysis of this sample with acceptable recoveries of spiked materials demonstrates that the laboratory techniques for this method are in control. Where required, this sample is analyzed in conjunction with MS/MSD samples. If the

MS/MSD pair shows poor recoveries due to interferences or matrix effects, yet the LCS is acceptable, this is strong evidence that the method has been performed correctly by the laboratory for these samples, but the sample matrix has affected the results. Results of LCS analyses must be cross-referenced with the corresponding MS/MSD and sample analytical data in the project file. LCSs are control charted to graphically demonstrate laboratory control or monitored through use of control tables. LCSs are described in the ITAS Division SOP No. ITAS-IT-QC-0004, "Use and Purpose of Laboratory Control Samples."

8.5.3.9 Analytical Spike (AS)

An AS sample is created by spiking target analytes into a prepared portion of a sample just prior to analysis. It provides information on matrix effects encountered during analysis such as suppression or enhancement of instrument signal levels. It is most often encountered with elemental analyses involving the various forms of atomic spectroscopy and is often referred to as the "method of standard additions" (MSA).

8.5.3.10 Internal Standard Spike (IS)

An IS is an analyte which has the same characteristics as the surrogate, but is added to a sample just prior to analysis. It provides a short-term indication of instrument performance, but it may also be an integral part of the analytical method in a non-quality control sense, e.g., to normalize data for quantitation purposes.

8.5.4 Matrix QC Samples

Matrix QC samples include MS, MSD, and duplicate samples which are discussed in Section 8.5.3.

8.5.5 Radiological QC Samples

Radiological QC samples are listed in Section 8 of the OS QAMP appendices when applicable. The following is a discussion of QC samples that are specific only to radiochemical analyses.

8.5.5.1 Yield Monitors

Yield monitors are added to the actual samples. There are two types of yield monitors: tracers and carriers. A tracer is a radioisotope usually of the same element, and usually having the same mode of decay as the analyte, that is added to the sample to monitor recovery. A carrier is a non-radioactive solution added to assist in isolating the specific isotope of an element. When standardized, the carrier can also provide recovery information gravimetrically.

8.5.6 Performance Evaluation Samples (PEs)

PE samples may be blind or double-blind and may be internal or external. PE

samples are discussed in detail in section 9.4.1.

8.6 Data Reduction, Verification, and Reporting

Data review procedures, ideally defined as a set of computerized and manual checks applied at various appropriate levels of the measurement process, will be clearly defined for all measurement systems in operation-specific SOPs. Responsibilities for data and report review are defined in the ITAS Division SOP No. ITAS-IT-QC-0003, "ITAS Data and Report Review Responsibilities". Data review begins with the reduction (processing) of data and continues through verification of the data and the reporting of analytical results. Calculations are checked from the raw data to final value prior to reporting results for each group of samples. Data reduction can be performed by the analyst who obtained the data or by another analyst. Data verification starts with the analyst and continues with review by a second level reviewer who verifies that data reduction has been correctly performed and that the reported analytical results correspond to the data acquired and processed. The procedure is outlined in Figure 8.6-1.

8.6.1 Data Reduction

The analyst's responsibilities for data reduction include the following:

- Proper identification of analysis output (charts, chromatograms, mass spectra, etc.)
- Calculation of instrument linearity
- Calculation or verification of QC sample/standard results
- Calculation or verification of sample results
- Use of proper data recording procedures (as described in operation-specific SOPs)
- Documentation of problems encountered
- Reporting of any nonconformances
- Continuation of internal chain-of-custody, if applicable

In general, data will be processed by an analyst in one of the following ways:

- Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets
- Input of raw data for computer processing
- Direct acquisition and processing of raw data by a computer

If data are manually processed by an analyst, all steps in the computation shall be provided including equations used and the source of input parameters such as response factors (RFs), dilution factors, and calibration constants. If calculations are not

performed directly on the data sheet, they may be attached to the data sheets.

For data that are input by an analyst and processed using a computer, a copy of the input shall be kept and uniquely identified with the project number and other information as needed. The samples analyzed must be clearly defined.

If data are directly acquired from instrumentation and processed, the analyst must verify that the following are correct:

- Project and sample numbers
- Calibration constants and RFs
- Units
- Numerical values used for detection limits (if a value is reported as "less than")

Analysis-specific calculations for methods are provided in operation-specific SOPs. In cases where computers perform the calculations, software must be validated or verified (if industry-standard software is used) in accordance with operation-specific SOPs before it is used to process data. Software validation and verification is discussed in Section 6.0.

The analyst (initial reviewer) is further required to initiate a data review check list for each batch of samples. Data review check lists are described in the ITAS Division SOP No. ITAS-IT-QC-0003, "ITAS Data and Report Review Responsibilities". ITAS data review check lists are shown for the following analyses:

- Metals (Figure 8.6-2)
- General Chemistry (Figure 8.6-3)
- Air (Figure 8.6-4)
- Radiochemistry (Figure 8.6-5)
- GC/MS (Figure 8.6-6)
- GC (Figure 8.6-7)
- HPLC (Figure 8.6-8)
- Dioxins/Dibenzofurans (Figure 8.6-9)

Data review check lists define and document the reviews that are performed on analytical data. The data review check list contains the specific items to be verified for the applicable test method. The items in the check list must be addressed by the initial reviewer (analyst), who must add to the check list any comments that should be relayed to the Project Manager for inclusion in the case narrative. The signature of the reviewer on the check list will serve to document that the initial data verification has been performed.

8.6.2 Data Verification

Following the completion of the initial

review by the analyst, a systematic second-level review of the data is performed by an experienced peer, technical person, or supervisor. The second level reviewer examines the data using the appropriate check list signed by the analyst. This review includes at least 20% of all items listed and in some cases up to 100% of all items (e.g. if mistakes are found in the 20% review). Any exceptions noted by the analyst must be reviewed. Included in this review is an assessment of the acceptability of produced data with respect to:

- Adherence of procedure used to the requested analytical method or SOP
- Correctness of numerical input when computer programs are used
- Numerical correctness of calculations
- Correct interpretation of chromatograms, mass spectra. etc.
- Acceptability of QA/QC data
- Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.)
- Documentation of dilution factors, standard concentrations, etc.

This review also serves as verification that the process that the analyst has followed is correct in regard to the following:

- The analytical procedure follows the methods and specific instructions given in the QAS, QAPjP, SOP, and/or project file
- Nonconforming events have been addressed by corrective action as defined in a nonconformance memo
- Relevant comments about sample or analysis problems are clearly stated
- Valid interpretations have been made during the examination of the data and the review comments of the initial reviewer are correct
- The package contains all of the necessary documentation for data review and report production, and results are reported in a manner consistent with the method used for preparation of data reports

The specific items covered in the second-level review may vary according to the analytical method, but this review of the data must be documented on the data review check list with the signature of the person performing the review.

A third-level review is performed by the Project Manager. This review is required before results are submitted to clients. This review serves to verify the completeness of the data report and to ensure that client project requirements are met for the analyses performed. The items to be reviewed are:

- Analysis results are present for every sample in the analytical batch or sample delivery group

- Every parameter or target compound requested is reported with either a concentration of detection limit

- The correct units and correct number of significant figures are given for each sample and each parameter reported

- If specific data reporting forms were requested, all forms are present and are completed correctly

- All nonconformances and data evaluation statements that impact the data quality are accompanied by clearly expressed comments from the laboratory

- The final report is legible, contains all the supporting documentation required by the project, and is in either the standard ITAS format or in the client-required format

A case narrative to accompany the final report will be prepared by project management. This narrative will include relevant comments from the earlier reviews as determined by the Project Manager.

8.6.3 Data Reports

The format and content of data reports are dependent upon client needs such as client or contract requirements and government agency reporting formats. There are three general categories of data reports:

- Certificate of Analysis
- Data Package
- Electronic Data Transfer (EDT)

8.6.3.1 Certificate of Analysis

ITAS laboratories report data in a standard format, unless client or contract requirements take precedence. Figure 8.6-10 shows pages one and two of the standard ITAS Certificate of Analysis.

On page one, client/project information is presented such as:

- Client name and address
- Date
- Job Number
- Purchase Order number
- Project Identification
- Date samples received
- Number and type of samples

After the client/project information, explanatory text begins with an

Introduction. The Project Manager or designee signs page one after reviewing and approving the report.

Page two continues the explanatory text section with an Analytical Results/Methodology section and a Quality Control section. Following page two is a presentation of the results of the testing program along with QC sample summaries as appropriate.

Data presentation includes:

- Sample identification (both client and laboratory ID)
- Parameter(s) analyzed
- Reported values
- Units of measurement
- Detection limit(s)
- Explanation of abbreviations used, if applicable
- Dates of extractions/digestions and analysis
- QA/QC data (if requested by the client)

8.6.3.2 Data Package

ITAS routinely prepares data packages in accordance with USEPA CLP protocol for samples analyzed according to the CLP Statement of Work. "CLP-like" data packages are also routinely provided for non-CLP analyses. Data packages shall be prepared to meet client and contractual needs. Special data package requests should be addressed with the laboratory prior to sample analysis to assure the proper protocol is followed to generate the needed data package elements.

In general, data packages consist of a case narrative followed by computer-generated data forms, supported by copies of all associated raw data. This may include but not be limited to copies of:

- Chromatograms
- Extraction notes
- Digestion logs
- Strip charts or instrument computer printouts
- Data worksheets
- Standards logs
- Chain-of-Custody records

8.6.3.3 Electronic Data Transfer (EDT)

Upon request, data may be transmitted via computer or diskette. Each operating unit will work with the client to provide a computer format that is consistent with the output of laboratory data and meets contractual needs. Procedures for EDT are documented in operation-specific SOPs.

8.6.3.4 Verbal Results

Any analytical results communicated verbally or by facsimile should be reviewed and approved prior to the communication. Thus, these results must be of the same quality as the hard copy report.

8.6.3.5 Data Reporting

Sample results are reported per analytical method SOPs or per contract specification. Normally, the laboratory determines a reporting limit at which any analyte of interest detected at or above that level is reported as a positive value and any analyte of interest not detectable or detected below that level is reported as a "less than" value. However, in some cases a situation may occur, due to a contractual requirement, QAPjP, QAPP, client request, etc., that requires the laboratory to report sample results in a specified manner. Some examples are given below:

- The laboratory may be requested to report all analytes of interest that are less than the laboratory's reporting limit but are measurable by the analysis. This data will be flagged with an appropriate qualifier.

- The laboratory may be requested to report any tentatively identified compounds less than or greater than the laboratory's reporting limit. This data will be flagged with an appropriate qualifier.

- The laboratory may be requested to report sample results using a reporting limit that is higher than their normal level. In this case, all analytes of interest not detected or detectable below that level would be reported as "less than" and only the analytes of interest found at or above that level would be reported as positive values. In this case, the laboratory will state the specified reporting level rather than their normal levels.

In these types of cases, the laboratory must include documentation in the project file that supports their reporting procedure.

It is the responsibility of the laboratory to provide for a reporting system that ensures that any problems associated with an analysis are properly documented on a nonconformance memo, communicated to the appropriate ITAS Associates, and addressed appropriately in the data report.

8.7 Data Validation

In ITAS and this OS QAMP, data validation refers to data reviews conducted in accordance with the USEPA CLP "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses" and "Laboratory Data Validation Functional Guidelines for Inorganic Analyses". Data validation performed by ITAS will be done according to ITAS Division SOP No. ITAS-IT-DV-001, "Quality Assurance Plan - Data Validation".

This form of data validation provides an impartial confirmation of the laboratory's results. It is usually performed by a third party. Qualifiers are assigned to data, when required, per the above mentioned documents. The ITAS FAS units routinely perform data validation services.

8.8 Preventive Maintenance

Instruments, equipment, and parts are subject to wear, deterioration, or change in operational characteristics. Within ITAS, preventive maintenance is an organized program of actions taken to maintain proper instrument and equipment performance. The primary purpose of this program is to prevent instrument and equipment failure and minimize down time. A properly implemented preventive maintenance program increases the reliability of a measurement system.

Each instrument or piece of equipment shall be uniquely identified. Each operating unit shall maintain the following:

- Instrument/equipment inventory list
- Instrument/equipment major spare parts list or inventory
- External service contract documents (if applicable)
- Instrument-specific preventive maintenance logbook or file for each functional unit

The record of maintenance shall include at a minimum:

- Actions taken, including parts replaced
- Analyst initials and date maintenance was performed

ITAS documents and describes in detail instrument/equipment preventive maintenance in operation-specific SOPs. SOPs are specific to the type of instrument or equipment being used for sample analysis.

8.8.1 Responsibilities

Within each laboratory, the Operations Manager is responsible for overseeing the preventive maintenance program. Group Leaders and Analysts actually implement and document the program. The QA/QCC shall review implementation to verify compliance.

8.8.2 Frequency of Maintenance

The frequency of maintenance must consider manufacturer's recommendations and previous experience with the instrument or equipment. Schedules of preventive maintenance along with the required frequency are shown in Appendix Section 7.

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9.0 QUALITY ASSESSMENT AND RESPONSE

Each ITAS operating unit shall establish, implement, and document procedures to detect, prevent, and correct quality problems and to ensure quality improvement. Items and processes that do not meet established requirements must be investigated to determine their cause. Improvements must be implemented in the operations which will prevent a recurrence of these quality problems and provide overall quality performance. All phases of laboratory work should be designed with the objective of preventing problems and improving quality on a continuous basis.

9.1 Internal QC

The quality of all data produced at ITAS operations is demonstrated by the analysis of required QC samples in addition to the specified method performance criteria such as calibrations. Operation-specific SOPs include information on all requirements for the type of QC samples, their target frequencies, and target acceptance criteria for each analytical methodology to be used. Additionally, these SOPs describe the appropriate actions to be taken when a QC sample result does not meet target acceptance criteria. This information is listed in Table 8.5.1 for inorganic QC samples and Table 8.5-2 for organic QC samples.

9.2 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

Section 8.5 of this document describes the QC samples that are employed at ITAS as a routine part of sample analysis. The results of these QC samples will be used to validate the precision and accuracy of the laboratory measurements. QC samples are split into two categories: Laboratory Quality Control Measurements and Matrix Quality Control Measurements. These are described in the following sections:

9.2.1 Laboratory QC Measurements

Laboratory QC samples (discussed in section 8.5.3) demonstrate that the functions which are under laboratory control are within acceptable limits. Table 9.2-1 lists laboratory QC samples and their purpose.

9.2.2 Matrix QC Measurements

Matrix QC samples provide information regarding any influence the sample matrix may exert on the precision and accuracy of the analytical results. As this influence is beyond the control of the laboratory, matrix QC samples outside the acceptance criteria are not always cause for re-analysis of the sample. Matrix QC samples include

laboratory MS, MSD, and duplicate samples. Matrix QC samples and their purpose are listed in Table 9.2-2.

9.2.3 Precision and Accuracy Limits

Precision and accuracy limits are defined in the applicable methods and will be used to determine the acceptability of the QC sample results. In the case where a method does not specify precision and accuracy limits, internal limits will be determined by the ITAS operating unit and documented in operation-specific SOPs.

Table 9.2-3 shows the precision and accuracy measurements employed by ITAS. MS, MSD, and duplicate sample results are evaluated using method or laboratory limits. Control charts or tables are maintained by the analyst for LCSs on a "real time" basis and are used to assess the level of laboratory control. It is the responsibility of each laboratory analyst to update any other client-required control charts or control tables as a part of routine data reduction.

9.3 Nonconformance, Corrective Action, and Deficiency

9.3.1 Nonconformance

A nonconformance is a deviation or event beyond the limits and criteria established for standard operations, which may lead to a degradation of quality to an unacceptable or indeterminate level. Nonconformances over which the operating unit has control must have the root cause determined so that the possibility of the nonconformance recurring is minimized or eliminated.

Nonconformances may include (but are not limited to) the following:

- Sample holding time exceeded
- Incorrect sample preparation or analysis techniques used
- Invalid instrument calibration used
- QC sample data (blank, spike, duplicate, surrogates, LCS, etc.) are outside acceptance criteria.
- Incorrect data reported to the client
- Sample lost during extraction/analysis; no re-prep or re-analysis possible
- Any other situation that might adversely affect the final data quality

As soon as deviation from accepted laboratory practice is discovered, it is required to be documented. There are two types of documentation within the ITAS system for nonconformances. These are the ITAS Nonconformance Memo (NCM), Figure 9.3-1 (pages 1 and 2) and the ITAS Condition Upon Receipt Variance Report (CUR), Figure 8.3-1.

9.3.1.1 Nonconformance Memo (NCM)

Information to be documented on the NCM include (but are not limited to) the following:

- Laboratory area affected
- Nonconformance category
- Client notification
- Corrective action (root cause and actions to prevent recurrence should be included, as appropriate)
- QC review (nonconformance or deficiency must be checked off)
- Verification of corrective action if nonconformance (verification is not required for deficiencies)
- Signature by QA/QCC or designee verifying NCM closure
- Routing destination (Quality/Operations files or Project file)

Upon completion, original NCMs are stored in the appropriate project file if project-specific or are stored in the facility Quality/Operations files if non-project specific.

Nonconformances identified through surveillance, or through an internal or external audit require documentation and tracking to verify that the root cause has been determined and that corrective actions have been taken to prevent recurrence. The NCM may be used for this purpose.

9.3.1.2 Condition Upon Receipt Variance Report (CUR)

A CUR is generated by sample control during the log-in process to document nonconformances identified upon receipt of samples in the laboratory. These nonconformances are outside of laboratory control and do not require corrective actions to be taken within the laboratory. The corrective action in this case is client notification. Actions to prevent recurrence should take the form of client education when possible. Nonconformances documented on a CUR may include (but are not limited to) the following:

- Not enough sample received for proper analysis
- Sample received without proper preservative
- Sample received in improper container
- Sample received broken or leaking
- Sample received outside temperature specifications
- Sample received without proper paperwork
- Sample received without or with broken custody tape

- Chain-of-Custody broken (not relinquished by the client)
- Sample information on the container does not match the accompanying paperwork
- All shipping containers (coolers) on waybill not received in the sample shipment

Once the nonconformance is identified and the CUR initiated, the laboratory Project Manager is notified. The Project Manager then notifies the client and requests instructions on how to proceed with the samples. The client contact and the client response to the nonconformance must be documented on the CUR and communicated to sample control so that log-in may proceed. These nonconformances must be resolved prior to sample prep and analysis.

9.3.2 Corrective Action

All nonconformances shall have a corrective action. The process by which corrective action is performed requires a determination of root cause, immediate action, and actions taken to prevent recurrence. The latter two may be the same action. Corrective actions include (but are not limited to) the following:

- Recalibration of instruments, using freshly prepared calibration standards
- Reanalysis of samples
- Replacement of lots of solvent or other reagents that yield unacceptable blank values
- Additional training of laboratory Associates in correct implementation of sample preparation and analytical techniques
- Reassignment of Associates
- Communication with the client to determine appropriate action (e.g. resampling, processing the sample "as is", terminating analysis, etc.)

9.3.3 Deficiency

A deficiency is a deviation from documented procedures, practices, standards, or a defect in an item that is determined *not* to render the quality of an item or service unacceptable or indeterminate. The QA/QCC shall determine whether the deviation is a nonconformance or a deficiency.

9.3.4 Responsibilities

All laboratory Associates are responsible for identifying and reporting any deviation from accepted laboratory practice that might affect the quality of the data. Once a possible nonconformance is identified, a NCM or a CUR is generated and routed to that Associate's supervisor for further review and documentation.

The QA/QCC is responsible for verifying

corrective actions and tracking NCM's until closure. The corrective action must be performed in a timely manner.

The QA/QCC (or designee) is responsible for logging all nonconformances into a master nonconformance log (example shown in Figure 9.3-2).

9.4 QA/QC Audits

ITAS operating units are subject to numerous assessments in the form of audits, both internal (self assessment) and external (independent assessment). Laboratory audits within ITAS can be broken down into four major categories:

- Performance Audits
- Surveillances
- Quality Systems Audits
- Project Audits

Audits of laboratories are performed to determine the degree of adherence to policies, procedures, and standards which include:

- IT and ITAS Quality Assurance Policy
- IT and ITAS Procedures
- Contractual Requirements
- Regulatory Obligations

Audits serve as a useful management tool to evaluate the appropriateness of QA policies. They identify areas for improvement with regard to compliance with policies, procedures, and standards, providing means for correction prior to system failure requiring shut down. In addition, they serve to strengthen the documentation trail assuring known data quality.

9.4.1 Performance Audits

Performance audits are conducted on an ongoing basis within the laboratory by the QA/QCC. These audits are reported to the Operating Unit Director and the Division Director, QA/QC. Performance audits vary with the needs of the operating unit. Performance audits include internal and external performance evaluation (PE) samples. These are discussed in the following sections.

9.4.1.1 Internal Performance Evaluation

The QA/QCC has the responsibility of monitoring the performance of the laboratory by inserting blind QC samples ("true" value(s) unknown to analyst) into the sample stream periodically and analyzing the results. The blind QC samples will be scheduled throughout the year to cover all routine analyses on an annual basis. Internal Performance Audits

are performed on a routine basis and are described in operation-specific SOPs. In addition, they may also be performed along with a project (client requested) or any time the QA/QCC or Operating Unit Director requests the performance audit study. Performance audit samples demonstrate data quality by statistical analysis. The results of these samples may also be used to document the training level of the analyst(s) performing the work. These results are linked to the analyst(s) in the Associate training files.

9.4.1.2 External Performance Evaluation

Each laboratory participates in external PE programs such as the USEPA Water Supply (WS), Water Pollution (WP), and/or Contract Laboratory Program (CLP) quarterly proficiency program for chemical parameters and/or the USEPA Intercomparison Program through the Environmental Monitoring Support Laboratory in Las Vegas (EMSL-LV) for radiochemical parameters. In addition, many state agencies and private contractors provide PE samples to challenge the laboratories and evaluate the effectiveness of the laboratory program. All external PE sample studies and results shall be maintained as quality records in the laboratory Quality/Operations files.

Since participation in these programs and others varies with the type of work performed within each ITAS laboratory, the specifics of participation are described in Appendix Section 6.

9.4.1.3 Double-Blind Performance Evaluation

ITAS employs a "double blind" PE sample program involving semiannual studies. This program applies to all ITAS laboratories. Double-blind PE samples are blind PE samples submitted to the laboratory under the pretense that they are normal client samples. The results of the study are reported to the Vice President, IT Analytical Services, the Division Technical Director, and the Division Director, QA/QC. Recommendations for quality improvement are submitted to the Laboratory Directors, and corrective actions are implemented as necessary.

9.4.2 Surveillances

Surveillances are detailed inspections of specific areas of a laboratory and its QA Program. Surveillances do not require the extensive planning and preparation required for audits and are conducted on a much more informal basis. The QA/QCC shall observe the activity of interest while it is in process and/or review objective evidence. A checklist for the applicable documents and criteria may be used for this review.

A surveillance is performed each month by the QA/QCC (unless a systems audit or follow-up audit is performed). The scope of the surveillance is determined by the QA/QCC. This allows for a concentrated focus on areas of the laboratory that may be suspect or require additional monitoring to verify compliance with policies, procedures, and standards. The QA/QCC may use the nonconformance/corrective action system to determine trends in a laboratory area that require further investigation. The purpose of a surveillance is to find and correct problems before they become out-of-control situations.

Once the surveillance is complete, the QA/QCC will assign a score and will issue a report to the responsible manager. A copy of the report is sent directly to the Laboratory Director and to the Division Director, QA/QC in the laboratory monthly report to management. The report details the results of the surveillance, and requests a corrective action plan complete with target dates and Associate assignments. The QA/QCC must work with the surveyed group to recommend corrective action and then follow-up after the proposed target date to verify that corrective action was indeed performed. The QA/QCC shall document by memorandum that corrective action was taken. Surveillances are fully described in operation-specific SOPs.

9.4.3 Quality Systems Audits

Four times per year, each laboratory undergoes an internal audit to identify the level of compliance with established, documented, quality assurance systems. Two of these audits are designed and conducted by the QA/QCC. The remaining two are conducted by the Division Director, QA/QC or designee. The Division audits usually consist of a 2-4 day comprehensive review of all quality systems in the laboratory. Six months later, a second or follow-up audit is conducted to assess compliance with the corrective action plan established by the audited laboratory after completion of the first audit. The follow-up can be performed in 1-2 days. The Lead Auditor reserves the right to lengthen the audit or require a complete re-audit in 3 to 6 months depending upon the extent of the problems discovered. Findings which have not been satisfactorily resolved between the two audits shall be specifically reported to the Division Operations Director and Vice President, IT Analytical Services, for resolution.

Systems audits not conducted by the QA/QCC are lead by an ITAS certified Lead Auditor (see System Procedure 8907-QAC-04, "Standard Operating Procedure for Auditors Certification at ITAS Laboratories") under the direction of the Division Director, QA/QC. The Division

Director, QA/QC (or designee) will prepare a schedule of audits to be conducted during the fiscal year and will select appropriate audit teams depending upon the nature and depth of the audit. The source documents for systems audits are the ITAS QAMP, the ITAS Operation-Specific QAMP, and SOPs. The scope of the audit takes into account the expectations of external auditors, contracts, and regulatory requirements. A systems audit check list is prepared for the year and used in all locations audited to provide consistency and objectivity to the audit team.

At the beginning of the audit, the audit team will meet with the Operating Unit Director and the QA/QCC to discuss the goals of the audit. At the close of the audit, the audit team will debrief the Operating Unit Director, QA/QCC, the laboratory Technical Director, Project Managers, and Group Leaders, and will discuss and present the audit findings and observations. Additional laboratory staff may be invited to the debriefing, as deemed necessary by the Lead Auditor. The Lead Auditor can close an audit finding or observation during the debriefing if the laboratory staff can satisfactorily demonstrate that the finding/observation is inappropriate or has been corrected prior to the debriefing. Also during this meeting, recommendations for corrective actions will be discussed. If corrective actions are requested to be taken immediately after audit closure, the actions must be taken.

An audit report will be prepared by the Lead Auditor and will include the following:

- Cover memo summarizing the audit process, any findings, and announcement of the preliminary audit ranking
- Audit Check List
- Finding Report(s)
- Observation Report(s)
- Corrective Action Plan (to be completed by the laboratory)

The audit report shall be completed as soon as possible after completion of the audit, but shall take no longer than 45 days. The original audit report will be addressed to the Operating Unit Director, who is responsible for responding within the designated time frames established by the Lead Auditor. A completed copy of the systems audit report will be sent to the QA/QCC and the Division Director, QA/QC.

Upon receipt of the audit response, the Lead Auditor will evaluate the proposed corrective action plan and will reply stating acceptance or rejection of the plan or its

elements. Approximately six months later, the Lead Auditor or designee will perform a second audit of the operation and verify completion of the initial audit corrective action plan. The Lead Auditor will then issue a final audit report detailing the results of implementation and will issue a final audit ranking for the year. A positive change in ranking is indicative of improvement in implementation of the QA Program. Quality systems audits are described in a operation-specific SOPs.

9.4.4 Project Audit

Project or data quality audits are designed to address the DQOs (precision, accuracy, representativeness, and completeness) of all data associated with a particular project. These audits also review a project for compliance with contractual requirements set forth in a QAPjP or formal contract. Project audits may be conducted by IT, ITAS, or project QA staff. A project-specific check list is prepared using the QAPjP and/or contract as the source document(s). The audit report is addressed to the Operating Unit Director who is required to respond within the designated time frame stipulated by the Lead Auditor. As with all other audits, a follow-up audit for verification of compliance with the corrective action plan is to be performed.

9.4.5 Findings, Observations, Comments, and Recommendations

Findings represent areas in which the operation or operating unit section as a system is not in compliance with the requirements of the ITAS QA Program. Findings are situations that could directly affect the quality of resulting work. Findings require that a corrective action plan be developed by the Operating Unit Director, who will identifying the root cause of the problem and will schedule action to prevent recurrence.

Observations represent isolated instances of noncompliance or questionable practices. They present situations that could become findings if left unresolved. As with findings, a corrective action plan is required.

Comments or recommendations shall be written by the auditor in an attempt to share information and provide constructive criticism in order to improve performance or documentation in an area. Comments might also indicate areas that may become noncompliant. If attention is not paid to the comment, it is likely to become an observation. Comments and recommendations do not require any formal response by the audited organization, but it is strongly recommended that they be reviewed for appropriate action. Included in

the comments and observations are those which describe exemplary practices. Audit reports should not focus only on negative aspects of the program and may include a section on exemplary practice.

9.4.6 Audit Ranking

Internal ITAS QA Systems Audits require a preliminary and final ranking to be assessed. Audit check list scores and assessments of open observations and findings (not corrected since the last internal or client audit) are considered in the audit ranking process. Laboratories are ranked as either excellent, acceptable, marginal, or unacceptable. These ranks are described as follows:

- Excellent - Meets or exceeds established requirements for all areas audited.
- Acceptable - Audited work meets all requirements of the ITAS QA Program with only a few minor deviations from established requirements.
- Marginal - Audited work represents a basic QC practice with actions required by the laboratory to improve operations immediately.
- Unacceptable - Audited work indicates that quality practice is not implemented on a regular basis and one or more areas will be shut down for correction.

The Division Director, QA/QC, will issue a memorandum to all QA/QCCs and Operating Unit Directors annually describing the process of determining the audit rank.

While audit ranking allows for comparison of laboratories across the network, caution is advised in using the ranking alone without a detailed review of the situations or conditions observed that caused the Lead Auditor to arrive at that rank.

9.4.7 Client Satisfaction Survey

Each ITAS operating unit has the responsibility to understand client needs, and whether ITAS services are meeting those needs and expectations. At least three client satisfaction surveys should be performed monthly, within each operating unit, to randomly selected clients by the QA/QCC or designee. The IT Corporation Client Satisfaction Survey form (Figure 9.4-1) should be utilized with distribution to the ITAS Project Manager, Operating Unit Director, Division Operations Director, Vice President, IT Analytical Services, Vice President, Quality and Health Services, and Division Director, QA/QC. Any corrective or follow-up action must be documented on the form and implemented by the Project Manager or Operating Unit Director.

9.5 Quality Reports to Management

The QA/QCC and the Division Director, QA/QC shall prepare reports to

management on a monthly basis indicating the effectiveness of the QA Program. The QA/QCC shall send a quality report to the Division Director, QA/QCC. An example outline for the QA/QCC's report is shown in Figure 9.5-1. The Division Director, QA/QC, shall send a summary of the QA/QCC's reports to the Vice President, IT Analytical Services.

9.6 Management Review of the Quality Assurance Program

Management at all levels shall assess the QA Program and its performance. Management assessment shall identify barriers that hinder the organization from achieving its objectives in accordance with quality, safety, and environmental requirements. Results of management assessments shall be documented and corrective action taken. The effectiveness of the implementation of corrective actions shall be included in the next management assessment.

An example of the management assessment approach will be to conduct double blind studies on the appropriate laboratories (see Section 9.4.1.3). In such studies, a client contacts the laboratory and submits a sample of known parameters and values for analysis that is totally blind to the laboratory management and the analysts. These studies allow assessment of the total process from initial client contact through final reporting.

Review of the adequacy of the ITAS' QA Program is ongoing. At any time, the Division Operations Director, an Operating Unit Director, or the Division Technical Director may present, in writing, recommended changes to the Division Director, QA/QC. During the QA systems audits, the QA Program is discussed with the management of the facility audited. This feedback is valuable and necessary to the progress of the QA Program in meeting the constantly-changing needs of the environmental industry.

In addition to these ongoing reviews, the Vice President, IT Analytical Services shall conduct an annual review of the QA Program considering:

- Results of the QA systems audits. Are undesirable trends occurring?
- Status of QA documents. Are the current documents adequate? Are new documents needed?
- Is the auditing program fulfilling its purpose?

The Vice President will consult with the Division Operations Director, Operating Unit Directors, and the Vice President, Quality and Health Services, as necessary, during the review. To document the review, the Vice President, IT Analytical Services,

will issue a memo to the Division Director, QA/QC, stating the extent of the review and will present recommendations.

FIGURE 1.2-1
INTERNATIONAL TECHNOLOGY CORPORATION
ANALYTICAL SERVICES
DIVISION OPERATIONS

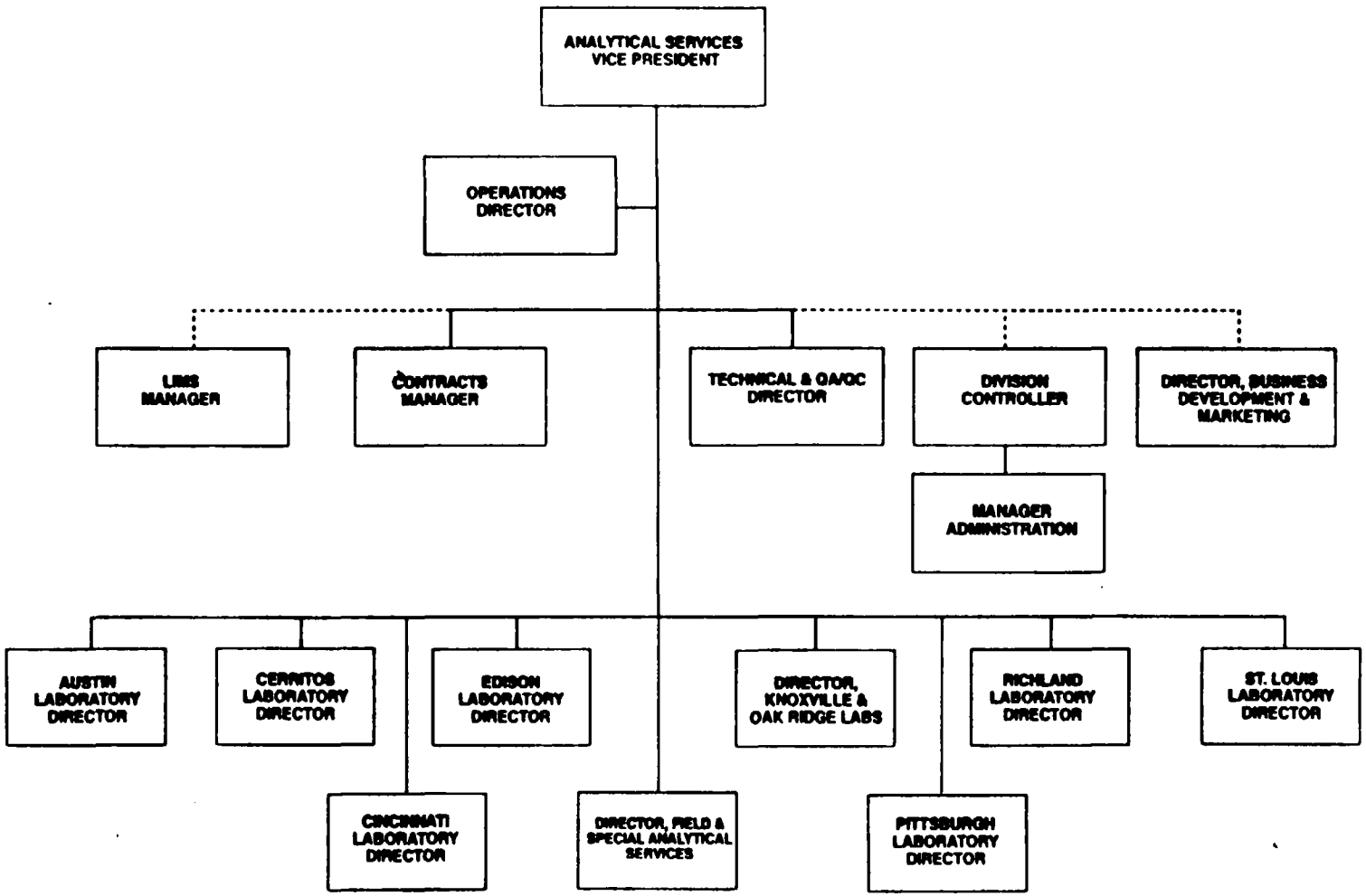

FIGURE 3.1-1
IT Analytical Services
Example Associate Qualification Form

Name: _____ **Hire Date:** _____

Title: _____ **Supervisor:** _____

PROCEDURE NAME/NUMBER	QUALIFY DATE	APPROVAL SIGNATURE

TRAINING SESSION	DATE	APPROVAL SIGNATURE

FIGURE 3.2-1
Example Individual Training Record

Name: _____ Hire Date: _____

Title: _____ Supervisor: _____

I. ACADEMIC TRAINING/DEGREES

Name of Institution (Including Current Enrollment)	City, State	Curriculum Major	Attendance	Degree(s) Received/Expected	Degree Date

II. SPECIAL SCHOOLING/TRAINING

Date(s)	Course Title	Sponsored By (IT or External)/Location

III. SPECIALIZED EXPERIENCE/ON-THE-JOB TRAINING

Date(s)	Specialized Experience	Reference (Paper or Project)

Associate Signature/Date: _____

QA Concurrence/Date: _____

TRAINREC.FRM\pbc\07-18-93

FIGURE 3.2-2

Example ITAS New Employee Quality Assurance Orientation Form

Name: _____ Date of Hire: _____

Job Title: _____ Report to Work Date: _____

QUALITY ASSURANCE PROGRAM SECTION	REVIEW (X)
Statement of Management Position	
ITAS Quality Assurance Management Plan (QAMP)	
Operation-Specific Quality Assurance Management Plan (OS-QAMP)	
Nonconformance and Corrective Action	
Data Entries and Corrections	
NQA-1	
NRC Regulatory Guide	
Quality-related responsibilities for Job Title (Section and/or Topic):	

I attended the session covering QA sections and/or topics as described above and understood the material presented during the session.

_____ _____

Associate's Signature Date

_____ _____

QA/QC Coordinator's Signature Date

QA Exam Given? _____ Orientation was adequate _____ Further training is needed _____

Follow-up sessions covered:

_____

_____

_____ _____

Associate's Signature/Date QA/QC Coordinator's Signature/Date

THIS DOCUMENT MUST BE RETAINED IN THE ASSOCIATE'S TRAINING FILE

FIGURE 3.2-3

Example ITAS Lead Auditor Certification Form

NAME	LOCATION	DATE

QUALIFICATION POINT REQUIREMENTS		CREDITS
EDUCATION - University/Degree/Date	4 Credits Max.	
1. Undergraduate Level		
2. Graduate Level		
EXPERIENCE - Company/Dates	9 Credits Max	
1 Technical (0-5 credits)		
2. Nuclear Industry (0-1 credits) OR		
3 Analytical (Environmental) Industry (0-1 credit) OR		
4 Quality Assurance (0-3 credits) OR		
5 Auditing (0-4 credits)		
PROFESSIONAL ACCOMPLISHMENT - Certificate/Date	2 Credits Max	
1. Society		
2 Other		
MANAGEMENT - Justification/Evaluator/Date	2 Credits Max	
Explain.		
Evaluated By (Name & Title	Date	
	Total Credits	0

AUDIT TRAINING/PARTICIPATION				
AUDIT COMMUNICATION SKILLS				
Evaluated By (Name & Title)				Date
AUDIT TRAINING COURSES				
Course Topic or Title				
1				
2				
AUDIT PARTICIPATION				
Location	Type of Audit		Date(s)	
1				
2				
3				
4				
5				
6				
7				
EXAMINATION		Passed		Date
AUDITOR QUALIFIED CERTIFIED BY: (Signature & Date)		DATE CERTIFIED:		
ANNUAL EVALUATION				
(Signature & Date)				

FIGURE 5.0-1
Example Procedural Change Form

ITAS _____ LABORATORY

PROCEDURE/DOCUMENT CHANGE

PROCEDURE/DOCUMENT TITLE AND NUMBER:

PROCEDURE/DOCUMENT SECTION(S) AFFECTED BY CHANGE:

REASON FOR ADDITION OR CHANGE:

CHANGE EFFECTIVE FROM: _____ (DATE) TO: _____ (DATE)

SAMPLES OR PROJECTS AFFECTED:

CHANGE OR ADDITION (SPECIFY SECTION; USE ADDITIONAL SHEETS IF NECESSARY):

SUBMITTED BY:	DATE:
	QA/QC COORDINATOR
	LABORATORY DIRECTOR
	DIVISION DIRECTOR, QA/QC

FIGURE 5.4-1
ITAS Standard Administrative SOP Format

1. Purpose, Application and Responsibility

2. References

3. Associated SOPs

4. Definitions

5. Procedure
   - 5.1 Summary
   - 5.2 Safety
   - 5.3 Required Equipment
   - 5.4 Administrative Procedure
   - 5.5 Calculations
   - 5.6 Quality Control

6. Nonconformance and Corrective Action

7. Records Management and Documentation

Note: The inclusion of subsections 5.3 through 5.6 is left up to the discretion of the SOP's author, as appropriate.

FIGURE 5.4-2
ITAS Standard Technical SOP Format

1. Purpose, Application and Responsibility
   - 1.1 Purpose
   - 1.2 Application
   - 1.3 Responsibilities
2. References
3. Associated SOPs
4. Definitions
5. Procedure
   - 5.1 Summary
   - 5.2 Safety
   - 5.3 Interferences
   - 5.4 Preservation and Holding Time
   - 5.5 Required Equipment
   - 5.6 Reagents/Standards
   - 5.7 Calibration
   - 5.8 Analysis/Operation
   - 5.9 Calculations
   - 5.10 Quality Control
6. Nonconformance and Corrective Action
7. Records Management and Documentation

FIGURE 8.0-1
Data Collection Process Flow Chart

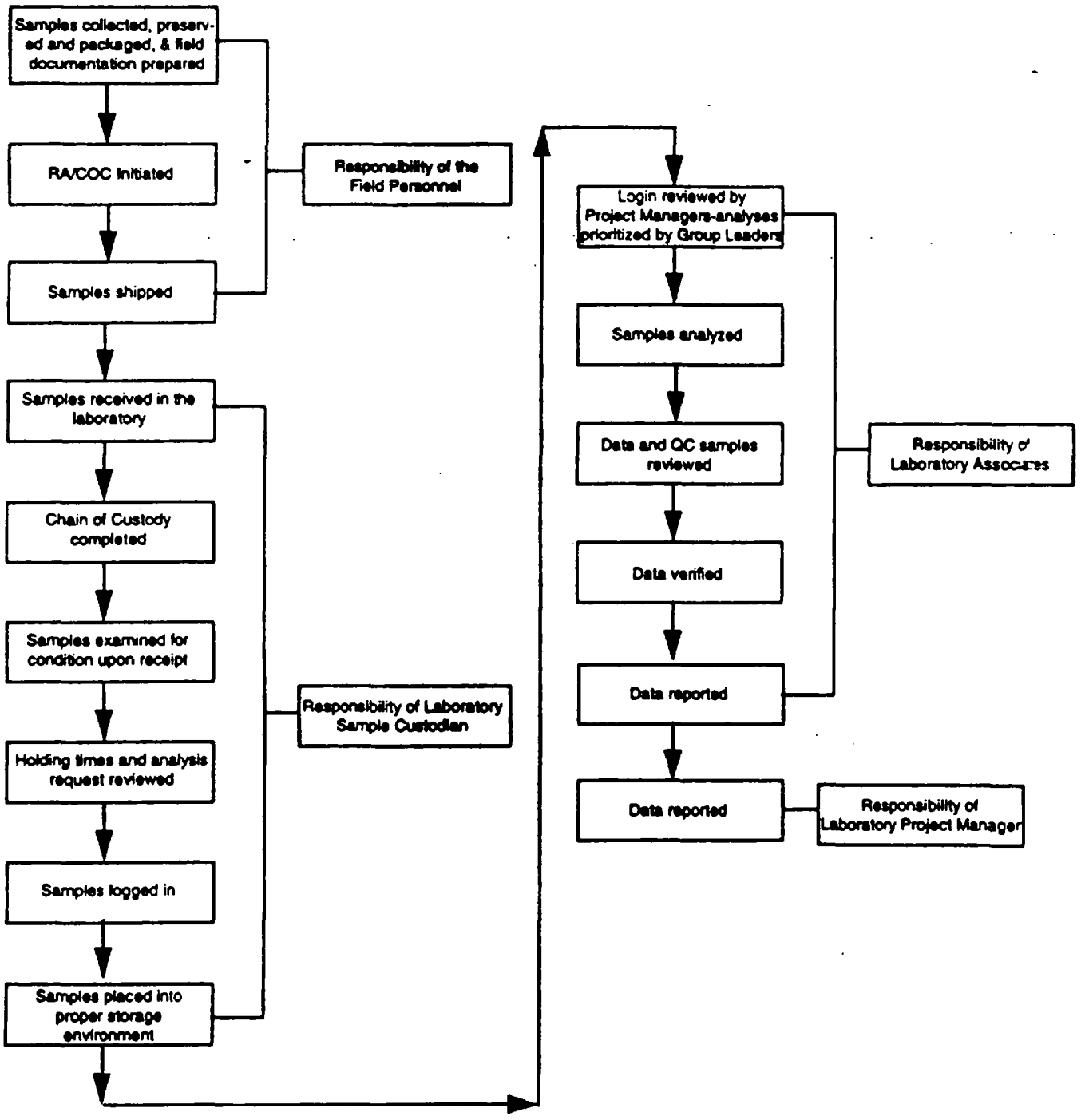

FIGURE 8.1-1

ITAS Analysis Request/Chain-of-Custody Form

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD*

Reference Document No. 323490
Page 1 of ____

Project Name/No [1] _____ Samples Shipment Date [7] _____ Bill to [5] _____

Sample Team Members [2] _____ Lab Destination [8] _____

Profit Center No [3] _____ Lab Contact [9] _____

Project Manager [4] _____ Project Contact/Phone [12] _____ Report to: [10] _____

Purchase Order No [6] _____ Carrier/Waybill No. [13] _____

Required Report Date [11] _____

ONE CONTAINER PER LINE

Sample Number [14]	Sample Description/Type [15]	Date/Time Collected [16]	Container Type [17]	Sample Volume [18]	Preservative [19]	Requested Testing Program [20]	Condition on Receipt [21]	Disposal Record No. [22]

Special Instructions: [23]

Possible Hazard Identification: [24]
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal: [25]
Return to Client ☐ Disposal by Lab ☐ Archive (mos.)

Turnaround Time Required: [26]
Normal ☐ Rush ☐

QC Level: [27]
I. ☐ II. ☐ III. ☐ Project Specific (specify):

1. Relinquished by [28] (Signature/Affiliation)	Date: Time:	1. Received by [28] (Signature/Affiliation)	Date: Time:
2. Relinquished by (Signature/Affiliation)	Date: Time:	2. Received by (Signature/Affiliation)	Date: Time:
3. Relinquished by (Signature/Affiliation)	Date: Time:	3. Received by (Signature/Affiliation)	Date: Time:

Comments: [29]

White To accompany samples
Yellow Field copy
*See back of form for special instructions

FIGURE 8.3-1 **Work Order No.:**_____

Condition Upon Receipt Variance Report

ITAS - _____ **Laboratory**

Client:_____ Date:_____

Project No:_____ Initiated by:_____

Analysis Requested:_____ RFA/COC Numbers:_____

Client Sample Numbers Affected:_____

Condition/Variance (Check all that apply):

1. ☐ Not enough sample received for proper analysis.
   Received approximately:_____
2. ☐ Sample received broken/leaking.
3. ☐ Sample received without proper preservative.
   - ☐ Cooler temperature not within 4°C ± 2°C
     Record temperature:_____
   - ☐ pH_____
   - ☐ other:_____
4. ☐ Sample received in improper container.
5. ☐ Sample received without proper paperwork. Explain:
   _____
6. ☐ Paperwork received without sample.
7. ☐ No sample ID on sample container.
8. ☐ Custody tape disturbed/broken/missing.
9. ☐ Sample splits performed by lab.
10. ☐ Volatile sample received with approximately _____ mm headspace.
11. ☐ Sample ID on container does not match sample ID on paperwork. Explain: _____
    _____
    _____
12. ☐ All coolers on airbill not received with shipment
13. ☐ Other (explain below):
    _____
    _____
    _____

Notes:
_____
_____

Corrective Action:

☐ Client's Name: _____ Informed verbally on: _____ By: _____

☐ Client's Name: _____ Informed in writing on: _____ By: _____

☐ Sample(s) processed "as is". Comments: _____

☐ Sample(s) on hold until: _____ If released, notify: _____

Sample Control Supervisor Review:_____ Date: _____

Project Management Review: _____ Date: _____

SIGNED ORIGINAL MUST BE RETAINED IN THE PROJECT FILE

FIGURE 8.6-1
Data Review Process

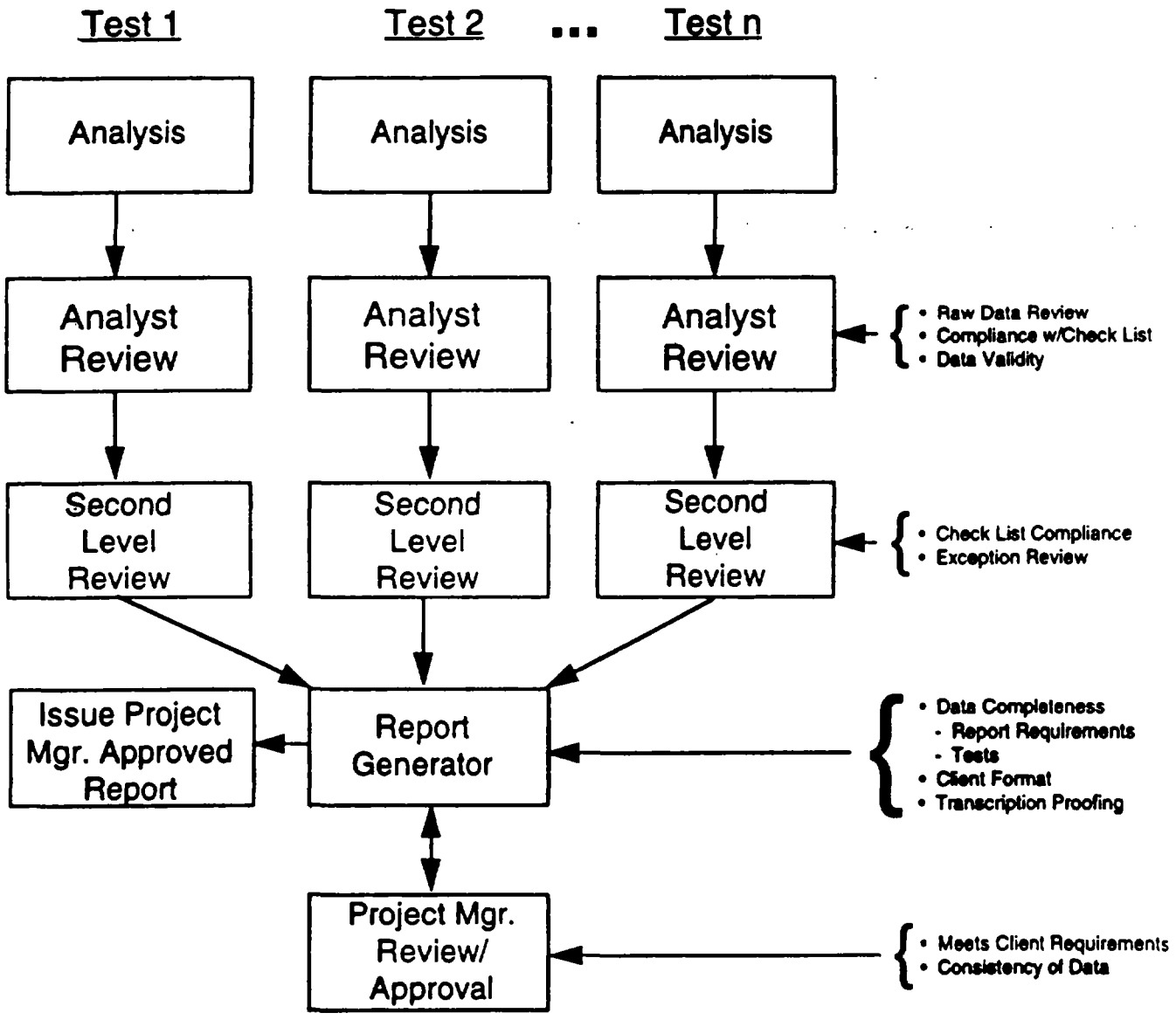

FIGURE 8.6-2
ITAS Data Review Check List
METALS

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Initial Calibration 1. Performed at required frequency with required number of levels?				
2. Correlation coefficient within QC limits?				
3. Initial calibration verification (ICV) analyzed immediately after calibration and results within QC limits?				
4. Initial calibration blank (ICB) analyzed immediately after ICV and concentrations of all parameters ≤ reporting limit?				
B. Continuing Calibration 1. CCV analyzed at required frequency and all parameters within QC limits?				
2. CCB analyzed at required frequency and all results ≤ reporting limit?				
C. Sample Analysis 1. Were any samples with concentrations > the linear range for any parameter diluted and reanalyzed?				
2. Were all sample holding times met?				
D. QC Samples 1. MS or MS/MSD percent recovery within QC limits?				
2. Analytical spikes within QC limits?				
3. LCS recovery within QC limits?				
4. ICP only: One serial dilution performed per SDG?				
5. ICP only: CRDL standard (CRI or CRA) analyzed at required frequency?				
6. ICP only: Interference check samples (ICSA, ICSAB) analyzed at the beginning and end of analytical run or at minimum frequencies and within QC limits?				

FIGURE 8.6-2
ITAS Data Review Check List
METALS

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
E. Other 1. Are all nonconformances included and noted?				
2. Is the correct date and time of analysis shown?				
3. Did the analyst sign and date the front page of the analytical run?				
4. Correct methodology used?				
5. Transcriptions checked?				
6. Calculations checked at minimum frequency?				
7. Units checked?				

Comments on any "No" response:

_____

_____

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_____

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_____

_____

Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-3
ITAS Data Review Check List
GENERAL CHEMISTRY

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Initial Calibration 1. Does the standard curve consist of a Blank (when required) and the required minimum number of calibration standards?				
2. Is the initial calibration correlation coefficient ≥ 0.995?				
B. Continuing Calibration 1. Is the Continuing Calibration Verification (CCV) percent recovery within QC limits?				
C. Sample Analysis 1. Were all sample holding times met?				
D. QC Samples 1. Is the Method Blank concentration less than the reporting limit?				
2. Is the Laboratory Control Sample (LCS) AND/OR the Matrix Spike (MS) % recovery within QC limits?				
3. When MS/MSD analyzed, is RPD within QC limits?				
4. When duplicate sample analysis performed, is RPD within QC limits (± 20 %)?				
E. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Was correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Did the analyst sign and date the front page of the analytical run?				
7. Units checked?				

FIGURE 8.6-3
ITAS Data Review Check List
GENERAL CHEMISTRY

Comments on any "No" response:

_____

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_____

Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-4
ITAS Data Review Check List
AIR ANALYSIS - METHOD TO-14

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Initial Calibration: 1. Was BFB analyzed at beginning of 12-hour period?				
2. Did BFB meet QC limits (all masses met criteria)?				
3. Is the %RSD for all nonpolar analytes <25%? (A maximum of two analytes may be above this but below 40%)				
4. Is the %RSD for all polar analytes <30%? (A maximum of two analytes may be above this but below 45%)				
5. Were a minimum of five calibration points used?				
B. Continuing Calibration 1. Was BFB analyzed at beginning of 12-hour period?				
2. Did BFB meet QC limits (all masses met criteria)?				
3. Was the %D for all CCCs <25% for all nonpolar targets? (A maximum of two are allowed outside this criteria, but must be <40%)				
4. For polar analytes, do all compounds have a %D of 30% or less? (A maximum of two are allowed outside but must be < 45%)				
5. Are all calibration points on the Continuing Calibration present?				
C. Sample Analysis 1. Are internal standard areas within 50-150% of the internal standard areas of the continuing calibration standard analyzed?				
2. Are all sample surrogate values within internal QC limits?				
3. Are all analytes quantitated within the calibrated range of the instrument?				
4. Were a minimum of three RFs checked for each sample to insure the proper RFs are being used for quantitation?				

FIGURE 8.6-4
ITAS Data Review Check List
AIR ANALYSIS - METHOD TO-14

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
D. QC Samples 1. Are all Blank surrogate values within internal QC limits?				
2. Are all analytes in Blanks < the reporting limit?				
3. Are Reference Standard control values within QC limits for air media?				
4. Are all duplicate RPDs within internal QC limits?				
E. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Units checked?				

Comments on any "No" response:

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Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-5
ITAS Data Review Check List
RADIOCHEMISTRY

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Calibration 1. Is the calibration documentation included where applicable?				
B. Sample Analysis 1. Are the Sample Yields within acceptance criteria?				
2. Were all sample holding times met?				
C. QC Samples 1. Is the Blank Yield within acceptance criteria?				
2. Is the Minimum Detectable Activity for the Blank result ≤ the Contract Detection Limit?				
3. Is the Blank result ≤ the Contract Detection Limit?				
4. Is the Blank result greater than the Contract Detection Limit but the Sample result less than the Contract Detection Limit?				
5. Is the LCS result within acceptance criteria?				
6. Is the LCS yield within acceptance criteria?				
7. Is the LCS Minimum Detectable Activity less than or equal to the Contract Detection Limit ?				
8. MS/MSD results and yield meet acceptance criteria?				
9. Duplicate sample results and yield meet acceptance criteria?				
D. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Units checked?				

FIGURE 8.6-5
ITAS Data Review Check List
RADIOCHEMISTRY

Comments on any "No" response:

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Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-6
ITAS Data Review Check List
GC/MS

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Tuning 1. BFB/DFTPP tuning criteria met?				
2. Mass list, RIC, and the mass spectrum included?				
3. Correct BFB/DFTPP included with analytical runs?				
B. Initial Calibration 1. RRF and %RSD within acceptance criteria?				
2. Runs checked for saturation?				
3. CLP only: Are surrogates and internal standards labeled on the chromatograms?				
C. Continuing Calibration 1. RRF and % Difference within acceptance criteria?				
D. Sample Analysis After tune, initial calibration, continuing calibration, and method blank criteria have been met: 1. Sample name and other header information correct?				
2. RRT of identified compounds within ±0.06 RRT units of RRT of standard component?				
3. Ions present in the standard spectra with abundance of >10% of the base ion present in sample spectra?				
4. Surrogate recoveries within limits?				
5. Quantified against the appropriate standard?				
6. Run(s) within linear range?				
7. Were all sample holding times met?				
8. TCL match?				

FIGURE 8.6-6
ITAS Data Review Check List
GC/MS

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
E. QC Samples 1. All Method Blank results ND or hits below reporting limit?				
2. Method Blank analyzed at required frequencies?				
3. Are MS/MSD % recoveries and RPD within QC limits?				
4. Are LCS % recoveries within QC limits?				
5. Second source check standard successfully analyzed?				
F. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Were all manual integrations checked by a second reviewer?				
7. Units checked?				

Comments on any "No" response:

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Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-7
ITAS Data Review Check List
GC

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Initial Calibration 1. Was the maximum %RSD within QC limits?				
2. Were calibration factors updated or were curves drawn for 600 series methods or 8000 series methods?				
3. Are retention time windows established and updated in method?				
4. Did the standards pass the resolution check criteria?				
5. Was the percent breakdown within QC limits?				
B. Continuing Calibration 1. Was the maximum %D within QC limits?				
2. Are compounds within retention time windows?				
3. Was the percent breakdown within QC limits?				
C. Sample Analysis After initial calibration, continuing calibration, and method blank criteria have been met: 1. Are sample name and other header information correct?				
2. Do surrogate % recoveries meet QC criteria?				
3. Were the runs checked for saturation?				
4. Are all hits confirmed if required?				
5. Are all compounds within linear range of calibration curve?				
6. Were all sample holding times met?				
7. Do reported results take into account dilutions, sample weights, and percent moistures?				
D. QC Samples 1. Are all Method Blank hits below the reporting limit?				
2. Are LCS spike % recoveries within QC limits?				
3. Are batch MS/MSD spike % recoveries within QC limits?				

FIGURE 8.6-7
ITAS Data Review Check List
GC

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
D. QC Samples (continued) 4. Are MS/MSD and/or Duplicates (duplicate sample analyses) RPD within QC limits?				
5. Was second source check standard analyzed successfully?				
E. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Were all manual integrations checked by a second reviewer?				
7. Units checked?				

Comments on any "No" response:

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Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-8
ITAS Data Review Check List
HPLC

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Initial Calibration 1. Was the maximum %RSD within QC limits or was the correlation coefficient of the curve ≥ 0.995?				
2. Was each run checked for saturation?				
3. Was each run checked for coeluting compounds?				
B. Continuing Calibration 1. Was the maximum %D within QC limits?				
2. Was the run checked for saturation?				
3. Was each run checked for coeluting compounds?				
C. Method Blanks 1. Are all hits below the PQL?				
2. Was a Method Blank analyzed for each set of samples extracted by the same method on the same day?				
3. Do surrogate % recoveries meet QC criteria?				
4. Are peaks quantified against the appropriate standard?				
5. Was the run(s) checked for saturation?				
D. Sample Analysis After initial calibration, continuing calibration, and method blank criteria have been met: 1. Are sample name and other header information correct?				
2. Do surrogate % recoveries meet QC criteria?				
3. Were the runs checked for saturation?				
4. Are all hits confirmed?				
5. Were all sample holding times met?				

FIGURE 8.6-8
ITAS Data Review Check List
HPLC

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
E. QC Samples 1. Are matrix spike/matrix spike duplicate (MS/MSD) spike % recoveries within QC limits?				
2. Are Laboratory Control Sample (LCS) spike % recoveries within QC limits?				
3. Are MS/MSD and/or Duplicates (duplicate sample analyses) RPD within QC limits?				
F. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Were all manual integrations checked by a second reviewer?				
7. Units checked?				

Comments on any "No" response:

_____

_____

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_____

Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-9
ITAS Data Review Check List
DIOXINS/DIBENZOFURANS

Work Order Number(s):
Lab Sample Numbers or SDG:
Method/Test/Parameter:

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
A. Initial Calibration 1. Percent RSD within QC limits?				
2. Windowing solution analyzed and retention time windows determined?				
3. Were all signal/noise ratios met?				
4. Were all ion isotopic ratios within specifications?				
5. Was the 2,3,7,8-TCDD resolution met?				
B. Continuing Calibration 1. Continuing calibration standard results within QC limits?				
2. Were all signal/noise ratios met?				
3. Were all ion isotopic ratios within specifications?				
4. Was the window defining solution analyzed at the appropriate frequency?				
5. Were the proper types of continuing calibration check solutions run at the appropriate frequency?				
6. Was the 2,3,7,8-TCDD resolution met?				
C. Sample Analysis 1. Were sample holding times met?				
2. All analyte hits and NDs within set retention time windows?				
3. Are internal standard recoveries within QC limits?				
4. Was a minimum of 20% of the raw data recalculated?				
5. Were signal/noise ratios met for positive results?				
6. Were ion isotopic ratios met for positive results?				

FIGURE 8.6-9
ITAS Data Review Check List
DIOXINS/DIBENZOFURANS

Review Item	Yes (✓)	No (✓)	N/A (✓)	2nd Level Review (✓)
D. QC Sample Analysis 1. All Method Blank results "None Detected"?				
2. Native spike recoveries of batch MS/MSD within QC limits?				
3. Native spike recoveries of batch LCS (or Blank Spike) within QC limits?				
4. Are internal standard recoveries within QC limits?				
5. Is the RPD of batch MS/MSD within QC limits?				
E. Other 1. Are all nonconformances included and noted?				
2. Are all required forms filled out?				
3. Correct methodology used?				
4. Transcriptions checked?				
5. Were all calculations checked at minimum frequency?				
6. Were all manual integrations checked by a second reviewer?				
7. Was % moisture and/or % lipids performed?				
8. Were sample results corrected for % moisture if requested by a client?				
9. Units checked?				

Comments on any "No" response:

_____

_____

_____

_____

_____

Analyst: _____ Date: _____

Second-Level Review: _____ Date: _____

FIGURE 8.6-10
Example Certificate of Analysis
Page 1 of 2

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

Client Name Date
Client Company
Client Address

Work Order No

This is a Certificate of Analysis for the following samples
Client Project ID
Date Samples Received
Number of Samples

I. Introduction

This section describes general project information It also includes the date the samples were received and provides a listing of the sample numbers (Both client and laboratory numbers)

Reviewed and Approved

Project Manager

American Council of Independent Laboratories
International Association of Environmental Testing Laboratories
American Association for Laboratory Accreditation

FIGURE 8.6-10
Example Certificate of Analysis
Page 2 of 2

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
(615) 690-3211

Client Project ID ITAS Project No :

II. Analytical Data

This section describes the sample preparation and analytical methodologies used to extract and analyze the samples It also describes how the sample results are reported Additionally, any project anomalies, nonconformances, variance, or any other type of unusual occurrences that were noted by the laboratory are documented here

III. Quality Assurance/Quality Control

This section describes what type or level of QA/QC was followed QA/QC requirements may be internal or client-specific Any QA/QC data that exceeded the acceptance criteria will be noted here. Comments may also be included regarding how the QC sample results may have affected the data.

(The sample results follow on additional pages in tabular form)

FIGURE 9.3-1
ITAS Nonconformance Memo
PAGE 1 of 2

LOG #. __-93-_____ page 1 of 2

ITAS-_____ Laboratory
LABORATORY NONCONFORMANCE MEMO (NCM)

PROJECT ID (Name/Number): _____
NCM INITIATED BY (Name/Date) _____
PARAMETER(S) _____
SAMPLE NUMBER(S) AFFECTED _____

AREA
- ☐ SHIP/REC ☐ GC ☐ GEN CHEM ☐ BIOASSAY ☐ IH
- ☐ ORG EXT ☐ HPLC ☐ METALS ☐ RADIOCHEM ☐ DATA VERIF
- ☐ INORG PREP ☐ GCMS ☐ GEO ☐ COUNTING ☐ REPORTING
- ☐ OTHER ☐ _____ ☐ _____ ☐ _____ ☐ _____

NONCONFORMANCE (check appropriate item(s)):

1 ☐ Not enough sample received for proper analysis

2 ☐ Holding time exceeded by _____ days due to

2.1 ☐ CATEGORY I Out of Laboratory Control
- ☐ Holding time expired at receipt

2.2 ☐ CATEGORY II Laboratory Dependent
- ☐ work backlog ☐ instrument failure
- ☐ communication ☐ other (see #10)

2.3 ☐ CATEGORY III Laboratory Reruns

2.3.1 ☐ *QA/QC*
- ☐ surrogates ☐ internal standards
- ☐ spike recoveries ☐ blank contamination

2.3.2 ☐ *CONFIRMATION*
- ☐ second column ☐ contamination check
- ☐ other (see #10)

2.3.3 ☐ *DILUTION*
- ☐ over calibration ☐ under calibration
- ☐ other (see #10)

2.3.4 ☐ *OTHER (see #10)*

3 ☐ Sample lost during extraction/analysis, no re-prep or re-analysis possible

4 ☐ QC data reported to client outside of:
- ☐ method limits ☐ internal limits
- ☐ QAPP limits ☐ contract limits
- ☐ regulatory limits ☐ blank criteria

5 ☐ Incorrect procedure(s) used (See #10)

6 ☐ Invalid instrument calibration (See #10)

7 ☐ Incorrect/incomplete data reported to client (See #10)

8 ☐ Reported detection limit(s) higher than
- ☐ method limits ☐ QAPP limits
- ☐ contract limits ☐ other (see #10)

Due to:
- ☐ sample matrix ☐ insufficient sample
- ☐ instrumentation ☐ other (see #10)

9 ☐ Other (specify): _____

10 ☐ Comments/Explanation _____

NOTIFICATION (check appropriate item(s)):

1 ☐ Client notified by (name and date) _____
- ☐ in writing ☐ by FAX
- ☐ by phone ☐ Other (explain)

2 ☐ Client's name _____ and response
- ☐ process "as is" ☐ resample
- ☐ on hold till ____ ☐ Other (explain)

PROJECT MANAGER (signature & date) _____

FURTHER ACTION REQUIRED. SEE PAGE 2 OF 2

FIGURE 9.3-1
ITAS Nonconformance Memo
Page 2 of 2

INTERNATIONAL TECHNOLOGY CORPORATION LOG #: __-93-_____ page 2 of 2

CORRECTIVE ACTION

☐ ROOT CAUSE: INITIALS/DATE _____

☐ CORRECTIVE ACTION INITIALS/DATE _____

☐ RESPONSIBILITY FOR PERFORMING CORRECTIVE ACTION ASSIGNED TO: _____

☐ ACTIONS TO PREVENT RECURRENCE INITIALS/DATE _____

FIRST LEVEL SUPERVISOR _____ DATE _____

RESPONSIBLE MANAGER _____ DATE _____

QC REVIEW

☐ NONCONFORMANCE ☐ DEFICIENCY

☐ FURTHER ACTION REQUIRED _____

ASSIGNED TO _____

QC COORDINATOR _____ DATE _____

CORRECTIVE ACTION VERIFICATION

☐ VERIFIED ☐ CANNOT VERIFY (specify reason)

REASON _____

NCM CLOSURE

QC COORDINATOR _____ DATE _____

SIGNED ORIGINAL MUST BE RETAINED IN FILE ☐ QUALITY/OPERATIONS FILE ☐ PROJECT FILE

FIGURE 9.3-2
Example Nonconformance Log

N C M #	DATE INITIATED	PROJECT ID/ WORK ORDER NUMBER	LAB AREA	NO. OF SAMPLES AFFECTED	NC CATEGORY	CORRECTIVE ACTION TARGET DATE	CORRECTIVE ACTION COMPLETION DATE	N OR D *	CORRECTIVE ACTION VERIFICATION DATE/INITIALS
XX- 93- 0001									
XX- 93- 0002									
XX- 93- 0003									
XX- 93- 0004									
XX- 93- 0005									
XX- 93- 0006									
XX- 93- 0007									
XX- 93- 0008									
XX- 93- 0009									
XX- 93- 0010									
XX- 93- 0011									
XX- 93- 0012									
XX- 93- 0013									
XX- 93- 0014									
XX- 93- 0015									
XX- 93- 0016									
XX- 93- 0017									
XX- 93- 0018									
XX- 93- 0019									
XX- 93- 0020									

*N = nonconformance; D = deficiency (NOTE: column 10 need not be completed for a deficiency)

FIGURE 9.4-1
ITAS Client Satisfaction Survey Form
(Page 1 of 2)

IT QUALITY / CLIENT SATISFACTION SURVEY

CLIENT INFORMATION:	PROJECT INFORMATION:
Client Company _____	IT Project Number _____
Client Contact _____ Title _____	
Address _____	Project Name _____
_____	Project Size ($000) _____
_____	
Phone _____	Work Description _____
IT INFORMATION: Date of Survey _____	_____
IT ANALYTICAL SERVICES DIVISION	_____
IT Center Performing Service _____	Project Manager _____
IT Host Center Name / Number _____	_____
IT Host Center Location _____	

INTRODUCTION

IT is committed to maintaining and continually improving the quality of the services and products we offer. We define quality as meeting client requirements Therefore, the best measure of our performance is our clients' level of satisfaction

We would like to ask you to help us by answering a few short questions that rate our performance on a scale of 1 to 5.
A rating of "1" indicates totally unsatisfactory performance, a "3" is acceptable, and a "5" means outstanding.

	Rating (1-5)	Weight	Score
1. On this scale of 1 to 5, how well does IT meet your requirements overall?		2.00	
2. How would you rate the timeliness of our work?		2.00	
3. How well have we met your requirements in adhering to and completing the required scope of work?		2.00	
4 How well did we do in meeting your schedule requirements?		2.00	
5. How do you rate the responsiveness of our staff?		2.00	
6 How do you rate the professional competence of our staff?		2.00	
7. What is your assessment of how well we have communicated with you during the course of our work?		2.00	

FIGURE 9.4-1
ITAS Client Satisfaction Survey Form
(Page 2 of 2)

IT QUALITY / CLIENT SATISFACTION SURVEY (p.2)

	Rating (1-5)	Weight	Score
8. How well does IT's management of our services meet your requirements?		2.00	
9. How well do our status and progress reports meet your requirements?		2.00	
10. How well do our invoices and billing procedures meet your requirements?		2.00	
11. How do you rate the consistency of our performance?		2.00	
12. How would you score the completeness of our services?		2.00	
13. How do you rate the overall value of the services and products provided to you by IT?		2.00	
TOTAL SCORE:			
AVERAGE SCORE:			
PERCENTAGE: Total Possible	130		

CLOSING

Thank you very much for your time. We appreciate your willingness to help us. Any concerns you may have raised will be addressed promptly by the IT Project Manager for your project.

There is one final question. What changes would you recommend that IT make to improve its service to you?

Again, Thank you. Survey Conducted by: _____

FOLLOWUP ACTION:	Distribution:
What and How	Project Manager _____
	Lab/FAS Director _____
	Div. Dir./VP _____
	VP QHS _____
	Div. Dir QA/QC _____
	Regional Director _____
Who: Date	Other _____
Reviewer _____	_____
Signature Date	_____

FIGURE 9.5-1
Example Outline Of QA/QCC Monthly Report to Management

I. Audits
   - A. Internal Surveillances
   - B. External Audits
   - C. Subcontractor Audits

II. Certifications
   - A. Pending
   - B. Received

III. Performance Evaluation Samples
   - A. In-House
   - B. Pending
   - C. Received (score)

IV. Holding Time Violations (HTV)
   - A. Total Holding Time Violations
   - B. Category I - Out of Laboratory Control
   - C. Category II - Laboratory Dependent
   - D. Category III - Laboratory Reruns

V. QAPjPs
   - A. Reviewed
   - B. Received

VI. Training
   - A. In-House
   - B. External

VII. Nonconformance Summary and Resolutions

VIII. QC Data/Control Chart Summary

IX. Standard Operating Procedures

X. Client Satisfaction Surveys

XI. Miscellaneous

TABLE 2.1-1
ITAS QUALITY ASSURANCE MANAGEMENT PLAN REQUIREMENTS MATRIX

ITAS QAMP (Rev.2) & OS QAMP (Rev.0)	ITAS QAM (REV 1)	ANSI/ASQC E4-19xx	QAMS 005/80	NQA-1	5700.6C	ANSI N13.30	ANSI/ASQC Q91-1987 (ISO-9001)
1 Management Commitment and Organization	2 Laboratory Organization	A1 Management Commitment and Organization	5.04 Project Organization and Responsibility	1 Organization	N/A	1.1 Introduction 1.2 Purpose 1.3 Scope	4.1 Management Responsibility
2 Quality Assurance Program Description	1 Introduction 3 Standard Laboratory Practice	A2 Quality Assurance Program Description	5.03 Project Description	2 Quality Assurance Program	1 Program	2.1 Special Word Usage 2.2 Specific Terms 5.1 Quality Assurance 5.2 Quality Control	4.2 Quality System
3 Associate Training and Qualification	16 Training	A3 Personnel Training and Qualification	N/A	2 Quality Assurance Program	2 Personnel Training and Qualification	3.2 Personnel Preparation	4.18 Training
4 Procurement of Items and Services	4 Material Procurement and Control	A5 Procurement of Items and Services	N/A	4 Procurement Document Control 7 Control of Purchased Items and Services	7 Procurement	N/A	4.6 Purchasing

TABLE 2.1-1
ITAS QUALITY ASSURANCE MANAGEMENT PLAN REQUIREMENTS MATRIX

ITAS QAMP (Rev.2) & OS QAMP (Rev.0)	ITAS QAM (REV 1)	ANSI/ASQC E4-19xx	QAMS 005/80	NQA-1	5700.6C	ANSI N13.30	ANSI/ASQC Q91-1987 (ISO-9001)
5 Document Control and Records	1 Introduction 12 Records Management	A6 Document Control and Records	5.01 Title Page 5.02 Table of Contents	6 Document Control 17 Quality Assurance Records	4 Documents and Records	3.6 Direct Bioassay-Record Retention 4.5 Indirect Bioassay-Record Retention	4.5 Document Control 4.16 Quality Records
6 Use of Computer Hardware and Software	10 Data Verification	A7 Use of Computer Hardware and Software	N/A	3 Design Control 11 Test Control	N/A	N/A	ISO 9000-3*
7 Work Processes and Operations	9 Analytical Procedures 14 QA/QC Audits	A8 Work Processes and Operations B1 Planning and Scoping B2 Design of Data Collection Operations	N/A	1 Organization 5 Instructions, Procedures, and Drawings 10 Inspection 14 Inspection, Test and Operating Status	5 Work Processes 6 Design 8 Inspection and Acceptance Testing	3.1 Facility Criteria	4.9 Process Control

TABLE 2.1-1
ITAS QUALITY ASSURANCE MANAGEMENT PLAN REQUIREMENTS MATRIX

ITAS QAMP (Rev.2) & OS QAMP (Rev.0)	ITAS QAM (REV 1)	ANSI/ASQC E4-19xx	QAMS 005/80	NQA-1	5700.6C	ANSI N13.30	ANSI/ASQC Q91-1987 (ISO-9001)
8 Data Collection and Production Operations	5 Sample Receipt and Initiation of Testing	B1 Planning and Scoping	5.05 QA Objectives for Measurement Data	2 Quality Assurance Program	1 Program	3.1 Facility Criteria	4.8 Product Identification and Traceability
	6 Calibration Practices	B2 Design of Data Collection Operations	5.06 Sampling Procedures	3 Design Control	6 Design	3.4 Direct Bioassay-Performance Criteria for Service Laboratories	4.11 Inspection, Measuring, and Test Equipment
	7 Preventive Maintenance	B3 Implementation of Planned Operations	5.07 Sample Custody	5 Instructions, Procedures, and Drawings	8 Inspection and Acceptance Testing	3.5 Direct Bioassay-Reporting Results	
	8 Analysis of Quality Control Samples		5.08 Calibration Procedures and Frequency	8 Identification and Control of Items		4.1 Indirect Bioassay-Responsibilities of the Service Laboratory Customer	
	9 Analytical Procedures		5.09 Analytical Procedures	9 Control of Processes		4.2 Indirect Bioassay-Analytical Methodology	
	10 Data Verification		5.11 Internal Quality Control Checks	11 Test Control		4.3 Indirect Bioassay-Performance Criteria for Service Laboratories	
			5.13 Preventive Maintenance	12 Control of Measuring and Test Equipment		5.2 Quality Control	
				13 Handling, Storage, and Shipping			

TABLE 2.1-1
ITAS QUALITY ASSURANCE MANAGEMENT PLAN REQUIREMENTS MATRIX

ITAS QAMP (Rev.2) & OS QAMP (Rev.0)	ITAS QAM (REV 1)	ANSI/ASQC E4-19xx	QAMS 005/80	NQA-1	5700.6C	ANSI N13.30	ANSI/ASQC Q91-1987 (ISO-9001)
9 Quality Assessment and Response	13 Nonconformance and Corrective Action	A4 Management Assessment	5.10 Data Reduction, Validation, and Reporting	2 Quality Assurance Program	3 Quality Improvement	3.3 Direct Bioassay-Interpretation of Measurements	4.10 Inspection and Testing
	14 Quality Assurance/Quality Control Audits	A9 Quality Improvement	5.12 Performance and System Audits	13 Handling, Storage, and Shipping	9 Management Assessment	3.5 Direct Bioassay-Reporting Results	4.13 Control of Nonconforming Products
	15 Quality Reports to Management	B4 Assessment of Data Usability	5.14 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness	15 Control of Nonconforming Items	10 Independent Assessment	4.4 Indirect Bioassay Reporting Results	4.14 Corrective Action
		B5 Quality Assessment and Response	5.15 Corrective Action	16 Corrective Action		6.1 Direct Bioassay Measurements	4.17 Internal Quality Audits
			5.16 Quality Assurance Reports to Management	18 Audits		6.2 Indirect Bioassay Measurements	4.20 Statistical Techniques

*Quality Management and Quality Assurance Standards, ISO 9000, Part 3, "Guidelines for the application of ISO 9001 to the development, supply and maintenance of software".

TABLE 2.3-1
ITAS Quality Assurance Documents

Document	Purpose	Required Approval
ITAS Quality Assurance Management Plan (QAMP)	• Provides ITAS Quality Assurance Policy • Is applicable to and provides direction for all ITAS laboratories • Covers administrative and technical aspects of QA/QC • Has precedence over all other ITAS quality related documents	• Chief Executive Officer (CEO), IT Corporation • Vice President, Quality and Health Services, IT Corporation • Vice President, IT Analytical Services • Division Director, Quality Assurance/Quality Control
Operation-Specific Quality Assurance Management Plan (OS QAMP)	• Describes the local implementation of the policies in the ITAS Quality Assurance Management Plan • Meets or exceeds all requirements of the ITAS QAMP • Describes services and quality requirements common to ITAS operations	• Vice President, Analytical Services, IT Corporation • Division Director, Quality Assurance/Quality Control • Vice President, Quality and Health Services • Division Operations Director • Operating Unit Director
OS QAMP Operation-Specific Appendices	• Describes services and quality requirements unique to each ITAS operation	• Laboratory QA/QCC • Technical Specialist • Operating Unit Director • Division Director, QA/QC • Division Technical Director
Manuals of Practice (MOP)	• Provides in-depth technical discussions of a specific topic • May be a collection of standard operating procedures (SOPs).	• Vice President, IT Analytical Services • Division Director, Quality Assurance/Quality Control

TABLE 2.3-1
ITAS Quality Assurance Documents
(Continued)

Document	Purpose	Required Approval
Division Standard Operating Procedures (SOP) (formerly ITAS Systems Procedures)	• Common to all ITAS operations and standard across the network • Provides detailed instructions describing how to perform a specific operation or task • Defines responsibilities as related to the operation or task • Defines quality requirements as related to the operation or task.	• ITAS Technical Specialist • Division Director, Quality Assurance/Quality Control • Division Director, Health and Safety • ITAS Standardization Committee Member
Laboratory-Specific Standard Operating Procedures (SOP)	• Provides detailed instructions describing how to perform a specific operation or task • Defines responsibilities as related to the operation or task • Defines quality requirements as related to the operation or task.	• Division Director, Quality Assurance/Quality Control • Division Director, Health and Safety • Operating Unit Director • Laboratory Technical Director • Laboratory QA/QCC
Project Specific Manuals, Quality Assurance Project Plans (QAPjPs), or Quality Assurance Program Plans (QAPPs)[1]	• Defines project requirements • Defines the organizational structure for a project and lines of communication between the parties • Defines contractual requirements as pertains to sample analysis • Defines regulatory requirements • Takes precedence over conventional ITAS QA practices for the project	• Operating Unit Director • Laboratory QA/QCC • Laboratory Technical Director • Laboratory Health and Safety Coordinator • Project Manager • Client Representative

TABLE 2.3-1
ITAS Quality Assurance Documents
(Continued)

Document	Purpose	Required Approval
Quality Assurance Summary (QAS) (Operation-specific document)	• Defines specific QA/QC requirements • Defines reporting requirements • Defines any client-specific requirement that varies from normal operation	• Approval varies within the operations

(1) Listed approvals required apply only to these documents when generated by ITAS.

TABLE 8.2-1
Inorganic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Acidity	Water	250 ml plastic or glass, Cool, 4°C, 14 days	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Alkalinity	Water	250 ml plastic or glass, Cool, 4°C, 14 days	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Ammonia	Water	500 ml plastic or glass, Cool, 4°C H_2SO_4 to pH < 2, 28 days	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Biochemical Oxygen Demand (BOD)	Water	1000 ml plastic or glass, Cool, 4°C 48 hours	Not Applicable	Not Applicable	200 ml, no preservative required, 48 hours
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Residual Chlorine	Water	250 ml plastic or glass, No preservative required, analyze immediately	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not applicable
Chromium (Cr^{+6})	Water	200 ml plastic or glass, Cool, 4°C, 24 hours	250 ml plastic or glass, Cool, 4°C, 24 hours	Not Applicable	Not Applicable
	Liquid	200 ml plastic or glass, Cool, 4°C, 24 hours	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Color	Water	250 ml plastic or glass, Cool, 4°C, 48 hours	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Conductivity	Water	250 ml plastic or glass, Cool, 4°C, 28 days	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Conductivity (continued)	Domestic Waste, Industrial Waste, Sludge, Solid, Sedument	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Amenable)	Water	1 liter plastic or glass, NaOH to pH > 12 0.6g ascorbic acid[6] Cool, 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours	1 liter plastic or glass NaOH to pH > 12 0.6g ascorbic acid[6] Cool, 4°C, 14 days	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	1 liter HDPE[5] NaOH to pH > 12 0.6g ascorbic acid[6] Cool, 4°C
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Free)	Water	Not Applicable	Not Applicable	Not Applicable	1 liter HDPE[5], NaOH to pH > 12 0.6g ascorbic acid[6] Cool, 4°C, 14 days
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	8 oz or 16 oz glass teflon lined lid, Cool, 4°C, 14 days

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Cyanide (Total)	Water	1 liter plastic or glass, NaOH to pH > 12, 0.6g ascorbic acid[10] Cool, 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours	1 liter plastic or glass, NaOH to pH > 12 0.6g ascorbic acid[10] Cool,4°C, 14 days	1 liter HDPE[5], NaOH to pH > 12 Cool, 4°C, 12 days	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	TCLP Leachate: 14 days Analysis: 14 days from end of TCLP leaching not to exceed 28 days total	Not Applicable	1 liter HDPE[5] NaOH to pH > 12 0.6g ascorbic acid[10] Cool, 4°C
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	8 or 16 oz glass teflon-lined lids, Cool, 4°C, 14 days	8 or 16 oz glass teflon-lined lids, Cool, 4°C, 12 days	Not Applicable
Flashpoint (Ignitability)	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	No requirements: 250 ml amber glass, Cool, 4°C is recommended	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Fluoride	Water	500 ml plastic, No preservation required, 28 days	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Oil and Grease (continued)	Soil	Not Applicable	8 oz amber glass with teflon-lined lid, Cool, 4°C, 28 days	Not Applicable	Not Applicable
Ortho-phosphorous	Water	100 ml plastic or glass, Filter on site Cool 4°C, 48 hours	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
pH	Water	100 ml plastic or glass Analyze immediately. This test should be performed in the field	100 ml plastic or glass, Analyze immediately. This test should be performed in the field	Method CLP, Analyze as close to extraction as possible	Not Applicable
	Liquid	Not Applicable	100 ml glass, Cool, 4°C, Analyze immediately. This test should be performed in the field	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	This test is performed in the laboratory	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	4 oz. glass or plastic, Cool, 4°C, Analyze as soon as possible.	Not Applicable	Not Applicable
Phenolics	Water	500 ml glass, Cool, 4°C H_2SO_4 to pH < 2, 28 days	1 liter glass recommended, Cool, 4°C H_2SO_4 to pH < 2, 28 days	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Phenolics (continued)	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phosphorus (Total)	Water	100 ml plastic or glass, Cool, 4°C H_2SO_4 to pH < 2, 28 days	Not Applicable	Not Applicable	100 ml HDPE[5], Cool, 4°C H_2SO_4 to pH < 2, 28 days
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Reactivity (Cyanide and Sulfide)	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	10 oz glass amber, Cool, 4°C, no headspace, analyze as soon as possible	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Settleable Solids	Water	1000 ml plastic or glass, Cool, 4°C, 48 hours	Not Applicable	Not Applicable	1 liter HDPE[5], Cool, 4°C, 24 hours
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Silica, Dissolved	Water	Plastic only, 100 mL, Cool, 4°C, 28 days	Not Applicable	Not Applicable	Plastic only, 100 mL, Cool, 4°C, 28 days
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
ICAP, GFAA, and Flame AA (excludes mercury)	Water	1 liter glass or polyethylene container, HNO_3 to pH ≤ 2, 6 months	1 liter glass or polyethylene container, pH ≤ 2 with HNO_3, 6 months	1 liter glass or polyethylene, Cool, 4°C, pH ≤ 2 with HNO_3, 180 days	Not Applicable
	Liquid	Not Applicable	No preservative required, 6 months	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	1 liter plastic or glass (glass only if organics are to be tested from the same bottle), HNO_3 to pH < 2, TCLP Leaching: 180 days from field collection to TCLP extraction. Analysis: 180 days from extraction to analysis (total elapsed time = 360 days)	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	1 liter glass or polyethylene container, 6 months	8 or 16 oz glass or polyethylene container Cool, 4°C, 6 months	Not Applicable	Not Applicable
	Soil	Not Applicable	8 or 16 oz glass or polyethylene container, Cool, 4°C, 6 months	8 or 16 oz glass or polyethylene container, Cool, 4°C, 180 days	Not Applicable
	Air	Not Applicable	Not Applicable	Not Applicable	Hi-Vols - store in humidity controlled environment, no holding time requirement IH - no holding time requirement
Mercury (CVAA)	Water	1 liter glass or polyethylene container, Cool, 4°C, HNO_3 to pH ≤ 2, 28 days	1 liter glass or polyethylene container, HNO_3 to pH ≤ 2, 13 days plastic, 38 days glass	1 liter glass or polyethylene container, Cool, 4°C, HNO_3 to pH ≤ 2, 26 days	Not Applicable
	Liquid	Not Applicable	No preservative required, 28 days	Not Applicable	Not Applicable

Table 8.2-1
Inorganic Sample Containers, Preservations, and Holding Times (continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2], [7]	CLP[3],[4]	Other
Mercury (CVAA) (continued)	TCLP Leachate	Not Applicable	1 liter HDPE[5], HNO_3 to pH < 2, TCLP Leaching: 28 days from field collection to TCLP extraction. Analysis: 28 days from extraction to analysis (total elapsed time = 56 days	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days	1 liter glass or polyethylene container, Cool, 4°C, 26 days	Not Applicable
	Soil	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days	1 liter glass or polyethylene container, Cool, 4°C, 26 days	Not Applicable
	Air	Not Applicable	Not Applicable	Not Applicable	Hi-Vols - store in humidity controlled environment, no holding time requirement IH - no holding time requirement

(1) National Pollutant Discharge Elimination System
(2) Resource Conservation and Recovery Act (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd edition, Final Update I, July 1992
(3) Contract Laboratory Program
(4) Holding times are calculated from verified time of sample receipt
(5) High density Polyethylene
(6) Should be used only in the presence of chlorine
(7) Holding times are calculated from date of collection

TABLE 8.2-2
Organic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[a,b]	CLP 88 & 90[a,b]	Other
Aromatic Volatiles	Water[1b]	40 ml glass VOA vial (in duplicate) with teflon-lined septa without headspace, Cool 4°C, Add sodium thiosulfate if residual chlorine, 7 days with pH > 2 14 days with pH ≤ 2	40 ml glass VOA vial (in duplicate) with teflon-lined septa without headspace, Cool 4°C, Add sodium thiosulfate if residual chlorine, HCl or H_2SO_4 or solid $NaHSO_4$ to pH ≤ 2, 14 days with pH ≤ 2	Not Applicable	40 ml glass VOA vial with teflon-lined septa in duplicate without headspace, Cool 4°C, HCl to pH ≤ 2.
	Liquid	Not Applicable	40 ml glass VOA with teflon-lined lid, Cool 4°C, 14 days	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	4 or 8 oz glass with teflon-lined lid, Cool, 4°C, TCLP Leachate: 14 days, Analysis: 14 days from end of TCLP leaching (not to exceed 28 days total)	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	4 or 8 oz glass with teflon-lined lid, Cool 4°C, 14 days	Not Applicable	Not Applicable
	Soil	Not Applicable	4 or 8 oz glass with teflon-lined lid, Cool, 4°C, 14 days	Not Applicable	Not Applicable
	Air	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Dioxins/ Dibenzofurans	Water[1b]	1 liter glass amber with teflon-lined lid, Cool, 4°C, Extract, 7 days Analysis, 40 days	1 liter glass amber with teflon-lined lid, Cool, 4°C, Extract, 30 days Analysis, 45 days from date of collection	Not Applicable	Not Applicable
	Liquid	Not Applicable	100 ml glass amber with teflon-lined lid, Cool, 4°C, Extract, 30 days Analysis 45 days from date of collection	Not Applicable	Not Applicable

Table 8.2-2
Organic Sample Containers, Preservatives, and Holding Times (continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2,3]	CLP 88 & 90[4,5]	Other
Nitroaromatics (continued)	Soil	Not Applicable	4 or 8 oz glass amber widemouth with teflon-lined lid Room temperature or cooler	Not Applicable	8 or 16 oz glass amber wide mouth with teflon-lined lid. Cool, 4°C. Extract, 14 days Analysis, 40 days
	Air	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Non-Methane Organic Compounds (NMOC)	Water[1]	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Air	Not Applicable	Not Applicable	Not Applicable	Summa Cannister, No preservation or holding time required
PAH	Water[1]	1 liter glass amber with teflon-lined lid. Adjust pH to 5-9 if extraction not to be done within 72 hours of sampling. Add sodium thiosulfate if residual chlorine present. Cool, 4°C. Extract, 7 days Analysis, 40 days after extraction	1 liter glass amber with teflon-lined lid. If residual chlorine present, add sodium thiosulfate. Cool, 4°C. Extract, 7 days Analysis, 40 days after extraction	Not Applicable	Not Applicable
	Liquid	Not Applicable	100 ml glass amber with teflon-lined lid. No preservative required. Extract, 14 days Analysis, 40 days after extraction	Not Applicable	Not Applicable

Table 8.2-2
Organic Sample Containers, Preservatives, and Holding Times
(continued)

Analytical Parameters	Matrix	Methods			
		NPDES[1]	RCRA (SW846)[2,3]	CLP 88 & 90[4,5]	Other
PAH (continued)	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	4 or 8 oz widemouth glass with teflon-lined lid. Cool, 4°C. TCLP Leaching: 14 days from field collection to TCLP extraction. Extract 7 days from the end of TCLP leaching (not to exceed 14 days total). Analysis, 40 days after extraction
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	4 or 8 oz glass widemouth with teflon-lined lid. Cool, 4°C. Extract, 14 days Analysis, 40 days after extraction	Not Applicable	Not Applicable
	Soil	Not Applicable	4 or 8 oz glass widemouth with teflon-lined lid. Cool, 4°C. Extract, 14 days Analysis, 40 days after extraction	Not Applicable	Not Applicable
	Air	Not Applicable	Not Applicable	Not Applicable	PUF/XAD-2. Cool, 4°C. Extract within 7 days of collection. Analyze within 40 days from extraction

TABLE 8.2-3
Radiological Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Recommended Containers[1]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis[2]
Gross Alpha/Beta	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	500 mls
	Soil	P, G	None		50[4] gms
Americium-241	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Carbon-14	Water	P, G	Field adjusted to pH > 9 with NaOH[3]	180 days after collection	100 mls
	Soil	P, G	None		50[4] gms
Calcium-45	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	100 mls
Curium-242	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Gamma Emitters Actinides, as applicable, Co-60, Cs-137, K-40, Mn-54, and other fission/activation products	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		650[7] gms
Iron-55	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	50 mls
Lead-210	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	500 mls
	Soil	P, G	None		50[4] gms
Neptunium-237	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms

TABLE 8.2-3
Radiological Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Recommended Containers[1]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis[2]
Promethium-147	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	250 mls
Plutonium-238,239/240	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Radium-226	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Radium-228	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Strontium-89,90 and Total Strontium	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Technetium-99	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	100 mls
	Soil	P, G	None		50 gms
Thorium-227,228,230,232	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Total Uranium	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	50 mls
	Soil	P, G	None		50[4] gms
Tritium	Water	P, G[6]	None	180 days after collection	100 mls
	Soil	P, G[6]	None		100 gms

TABLE 8.2-3
Radiological Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Recommended Containers[1]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis[2]
Uranium-233/234,235/236	Water	P, G	Field acidified to pH < 2 with HNO_3	180 days after collection	1000[5] mls
	Soil	P, G	None		50[4] gms
Uranium-238	Soil	P, G	None	180 days after collection	50[4] gms

1 Plastic (polyethylene), Glass
2 Assumes that quality control samples have been assigned in the field. If duplicates, matrix spikes and/or matrix spike duplicates are to be assigned by the laboratory additional multiple sample volumes are required.
Volumes listed are for standard aliquot size. Detection limit requirements may necessitate larger volumes.
3 Assumes that Carbon is in the form of CO_3^-.
4 May be aliquoted or sequentially determined from the same volume.
5 May be aliquoted or sequentially determined from the same volume.
6 Tritium is very volatile. Sample containers must by air tight to eliminate tritium loss.
7 Dry weight.

TABLE 8.4-1
Summary of Inorganic Method Calibrations

Analysis	Calibration	Methods			
		NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
Acidity	Initial	2 point calibration of pH meter (± 0.05 pH units of true value)	Not Applicable	Not Applicable	2 point calibration of pH meter (± 0.05 pH units of true value)
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Alkalinity	Initial	2 point calibration of pH meter (± 0.05 pH units of true value)	Not Applicable	Not Applicable	2 point calibration of pH meter (± 0.05 pH units of true value)
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Ammonia	Initial	7 levels plus blank. "r"[4] ≥ 0.995	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 level every 10 samples ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Ammonia (TKN)	Initial	7 levels plus blank "r"[4] ≥ 0.995	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 level every 10 samples ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
BOD	Initial	Winkler calibration	Not Applicable	Not Applicable	Winkler calibration
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Methods				
	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
Chloride (IC) (continued)	Ending	1 level ± 10% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Chloride (LACHAT)	Initial	8 levels plus blank $^{*}r^{*(4)} \geq 0.995$	3 levels plus blank $^{*}r^{*(4)} \geq 0.995$	Not Applicable	Not Applicable
	Continuing	1 point every 10 samples ± 15% of true value	1 standard every 15 samples ± 15% of true value	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	1 level ± 15% of true value	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Chlorine, Residual	Initial	Standardize titrant	Not Applicable	Not Applicable	Not Applicable
	Continuing		Not Applicable	Not Applicable	Not Applicable
	Ending		Not Applicable	Not Applicable	Not Applicable
	Other		Not Applicable	Not Applicable	Not Applicable
Chromium (Hexavalent) Cr^{+6}	Initial	4 standards plus blank $^{*}r^{*(4)} \geq 0.995$	Standard concentration ranging from 0.5 to 5 mg/L Cr(VI)	Not Applicable	7 standards plus blank $^{*}r^{*(4)} \geq 0.995$
	Continuing	1 point every 10 samples ± 15% of true value	1 independently-prepared check standard every 15 samples	Not Applicable	1 point every 10 samples ± 15% of true value
	Ending	1 point ± 15% of true value	Not Applicable	Not Applicable	1 point ± 15% of true value
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Color	Initial	3 standards plus blank	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 point every 10 samples	Not Applicable	Not Applicable	Not Applicable
	Ending	1 point	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Conductivity	Initial	Standardize meter with 0.01 M KCl	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 point every 10 samples ± 15% of true value	Not Applicable	Not Applicable	Not Applicable

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Calibration	Methods			
		NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
Conductivity (continued)	Ending	1 point ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	1 point ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
Cyanide (Amenable)	Initial	3 levels plus blank "r"[4] ≥ 0.995	6 levels plus blank "r"[4] ≥ 0.995	Not Applicable	8 levels plus blank "r"[4] ≥ 0.995
	Continuing	1 level every 10 samples ± 15% of true value	1 mid-level every 10 samples ± 15 % of true value	Not Applicable	1 level every 10 samples ± 15% of true value
	Ending	1 level ± 15 % of true value	1 level ± 15 % of true value	Not Applicable	1 level ± 15 % of true value
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Free)	Initial	Not Applicable	Not Applicable	Not Applicable	8 levels plus blank "r"[4] ≥ 0.995
	Continuing	Not Applicable	Not Applicable	Not Applicable	1 level every 10 samples ± 15 % of true value
	Ending	Not Applicable	Not Applicable	Not Applicable	1 level ± 15 % of true value
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Total)	Initial	6 levels plus blank "r"[4] ≥ 0.995	6 levels plus blank "r"[4] ≥ 0.995	minimum of 8 levels plus blank "r"[4] ≥ 0.995	8 levels plus blank "r"[4] ≥ 0.995
	Continuing	1 mid-level every 10 samples ± 15 % of true value	1 level every 10 samples ± 15 % of true value	1 level every 10 samples ± 15 % of true value	1 mid-level every 10 samples ± 15 % of true value
	Ending	1 level ± 15 % of true value	1 level ± 15 % of true value	1 level ± 15 % of true value	1 level ± 15 % of true value
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Calibration	Methods			
		NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
Flashpoint (Ignitability)	Initial	Not Applicable	p-Xylene reference standard must have flashpoint of 27.2°C ± 1.1°C	Not Applicable	Not Applicable
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Fluoride (IC)	Initial	3 levels plus blank "r" ≥ 0.995	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 level every 20 samples ± 10% of true value	Not Applicable	Not Applicable	Not Applicable
	Ending	1 level ± 10% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Fluoride (Ion-Specific Electrode)	Initial	5-8 levels plus blank "r" ≥ 0.995	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 mid-level every 10 samples ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Hardness	Initial	Standardize titrant	Not Applicable	Not Applicable	Hardness by calculation using ICP results
	Continuing	Not Applicable	Not Applicable	Not Applicable	
	Ending	Not Applicable	Not Applicable	Not Applicable	
	Other	Not Applicable	Not Applicable	Not Applicable	
Iodide (Titration)	Initial	2 points plus blank ± 0.5 N	Not Applicable	Not Applicable	2 points plus blank ± 0.5 N
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Calibration	Methods			
		NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
Methylene Blue Active Substances (MBAS)	Initial	9 points plus blank "r"[4] ≥ 0.995	Not Applicable	Not Applicable	6 points plus blank "r"[4] ≥ 0.995
	Continuing	Not Applicable	Not Applicable	Not Applicable	1 level every 10 samples ± 15% of true value
	Ending	Not Applicable	Not Applicable	Not Applicable	1 level ± 15% of true value
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Nitrogen, Nitrate-Nitrite	Initial	8 levels plus blank "r"[4] ≥ 0.995	Nitrate: 6 levels plus blank "r"[4] ≥ 0.995	Not Applicable	Not Applicable
	Continuing	1 level every 10 samples ± 15% of true value	1 level every 10 samples ± 15% of true value	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	1 level ± 15% of true value	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Odor	Initial	No calibration	Not Applicable	Not Applicable	Not Applicable
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Oil and Grease	Initial	This is a gravimetric determination. Calibrate balance before use.	This is a gravimetric determination. Calibrate balance before use.	Not Applicable	3 points plus blank "r"[4] ≥ 0.995
	Continuing			Not Applicable	1 point ± 15% of true value
	Ending			Not Applicable	1 point ± 15% of true value
	Other			Not Applicable	Not Applicable
pH	Initial	2-3 point calibration (± 0.05 pH units of true value)	2 point calibration (± 0.05 pH units of true value)	2 point calibration (± 0.05 pH units of true value)	Not Applicable
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Methods				
	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
pH (continued)	Other	Third point check	Third point check	Third point check	Not Applicable
Phenolics (Automated)	Initial	3 levels plus blank $^{*}r^{*(4)} \geq 0.995$	3 levels plus blank $^{*}r^{*(4)} \geq 0.995$	Not Applicable	Not Applicable
	Continuing	1 level every 10 samples ± 15% of true value	1 level every 10 samples ± 15% of true value	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	1 level ± 15% of true value	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phenolics (Manual)	Initial	5 levels plus blank $^{*}r^{*(4)} \geq 0.995$	5 levels plus blank $^{*}r^{*(4)} \geq 0.995$		
	Continuing	1 level every 10 samples ± 15% of true value	1 level every 10 samples ± 15% of true value		
	Ending	1 level ± 15% of true value	1 level ± 15% of true value		
	Other	Not Applicable	Not Applicable		
Phosphorous (Total and Ortho-phosphate) (LACHAT)	Initial	7 levels plus blank $^{*}r^{*(4)} \geq 0.995$	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 level every 10 samples ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Ending	1 level ± 15% of true value	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phosphorous (Ortho-phosphate) by IC	Initial	3 levels plus blank $^{*}r^{*(4)} \geq 0.995$	Not Applicable	Not Applicable	Not Applicable
	Continuing	Single point daily and after every 20 samples ± 10% of true value	Not Applicable	Not Applicable	Not Applicable

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Calibration	Methods			
		NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
GFAA and Flame AA Metals	Initial	3 levels plus blank "r"[4] ≥ 0.995	3 levels plus blank "r"[4] ≥ 0.995	3 levels plus blank (one standard at CRDL) "r"[4] ≥ 0.995	3 levels plus blank "r"[4] ≥ 0.995
	Continuing	1 level every 10 samples ± 10% of true value	1 level every 20 samples ± 20% of true value	Every 10 samples or every 2 hours, which ever is more frequent 1 level ± 10% of true value	1 level every 10 samples ± 10% of true value
	Ending	1 level ± 10% of true value	1 level ± 20% of true value	1 level ± 10% of true value	1 level ± 10% of true value
	Other	Quarterly - Instrument detection limits	Quarterly - Instrument detection limits	Daily - CRDL standards at the beginning of each run Quarterly - Instrument detection limits	Quarterly - Instrument detection limits
Mercury by CVAA	Initial	5 levels plus blank "r"[4] ≥ 0.995	5 levels plus blank "r"[4] ≥ 0.995	4 levels plus blank "r"[4] ≥ 0.995	5 levels plus blank "r"[4] ≥ 0.995
	Continuing	1 level daily or every 10 samples, whichever is more frequent ± 10% of true value	1 level every 10 samples ± 10% of original prepared standard	1 level every 10 samples or every 2 hours, which ever is more frequent ± 20 % of true value	1 level every 10 samples ± 10% of original prepared standard
	Ending	1 level ± 10% of true value	1 level ± 10% of original prepared standard	1 level ± 20 % of true value	1 level ± 10% of original prepared standard
	Other	Quarterly - Instrument detection limits	Quarterly - Instrument detection limits	Daily - CRDL standards at the beginning of each sequence Quarterly - Instrument detection limits	Quarterly - Instrument detection limits
ICP Metals	Initial	1 level and blank	1 level and blank	1 level and blank	1 level and blank
	Continuing	1 level every 10 samples ± 5% of true value	1 level every 10 samples ± 10% of true value	1 level every 10 samples or every 2 hours, whichever is more frequent ± 10% of true value	1 level every 10 samples ± 10% of true value

Table 8.4-1
Summary of Inorganic Method Calibrations
(continued)

Analysis	Methods				
	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP (88 & 90)[3]	OTHER
ICP Metals (continued)	Ending	1 level ± 5% of true value	± 10% of true value	± 10% of true value	± 10% of true value
	Other	Quarterly - Instrument detection limits Annually - ICP interelement correction factors ICSA, ICSAB: Analyze at beginning and end of every 8 hours	Quarterly - Instrument detection limits Annually - ICP interelement correction factors ICSA, ICSAB: Analyze at beginning and end of every 8 hours	Daily - CRI standards at the beginning and end of each sequence or every 8 hours, whichever is more frequent Quarterly - Instrument detection limits Annually - ICP interelement correction factors Quarterly - Linear Ranges ICSA, ICSAB: Analyze at beginning and end of every 8 hours	Quarterly - Instrument detection limits Annually - ICP interelement correction factors ICSA, ICSAB: Analyze at beginning and every 8 hours

(1) National Pollutant Discharge Elimination System
(2) Resource Conservation and Recovery Act (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd edition, Final Update I, July 1992
(3) Contract Laboratory Program
(4) "r" = correlation coefficient

TABLE 8.4-2
Summary of Organic Method Calibrations

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[3]	CLP 90[3]	OTHER
Aromatic Volatiles by GC	Initial	Minimum of 3 levels, lowest near but above MDL. If % RSD[4] < 10, assume linearity and average RF[5] used. Otherwise, plot calibration curve.	Minimum of 5 levels, lowest near but above MDL. If % RSD[4] < 20, linearity is assumed and average RF[5] is used. Otherwise, plot calibration curve.	Not Applicable	Not Applicable	5 levels If RSD[4] ≤ 20%, assume linearity. If > 20%, plot calibration curve.
	Continuing	1 or more calibration standards analyzed daily. Compare results to method calibration table.	Mid-level calibration standard analyzed every 10 samples. If not within ± 15 % of predicted response, recalibrate.	Not Applicable	Not Applicable	1 every 10 samples, % D[5] ≤ 15% 1 every 10 samples, % D ≤ 10% (≤ 15% for surrogates)
	Ending	Not Applicable	Retention times in windows for all compounds	Not Applicable	Not Applicable	Not Applicable
	Other	When doubt exists in compound identification, second column confirmation is recommended.	When doubt exists in compound identification, second column confirmation is recommended. Retention time windows established over 72-hour period by injection of each compound three times.	Not Applicable	Not Applicable	Not Applicable
Dioxins/ Dibenzofurans by HRGC/ LRMS[7]	Initial	3 levels If %RSD[4] <10%, use mean RF[5]. If %RSD ≥ 10%, plot calibration curve point to point	5 levels in triplicate % RSD[4] ≤ 15%	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 level each working day. %D[5] must be ≤10%. If not, analyze fresh standard. If still not, recalibrate	1 level every 12 hours after window performance mix. Standard must have RFs[5] with %D[5] ≤ 30% from initial	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Window performance mix	Not Applicable	Not Applicable	Not Applicable

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[3]	CLP 90[3]	OTHER
Nitroaromatics by HPLC (continued)	Ending	Not Applicable	Midpoint calibration standard after the end of sample run. Must agree within 20% of initial values, otherwise reinject all solutions in triplicate and recalculate calibration curve.	Not Applicable	Not Applicable	≤ 15% D[5] from initial for each analyte.
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Retention time windows established over 72 hour period by injection of each compound three times
Non-Methane Organic Compounds (NMOC)	Initial	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Minimum of 3 levels %RSD[4] must be ≤ 25 %
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Mid-level standard every 24 hours % D[5] must be ≤ 20 % from initial or recalibration required
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
PAHs by HPLC	Initial	Minimum of 3 levels, lowest near but above MDL. If %RSD[4] < 10, assume linearity and average RF is used. Otherwise, plot calibration curve.	Minimum of 5 levels, lowest near but above MDL. If %RSD[4] < 20, assume linearity and average RF is used. Otherwise, plot calibration curve.	Not Applicable	Not Applicable	Not Applicable
	Continuing	1 or more calibration standards analyzed daily. If not within ± 15% of predicted response, recalibrate.	Mid-level calibration standard analyzed every 10 samples. If not within ± 15% of predicted response, recalibrate.	Not Applicable	Not Applicable	Not Applicable

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[3]	CLP 90[3]	OTHER
PAHs by HPLC (continued)	Ending	Not Applicable	Retention times in windows for all compounds.	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Retention time windows established over 72-hour period by injection of each compound three times.	Not Applicable	Not Applicable	Not Applicable
PCBs by HRMS	Initial	Not Applicable	Not Applicable	Not Applicable	Not Applicable	5 Levels %RSD ≤ 30% for RFs
	Continuing	Not Applicable	Not Applicable	Not Applicable	Not Applicable	1 Level every 12 hours. RFs[9] ≤ 30% for natives after window defining solution
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Pesticides/ PCBs	Initial	Minimum of 3 levels, lowest near but above MDL. If % RSD[4] ≤ 10% use avg. RF[9]. Otherwise plot calibration curve	Minimum of 5 levels, lowest near but above MDL. If % RSD[4] ≤ 20 use average RF[9]. Otherwise plot calibration curve. Check for DDT[11] and endrin degradation. % breakdown must be < 20.	3 levels each time a new column is used. Beginning of 72-hour sequence: Evaluation Mixes: Linearity ≤ 10% Degradation ≤ 20%. Individual Standard Mixes to establish RTs[21] and CFs[12]	3 levels (except multi-components at one level), the lowest at the CRQL[16]. The RSD[4] must be ≤ 20 %, however, 2 compounds may be > 20 % but must be < 30 %. Analyze Resolution Check Mixture and PEM[13] prior to initial calibration.	Method 505: Minimum of 3 standards: % RSD[4] ≤ 20% Method 508A: Minimum of 5 standards: The RSD[4] of RF[9] must be < 6% for the 7 injections at 0.1 ng/uL level

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[3]	CLP 90[3]	OTHER
Petroleum Hydrocarbons, Total, by GC (continued)	Other	Not Applicable	Not Applicable	Not Applicable	Not Applicable	TN GRO[18] & DRO [4]: Retention time windows established over 72 hour period by injection of each method component three times. --- Retention time windows established over 72 hour period by injection of method standard 3 times.
Purgeable Halocarbons by GC	Initial	Minimum of 3 levels, lowest near but above MDL. If % RSD[4] < 10, assume linearity and average RF is used. Otherwise, plot calibration curve.	Minimum of 5 levels, lowest near but above MDL. If % RSD[4] < 20, linearity is assumed and average RF is used. Otherwise, plot calibration curve.	Not Applicable	Not Applicable	5 levels If RSD[4] ≤ 20%, assume linearity. If > 20%, plot calibration curve.
	Continuing	1 or more calibration standards analyzed daily. Compare results to method calibration tables.	Mid-level calibration standard analyzed every 10 samples. If not within ± 15 % of predicted response, recalibrate.	Not Applicable	Not Applicable	1 every 10 samples, % D[5] ≤ 15% --- 1 every 10 samples, % D[5] ≤ 10% (≤ 15% for surrogates)
	Ending	Not Applicable	Retention times in windows for all compounds	Not Applicable	Not Applicable	Not Applicable
	Other	When doubt exists in compound identification, second column confirmation is recommended.	When doubt exists in compound identification, second column confirmation is recommended. Retention time windows established over 72-hour period by injection of each compound three times.	Not Applicable	Not Applicable	Not Applicable

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[3]	CLP 90[3]	OTHER
Semivolatiles by GC/MS	Initial	Minimum of 3 levels, lowest near but above MDL If % RSD[4] ≤ 35%, can use mean RF[9]	Minimum of 5 levels, lowest near but above MDL. ≤ 30% RSD[4] for CCCs[18] SPCCs[17]: RF[9] ≥ 0.050	5 levels plus blank ≤ 30% RSD[4] for CCCs[18] SPCCs: RF_{avg}[9] or RF_{daily} ≥ 0.050	5 levels (except 8 compounds which require 4 levels) ≤ 20.5 % RSD[4] of method Minimum RRF[10] of method	Not Applicable
	Continuing	1 level every 24 hours If not within ± 20% of predicted response, recalibrate	Mid-level standard every 12 hours after tuning < 30% RSD[4] for CCCs[18] SPCCs[17]: RF[9] ≥ 0.050	1 level every 12 hours after tuning ≤ 25% D[5] for CCCs[18] SPCCs[17]: RF_{avg}[9] or RF_{daily} ≥ 0.050	1 mid-level standard every 12 hours after tuning ≤ 25 % D[5] of method Minimum RRF[10] and maximum RSD[4] of method	Not Applicable
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Other	DFTPP[19] tuning every 24 hours before standard or sample runs. Check column performance daily with benzidine and pentachlorophenol	DFTPP[19] tuning at the beginning of every 12 hour shift.	DFTPP[19] tuning at the beginning of every 12 hour shift. SPCCs[17]: RF_{avg}[9] or RF_{daily} ≥ 0.050	DFTPP[19] tuning at the beginning of every 12 hour shift for RT[21] and EICP area of internal standards evaluated against latest continuing calibration	Not Applicable
Semivolatiles by GC	Initial	Minimum of 3 levels, lowest near but above MDL. If % RSD[4] ≤ 10% use avg. RF. Otherwise plot calibration curve	Minimum of 5 levels, lowest near but above MDL. If % RSD[4] < 20 use average RF. Otherwise plot calibration curve.	Not Applicable	Not Applicable	Not Applicable

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[3]	CLP 90[3]	OTHER
Semivolatiles by GC (continued)	Continuing	1 or more calibration standards analyzed daily. If not within ± 10 % of predicted response, recalibrate.	Mid-level calibration standard run every 10 samples. If not within ± 15% of predicted response, recalibrate	Not Applicable	Not Applicable	Not Applicable
	Ending	Not Applicable	Retention times in windows for all compounds	Not Applicable	Not Applicable	Not Applicable
	Other	When doubt exists in compound identification, second column confirmation should be used.	When doubt exists in compound identification, second column confirmation should be used. Retention time windows established over 72 hour period by injection of each compound three times	Not Applicable	Not Applicable	Not Applicable
Volatiles by GC/MS	Initial	Minimum of 3 levels, lowest near but above MDL If % RSD[4] ≤ 35% can use mean RF[9]	Minimum of 5 levels, lowest near but above MDL % RSD[4] for CCCs[18] ≤ 30 SPCCs[17]: RF[9] ≥ 0.300 (0.250 for bromoform)	5 levels ≤ 30% RSD[4] of CCCs[18] SPCCs RF ≥ 0.300 (0.250 for Bromoform)	5 levels ≤ 20.5 % RSD[4] of method Minimum RRF[10] and maximum RSD must meet method criteria	Method 524.2: 5 levels plus blank ≤ 20% RSD[4] for all compounds ——— See operation-specific SOPs for air analysis
	Continuing	1 level every 24 hours after tune check standard Recoveries must meet limits given in method	Mid-level every 12 hours after tune check standard RF[9] of CCCs[18] ≤ 25% D[5] SPCCs[17]: RF[9] ≥ 0.300 (0.250 for bromoform)	1 level every 12 hours after tune check standard ≤ 25% D[5] for CCCs[18] SPCCs RF ≥ 0.300 (0.250 for Bromoform)	Mid-level every 12 hours after tune check standard %D[5] must be ≤ 25 from initial calibration Minimum RRF[10] must be met.	Method 524.2: 1 level every 8 hours after tune check standard ≤ 30% RSD[4] for all compounds ——— See operation-specific SOPs for air analysis
	Ending	Not Applicable	Not Applicable	Not Applicable	Not Applicable	See operation-specific SOPs for air analysis

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

Analysis	Calibration	NPDES[1]	RCRA(SW846)[2]	CLP 88[2]	CLP 90[2]	OTHER
Volatiles by GC/MS (continued)	Other	BFB[20] tuning at the beginning of every 24 hour shift.	BFB[20] tuning at the beginning of every 12 hour shift.	BFB[20] tuning at the beginning of every 12 hour shift. SPCCs[17]: RF_{avg} or $RF^{(9)}_{daily}$ ≥ 0.300 (0.250 for bromoform)	BFB[20] tuning at the beginning of every 12 hour shift for RT[21] and EICP area of internal standards evaluated against latest continuing calibration	Method 524.2: BFB[20] tuning at beginning of every 8 hour shift ---------- See operation-specific SOPs for air analysis
Volatiles by GC (Detectors in series)	Initial	Not Applicable	Minimum of 5 levels, lowest near but above MDL. If % RSD[4] ≤ 20, linearity assumed and average RF used. Otherwise, plot calibration curve.	Not Applicable	Not Applicable	Minimum of 3 levels, lowest near but above MDL. If % RSD[4] ≤ 10, linearity assumed and average RF[9] used.
	Continuing	Not Applicable	Mid-level calibration standard run every 10 samples. If not within ± 15% of predicted response, recalibrate. Retention times in windows for all continuing standards.	Not Applicable	Not Applicable	1 level every 10 samples % D[5] ± 15% from initial calibration
	Ending	Not Applicable	Retention times in windows for all compounds.	Not Applicable	Not Applicable	Not Applicable.
	Other	Not Applicable	When doubt exists in compound identification, second column confirmation is recommended. Retention time windows established over 72 hour period by injection of each compound three times	Not Applicable	Not Applicable	When doubt exists in compound identification, second column confirmation is recommended. Retention time windows established over 72 hour period by injection of each compound three times

Table 8.4-2
Summary of Organic Method Calibrations
(continued)

(1) National Pollutant Discharge Elimination System
(2) Resource Conservation and Recovery Act (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd edition, Final Update I, July 1992
(3) Contract Laboratory Program
(4) RSD - Relative Standard Deviation
(5) % D - Percent Difference
(6) TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
(7) HRGC/LRMS - High Resolution Gas Chromatography/Low Resolution Mass Spectrometry
(8) HRGC/HRMS - High Resolution Gas Chromatography/High Resolution Mass Spectrometry
(9) RF - Response Factor
(10) RRF - Relative Response Factor
(11) DDT - Dichloro-diphenyl-trichloro-ethane
(12) CF - Calibration Factor
(13) PEM - Performance Evaluation Mixture
(14) DRO - Diesel Range Organics. DRO corresponds to alkane range of C_{10} - C_{24}.
(15) GRO - Gasoline Range Organics. GRO corresponds to an alkane range of C_6 - C_{10}.
(16) CRQL - Contract Required Quantitation Limit
(17) SPCC - System Performance Check Compound
(18) CCC - Continuing Calibration Compounds
(19) DFTPP - Decafluorotriphenylphosphine
(20) BFB - Bromofluorobenzene
(21) RT - Retention Time

TABLE 8.4-3
Periodic Equipment Calibrations

Type of Calibration	Calibration Requirements
Balance Calibration	• Must be serviced and calibrated annually by a manufacturer's representative • Calibration must be checked daily before use by analyst with weight(s) classified as Class "S" (or Class "S" traceable) by NIST per operation-specific SOPs. • Quarterly calibrations must cycle through the range of weights applicable to a balance as described in operation-specific SOPs. • All Class "S" weights must be certified by an outside agency every three years. • Class "S" traceable weights used for daily balance calibration checks must be checked against a Class "S" weight monthly.
Thermometer Calibration	• Working thermometers must be calibrated against a certified NIST thermometer at least annually as described in operation-specific SOPs. • The NIST thermometer must be re-certified every three years.
Micropipettors	• Calibrations are checked gravimetrically as required by the operation-specific SOP. • Must be calibrated at the frequency (normally quarterly) required by the manufacturer at a minimum.
Syringes, Volumetric Glassware and Graduated Glassware	• All syringes and volumetric glassware are purchased as Class A items. • Class A items are certified by the manufacturer to be within ± 1% of the measured volume, therefore, calibration of these items by ITAS-laboratories is not required. • All analysts are trained in the proper use and maintenance of measuring devices to ensure the measurement of standards, reagents and sample volumes are within method tolerances.

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Acidity	Method Blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable	Not Applicable	Not Applicable
	Laboratory Control Sample	Frequency: 1 per batch of ≤ 20 samples Criteria: Percent recovery must be within laboratory control chart limits Corrective Action: If not within laboratory control chart limits, rerun all associated samples	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample	Frequency: 1 per batch of 20 samples Criteria: ≤ 20 % RPD[4] Corrective Action: Flag data outside of limit.	Not Applicable	Not Applicable	Not Applicable
Alkalinity	Method Blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable	Not Applicable	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Chlorine, Residual (continued)	Matrix Spike Sample	Frequency: 1 per batch of ≤ 20 samples Criteria: Must be within QC limits Corrective Action: Flag data outside of limit	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples Criteria: ≤ 20 % RPD[4] Corrective Action: Flag data outside of limit.	Water	Not Applicable	Not Applicable
Chromium (Hexavalent) Cr^{+6}	Method Blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples prepped Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable	Frequency: 1 per batch of ≤ 20 samples prepped Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	Frequency: 1 per batch of ≤ 20 samples Criteria: Percent recovery must be within laboratory control chart limits Corrective Action: If not within laboratory control chart limits, rerun all associated samples	Frequency: 1 per batch of ≤ 20 samples prepped Criteria: percent recovery of analyte must be within laboratory control chart limits Corrective Action: Rerun all samples associated with unacceptable LCS	Not Applicable	Frequency: 1 per batch of ≤ 20 samples Criteria: Percent recovery must be within laboratory control chart limits Corrective Action: If not within laboratory control chart limits, rerun all associated samples

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples (Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Chromium (Hexavalent) Cr^{+6} (continued)	Matrix Spike Sample	Frequency: 1 per batch of 20 samples Criteria: Must be within laboratory-established QC limits Corrective Action: Flag data outside of limit	Frequency: 1 per analytical batch of 20 samples Criteria: Advisory limits are 75% - 125% recovery Corrective Action: Reanalyze if sample remaining. If not, flag data associated with unacceptable matrix spike sample	Not Applicable	Frequency: 1 per batch of 20 samples Criteria: Must be within laboratory-established QC limits Corrective Action: Flag data outside of limit
	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample	Frequency: 1 per batch of 20 samples Criteria: ≤ 20 % RPD[4] Corrective Action: Flag data outside of limit.	Frequency: 1 per analytical batch of 20 samples Criteria: ≤ 20 %RPD[4] limit Corrective Action: Reanalyze if sample remaining. If not, flag data outside of limit.	Not Applicable	Frequency: 1 per analytical batch of 20 samples Criteria: ≤ 20 %RPD[4] limit Corrective Action: Reanalyze if sample remaining. If not, flag data outside of limit.
Color	Method Blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable	Not Applicable	Not Applicable
	Laboratory Control Sample	Frequency: 1 per batch of ≤ 20 samples Criteria: Percent recovery must be within laboratory control chart limits Corrective Action: If not within laboratory control chart limits, rerun all associated samples	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Cyanide (Free) (continued)	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Frequency: 1 per analytical batch of 20 samples Criteria: Limits are ≤ 20% RPD[4] Corrective Action: Reanalyze if sample remaining. If not, flag data associated with unacceptable duplicate sample
Cyanide (Total)	Method Blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable
	Laboratory Control Sample	Frequency: 1 per batch of ≤ 20 samples Criteria: Percent recovery must be within laboratory control chart limits Corrective Action: If not within laboratory control chart limits, rerun all associated samples	Frequency: 1 per batch of ≤ 20 samples Criteria: % recovery must be within ± 20% Corrective Action: Rerun all samples associated with unacceptable LCS	Frequency: 1 per batch of ≤ 20 samples Criteria: percent recovery of analyte must be within 80% - 120% Corrective Action: Rerun all samples associated with unacceptable LCS	Not Applicable
	Matrix Spike Sample	Frequency: 1 per batch of 20 samples Criteria: Must be within QC limits Corrective Action: Flag data outside of limit	Frequency: 1 per analytical batch of 20 samples Criteria: Advisory limit is 75% - 125% recovery Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Advisory limits are 75% - 125% recovery Corrective Action: Flag data associated data. Post digestion spike if sample result ≥ 4 times the spike level.	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Cyanide (Total) (continued)	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Limit is 75% - 125% recovery Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Duplicate Sample	Frequency: 1 per batch of 20 samples Criteria: ≤ 20 % RPD[4] Corrective Action: Flag data outside of limit.	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Advisory limits are ≤ 20% RPD[4] Corrective Action: Flag data associated with unacceptable duplicate sample	Not Applicable
Flashpoint (Ignitability)	Method Blank	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Laboratory Control Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample	Not Applicable	Frequency: 1 per batch of ≤20 samples Criteria: RPD[4] must be ≤ 20% Corrective Action: Flag data associated with unacceptable duplicate sample	Not Applicable	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Oil and Grease (continued)	Matrix Spike Sample	Frequency: 1 per batch of 20 samples Criteria: Must be within QC limits Corrective Action: Flag data outside of limit	Not Applicable	Not Applicable	Frequency: 1 per batch of 20 samples Criteria: Limits are 75% - 125% recovery Corrective Action: Reanalyze if sample remaining. If not, flag data associated with unacceptable matrix spike sample
	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample (Requires that two samples be sent by client)	Frequency: 1 per batch of 20 samples Criteria: ≤ 20 % RPD[4] Corrective Action: Flag data outside of limit.	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Advisory limits are ≤ 20% RPD[4] Corrective Action: Flag data associated with unacceptable duplicate sample	Not Applicable	Frequency: 1 per analytical batch of 20 samples Criteria: Advisory limits are ≤ 20% RPD[4] Corrective Action: Flag data associated with unacceptable duplicate sample
pH	Method Blank	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Laboratory Control Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: ≤ 20 % RPD[4] limit Corrective Action: Flag data outside of limit.	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Advisory limits are ≤ 20% RPD[4] Corrective Action: Flag data associated with unacceptable duplicate sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Advisory limits are ≤ 20% RPD[4] Corrective Action: Flag data associated with unacceptable duplicate sample	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
GFAA and Flame AA Metals, Mercury by CVAA	Method Blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples Criteria: Concentration ≤ CRDL[4]. If not, all samples between the CRDL and 10 X the blank values must be redigested. See CLP method for details. Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable
	Laboratory Control Sample	Frequency: 1 per batch of ≤20 samples Criteria: percent recovery of analyte must be within ± 20 % Corrective Action: Rerun all samples associated with unacceptable LCS	Frequency: 1 per batch of ≤20 samples Criteria: percent recovery of analyte must be within ± 20 % Corrective Action: Rerun all samples associated with unacceptable LCS	Frequency: 1 per batch of ≤20 samples Criteria: percent recovery of analyte must be between 80-120% (or supplier's established range for solid) Corrective Action: Rerun all samples associated with unacceptable LCS	Not Applicable
	Matrix Spike Sample	Frequency: 1 per batch of 20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable MS. (See SOP for detailed corrective action procedure and for other QC procedures.)	Frequency: 1 per batch of 20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable MS. (See SOP for detailed corrective action procedure and for other QC procedures.)	Frequency: 1 per batch of ≤20 samples Criteria: Limits for percent recovery are 75 - 125% unless sample conc. is > 4X the true value of the matrix spike Corrective Action: Flag data associated with unacceptable MS unless sample conc. is > 4X the true value of the matrix spike	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
GFAA and Flame AA Metals, Mercury by CVAA (continued)	Matrix Spike Duplicate Sample	Frequency: 1 per batch of 20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable MSD	Frequency: 1 per batch of 20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable MSD Post digestion spike if sample result ≥ 4X the spike level. Serial dilution at 5X, %D[5] < 10	Not Applicable	Not Applicable
	Duplicate Sample	Not Applicable	1 per 20 samples	Frequency: 1 per analytical batch of ≤20 samples Criteria: Advisory limits of ≤20% RPD[4] Corrective Action: Flag data outside of range	Not Applicable
ICP Metals	Method Blank	Frequency: 1 per batch of ≤20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	Frequency: 1 per batch of ≤20 samples Criteria: Concentration ≤ CRDL[6]. If not, all samples between the CRDL and 10 X the blank values must be redigested. See CLP method for details. Corrective Action: Rerun all samples associated with unacceptable blank	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples (Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
ICP Metals (continued)	Laboratory Control Sample	Frequency: 1 per batch of ≤20 samples Criteria: percent recovery of analyte must be within ± 20 % Corrective Action: Rerun all samples associated with unacceptable LCS	Frequency: 1 per batch of ≤20 samples Criteria: percent recovery of analyte must be within ± 20 % Corrective Action: Rerun all samples associated with unacceptable LCS	Frequency: 1 per batch of ≤20 samples Criteria: percent recovery of analyte must be between 80 - 120% except for Ag and Sb (or supplier's established range for solid) Corrective Action: Rerun all samples associated with unacceptable LCS	Not Applicable
	Matrix Spike Sample	Frequency: 1 per batch of ≤20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per batch of ≤20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable matrix spike sample Post digestion spike if sample result ≥ 4X the spike level. Serial dilution at 4X, %D[5] < 10	Frequency: 1 per batch of ≤20 samples Criteria: Advisory limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable matrix spike sample Post-digestion spike if sample result ≤ 4X the spike level	Not Applicable
	Matrix Spike Duplicate Sample	Frequency: 1 per batch of 20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per batch of 20 samples Criteria: Limits for percent recovery are 75 - 125% Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable

TABLE 8.5-1
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
ICP Metals (continued)	Duplicate Sample	Not Applicable	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Limit is ≤ 20% RPD[4] Corrective Action: Flag data outside of range	Not Applicable

(1) National Pollutant Discharge Elimination System
(2) Resource Conservation and Recovery Act (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd edition, Final Update I, July 1992
(3) Contract Laboratory Program
(4) RPD - Relative Percent Difference
(5) % D - Percent Difference
(6) CRDL - Contract Required Detection Limit

TABLE 8.5-2
Organic Laboratory Quality Control Samples

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Aromatic Volatiles by GC	Method Blank	Frequency: 1 per day Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is more frequent Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Not Applicable	1 per 10 samples
	Laboratory Control Sample	Frequency: 1 with each batch of samples or when new reagents are used Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Frequency: 1 per 20 samples or each batch of samples, whichever is more frequent Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Not Applicable	1 with MS/MSD (≤20 samples)
	Matrix Spike Sample	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	1 per batch (≤20 samples
	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	1 per batch of ≤ 20 samples

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Aromatic Volatiles by GC (continued)	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Surrogates	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: Re-extract samples or flag sample data not meeting surrogate criteria	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: samples which have any surrogate outside of lab established control limits will be flagged as estimated. Upon client request will be reanalyzed once and both sets of data reported.	Not Applicable	All samples, standards, and blanks
	Internal Standards	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	Not Applicable	Not Applicable
Dioxins/ Dibenzofurans	Method Blank	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all positive samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all positive samples associated with unacceptable blank	Not Applicable	Not Applicable
	Laboratory Control Sample	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Non-Methane Organic Compounds (NMOC) (continued)	Matrix Spike Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Frequency: 1 per 20 samples Criteria: %D must be ≤ 30% Corrective Action: Flag data associated with unacceptable duplicate sample
	Surrogates	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Internal Standards	Not Applicable	Not Applicable	Not Applicable	Not Applicable
PAHs by HPLC	Method Blank	Frequency: 1 with each batch of samples extracted or when new reagents used Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is more frequent Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Not Applicable	Not Applicable
	Laboratory Control Sample	Frequency: 1 with each batch of samples extracted or when new reagents used Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Frequency: 1 per ≤ 20 samples or each extraction batch of samples, whichever is more frequent Criteria: Percent recovery must be within laboratory derived acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
PAHs by HPLC (continued)	Matrix Spike Sample	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples received within a one month period Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples received within a one month period Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Surrogates	Not specified in method	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: Results must fall within laboratory established control limits Sample Criteria: Samples which have any surrogate outside of control limits will be flagged.	Not Applicable	Not Applicable
	Internal Standards	Optional	Optional	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Petroleum Hydrocarbons (Total) by GC (continued)	Surrogates	Not Applicable	Not Applicable	Not Applicable	Surrogates spiked into Method Blank and all samples (QC samples included) Method Blank and LCS Criteria: Recovery of surrogates should be within 50% - 150% Sample Criteria: Samples which have any surrogate outside of control limits will be flagged
	Internal Standards	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Purgeable Halocarbons by GC	Method Blank	Frequency: 1 per day Criteria: Concentration less than reporting limit Corrective Action: Reanalyze all samples associated with unacceptable blank	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is more frequent Criteria: Concentration less than reporting limit Corrective Action: Reanalyze all samples associated with unacceptable blank	Not Applicable	Not Applicable
	Laboratory Control Sample	Frequency: 1 with each batch of samples Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Reanalyze all samples associated with unacceptable LCS	Frequency: 1 per 20 samples Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Reanalyze all samples associated with unacceptable LCS	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Purgeable Halocarbons by GC (continued)	Matrix Spike Sample	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: Percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: Percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Surrogates	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: Reanalyze samples or flag sample data not meeting surrogate criteria	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: samples which have any surrogate outside of lab established control limits will be flagged as estimated. Upon client request will be reanalyzed once and both sets of data reported.	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Purgeable Halocarbons by GC (continued)	Internal Standards	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	Not Applicable	Not Applicable
Semi-volatiles by GC/MS[7]	Method Blank	Frequency: 1 with each batch of samples extracted or when new reagents used Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is greater Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank
	Laboratory Control Sample	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is greater Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Not Applicable	Frequency: 1 per batch of ≤ 20 samples extracted Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS
	Matrix Spike Sample	Frequency: 1 per 20 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is more frequent. Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Semi-volatiles by GC/MS[7] (continued)	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples received within a 14 day period Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable
	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Surrogates	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Re-extract samples or flag sample data not meeting surrogate criteria	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Re-extract samples or flag sample data not meeting surrogate criteria	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Samples are allowed one acid and/or one base/neutral surrogate outside of control limits. If two or more acid or base/neutral surrogates are out of control limits or any one surrogate is less than 10% recovery the sample will be re-extracted and reanalyzed.	Not Applicable
	Internal Standards	Optional, may be used for quantitation.	Internal Standards are added to all samples (QC samples included). Internal standard area of daily standard must be within -50 % to +100 % from the last daily calibration check standard. Otherwise, sample is reanalyzed.	Internal Standards are added to the method blank and all samples (QC samples included). Internal standard areas must be within -50 % to +100 % from the last daily calibration check standard. Otherwise, sample is re-analyzed	Internal Standards are added to the method blank and all samples (QC samples included). Internal standard areas must be within -50 % to +100 % from the last daily calibration check standard. Otherwise, sample is re-analyzed[4]

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Semivolatiles by GC	Method Blank	Frequency: 1 with each batch of samples extracted or when new reagents used Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is more frequent Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Not Applicable	Not Applicable
	Laboratory Control Sample	Frequency: 1 with each batch of samples extracted or when new reagents used Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is greater Criteria: Percent recovery must be within laboratory derived acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Not Applicable	Not Applicable
	Matrix Spike Sample	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples received within a one month period Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per analytical batch of ≤ 20 samples received within a one month period Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Semivolatiles by GC (continued)	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Surrogates	Not specified in method	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: Results must fall within laboratory established control limits Sample Criteria: Samples which have any surrogate outside of control limits will be flagged.	Not Applicable	Not Applicable
	Internal Standards	Optional	Optional	Not Required	Not Applicable
Volatiles by GC/MS	Method Blank	Frequency: 1 per day Criteria: Concentration less than reporting limit Corrective Action: Reanalyze all samples associated with unacceptable blank	Frequency: 1 per ≤ 20 samples Criteria: Concentration less than reporting limit Corrective Action: Reanalyze all samples associated with unacceptable blank	Frequency: 1 per 12 hours Criteria: Concentration less than reporting limit, except methylene chloride, acetone, 2-butanone must be ≤5X CRQL Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Frequency: 1 per 8 hours Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank
	Laboratory Control Sample	Frequency: Analyzed if MS results fall outside advisory limits Criteria: percent recovery for each analyte must be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Frequency: 1 per 8 hours containing all analytes of concern Criteria: percent recovery must be within acceptable control chart limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Volatiles by GC/MS[7] (continued)	Matrix Spike Sample	Frequency: 1 per ≤ 20 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per 20 samples Criteria: No criteria specified in method
	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Frequency: 1 per analytical batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable
	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Frequency: 1 per 20 samples Criteria: % Difference within laboratory limits
	Surrogates	Surrogates spiked into Method Blank and all samples (QC included) Method Blank Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Reanalyze samples, then flag sample data not meeting surrogate criteria	Surrogates spiked into Method Blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Reanalyze samples, then flag sample data not meeting surrogate criteria	Surrogates spiked into Method Blank and all samples (QC included) Method Blank Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: CLP guidelines will be followed.	Surrogates spiked into Method Blank and all samples. Method Blank Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: If surrogates not in control, sample will be reanalyzed to prove/disprove matrix interference.

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Volatiles by GC/MS[7] (continued)	Internal Standards	Internal standards may be used for quantitation (optional).	Internal Standards are added to all samples (QC samples included). Internal standard area of daily standard must be within -50 % to +100 % from the last daily calibration check standard. Otherwise, sample is reanalyzed.	Internal Standards are added to the method blank and all samples (QC samples included). Internal standard areas must be within -50 % to +100 % from the last daily calibration check standard. Otherwise, sample is re-analyzed	Internal Standard added to all samples and QC samples
Volatiles by GC (Detectors in series)	Method Blank	Not Applicable	Frequency: 1 per 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable blank	Not Applicable	Not Applicable
	Laboratory Control Sample	Not Applicable	Frequency: 1 per 20 samples or each extraction batch of samples, whichever is more frequent Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS	Not Applicable	Not Applicable
	Matrix Spike Sample	Not Applicable	Frequency: 1 per batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable

TABLE 8.5-2
Organic Laboratory Quality Control Samples
(continued)

Analysis	QC Sample	NPDES[1]	RCRA(SW846)[2]	CLP[3] (88 and 90)	OTHER
Volatiles by GC (continued)	Matrix Spike Duplicate Sample	Not Applicable	Frequency: 1 per batch of ≤ 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable matrix spike sample	Not Applicable	Not Applicable
	Duplicate Sample	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Surrogates	Not Applicable	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: samples which have any surrogate outside of lab established control limits will be flagged as estimated. Upon client request will be reanalyzed once and both sets of data reported.	Not Applicable	Not Applicable
	Internal Standards	Not Applicable	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	Not Applicable	Not Applicable

(1) National Pollutant Discharge Elimination System
(2) Resource Conservation and Recovery Act (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd edition, Final Update 1, July 1992
(3) Contract Laboratory Program
(4) CRQL - Contract Required Quantitation Limits
(5) DRO - Diesel Range Organics. DRO corresponds to alkane range of C_{10} - C_{24}.
(6) GRO - Gasoline Range Organics. GRO corresponds to an alkane range of C_6 - C_{10}.
(7) See operation-specific SOP for air analysis

Table 8.5-3
Field Quality Control Samples

Type	Applicability		Accuracy and Precision Application	Introduced By
	Inorganic	Organic		
Trip Blank (volatiles)		✓	Accuracy	Supplier of Containers
Field Blank	✓	✓	Accuracy	Field Sampler
Rinsate Blank	✓	✓	Accuracy	Field Sampler
Collocated Sample	✓	✓	Precision	Field Sampler
Replicated Sample	✓	✓	Precision	Field Sampler
Split Sample	✓	✓	Precision	Field Sampler
Field Duplicate	✓	✓	Precision	Field Sampler
Field Matrix Spike	✓	✓	Accuracy	Field Sampler

Table 8.5-4
Laboratory Quality Control Samples

Type	Frequency	Applicability		Accuracy and Precision Application	Introduced By
		Inorganic/ Radiochemical	Organic		
Reagent Blank	Can be done as part of method blank, determine separately with each new batch of reagent/solvents.	✓	✓	Accuracy	Analyst
Duplicate	1 out of 20 or at least 1/month/run	✓	✓	Precision	Analyst/ Prep
Continuing Calibration Standard	With each group of samples	✓	✓	Accuracy	Analyst/ Prep
Surrogate Standard	All standards, method blanks, and samples		✓ Method Dependent	Accuracy	Analyst/ Prep
Matrix Spikes	1 out of 20 or at least 1/month/run	✓	✓	Accuracy	Analyst/ Prep
Matrix Spike Duplicates	1 out of 20 or at least 1/batch	✓	✓	Both	Analyst/ Prep
Blank Spike (Laboratory Control Sample)	1 out of 20 or at least 1/batch with MS/MSD pair	✓	✓	Accuracy	Analyst/ Prep
Analytical Spike	As specified in methods, or as needed	✓		Accuracy	Analyst/ Prep
Internal Standards	Each sample and standard	✓	✓	Both	Analyst/ Prep
Method Blank	With each group of samples, or beginning and end of each run. For GC/MS, method is spiked with surrogates 1 out of 10	✓	✓	Accuracy	Analyst/ Prep
Yield Monitors	Operation-specific	✓		Accuracy	Prep

TABLE 9.2-1
Laboratory Quality Control Samples/Measurements

Sample/Measurement	Purpose
Initial Calibration	Ensures the calculated concentration is within the limits of error as defined by the initial calibration conformance requirements. (For example by using an average calibration factor with a conformance limit of ≤ 20% relative standard deviation, all samples calculated will be within 20% of the true value.)
Continuing and Ending Calibration	Ensure that the calculated concentration is within the limits of error defined by the continuing calibration conformance criteria (*e.g.* all values are within 15% of the true concentration).
Solvent Blanks	Demonstrates that the solvent used to prepare standards and dilutions is free of interferences as regards a specific analysis.
Method Blanks	Demonstrate the laboratory systems (*e.g.* glassware cleaning procedures) and laboratory reagents used for the preparation and analysis of samples have not contributed to a false positive or negative measurement.
Reagent Blanks	Demonstrate that the reagents purchased by the laboratory are free of interferences as regards an analysis and do not contribute to false positive or false negative results.
Volatile Holding Blanks	Demonstrate that the volatile organic samples are not cross contaminated during storage at the laboratory.
Laboratory Control Sample	Demonstrates the laboratory's ability to perform an analysis within the conformance requirements of the method.

TABLE 9.2-2
Matrix Quality Control Samples

Quality Control Sample	Purpose
Duplicate samples	Estimates the ability of the laboratory to obtain precise measurements on a sample. This measure is dependent on the homogeneity of the sample being duplicated. Solid samples often portray poor sample homogeneity and therefore often have poor duplication as regards to the sample result.
Matrix Spike Sample	Estimates the ability of the laboratory to obtain accurate measurements on a sample. The measure is dependent on the bias a sample matrix may cause regarding a given analyte.
Matrix Spike Duplicate Sample	In addition to verifying the accuracy of the matrix spike sample,the matrix spike duplicate can be used with the matrix spike sample as a measure of precision by calculating the relative percent difference (RPD).

TABLE 9.2-3
Precision and Accuracy Measurements

Measurement	Definition
Accuracy	The degree of agreement of a measurement with an accepted reference or true value. The only true or known values in the laboratory are spiked samples. Expressed as laboratory control sample percent recovery (LCS %R). $$LCS\ \%\ R = \frac{Found}{True} x 100$$ Found = the concentration of an analyte determined from sample analysis. True = the concentration of the analyte spiked into the sample.
Precision	The measure of analytical reproducibility of two values. Expressed as the relative percent difference (RPD) of two values. $$RPD = \left[\frac{\lvert x_1 - x_2 \rvert}{\left(x_1 + \frac{x_2}{2}\right)}\right] x\ 100$$ where: x_1 = first value x_2 = second value
Arithmetic mean $(\bar{x})$	The average of a set of values. $$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$ where: $\bar{x}$ = the mean x_i = the ith data value n = number of data values

TABLE 9.2-3
Precision and Accuracy Measurements
(Continued)

Measurement	Definition
Sample Standard Deviation (s)	A measure of the random (probable) error associated with a single measurement within a data set. $$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$ where: s = sample standard deviation $\bar{x}$ = the mean x_i = the ith data value n = number of data values
Quality Control Chart	A graphical representation of analytical accuracy. Displays the arithmetic mean of a data set, the upper and lower warning limits and the upper and lower control limits.
Upper Control Limit (UCL)	$UCL = \bar{x} + 3s$
Upper Warning Limit (UWL)	$UWL = \bar{x} + 2s$
Lower Warning Limit (LWL)	$LWL = \bar{x} - 2s$
Lower Control Limit (LCL)	$LCL = \bar{x} - 3s$

APPENDIX B

OPERATION-SPECIFIC
QUALITY ASSURANCE MANAGEMENT PLAN -
IT ANALYTICAL SERVICES DIVISION -
APPENDIX: OAK RIDGE LABORATORY-0

Operation-Specific
QUALITY ASSURANCE MANAGEMENT PLAN
IT ANALYTICAL SERVICES DIVISION

OAK RIDGE LABORATORY
APPENDIX

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APPENDIX

OAK RIDGE-0

LISTS OF APPENDIX SECTIONS, TABLES, AND FIGURES

LIST OF APPENDIX SECTIONS

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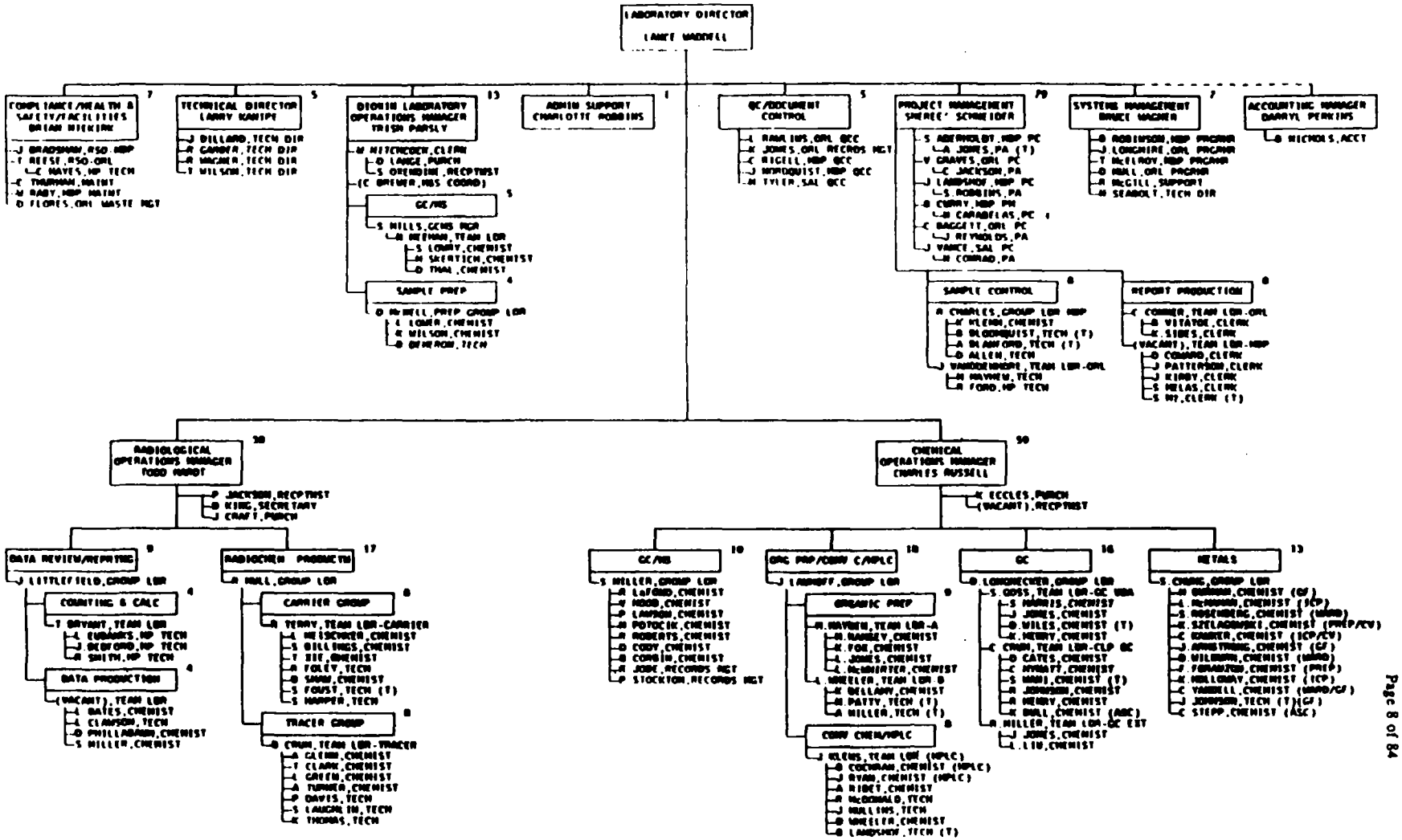
APPENDIX

OAK RIDGE-1

ORGANIZATIONAL CHART

FIGURE OR-1-1

ITAS MARYVILLE LABORATORY



APPENDIX

OAK RIDGE-2

INSTRUMENT LIST

TABLE OR-2-1
ITAS-OAK RIDGE LABORATORY
Instrument List
May 10, 1993

Instrument Type	Manufacturer	Model	Autosampler	Age
Gas Chromatograph/Mass Spectrometer	VG	Trio 1	HP 7673A	4
	Finnigan MAT	20/30	Tekmar	10+
	Finnigan MAT	20/30	Tekmar	5
	Hewlett Packard	5890/5970	HP 7673A	5
	Hewlett Packard	5890/5970	HP 7673A	5
Gas Chromatograph	Shimadzu	9A Dual ECD		11
	Shimadzu	9A FID, ECD		7
	Hewlett Packard	5890A Dual EC	HP 7673A	7
	Hewlett Packard	5890A Dual EC	HP 7673A	5
	Hewlett Packard	5890A HP, FID	HP 7673A	5
ICP Emission Spectrometer	Thermo Jarrell Ash (simultaneous)	61		5
	Perkin Elmer (sequential)	Plasma 2		8
Atomic Absorption Spectrophotometer	Perkin Elmer	5100		4
	Perkin Elmer	5100		4
	Thermo Jarrell Ash	Smith-Hieftje 22		5
	Buck Scientific	400		6
Ion Chromatograph	Waters	ICM-001012	Waters WISP	4
IR Spectrophotometer	Mattson	GL-2020		3
LACHET Spectrophotometer	Lachet	1300-0000		4
TOX Analyzer	Dohrmann-Envirotech	DX-20		4
TOC Analyzer	Dohrmann	DC-80		7
UV/VIS Spectrophotometer	Sequoia-Turner	340		9
Laser Fluorometer	Chemchek	KPA-10		5
Gamma Analysis System	Nuclear Data	9900		6
Germanium Gamma Detector	Tennelec	CNVDs30		6

TABLE OR-2-1
ITAS-OAK RIDGE LABORATORY
Instrument List
May 10, 1993
(continued)

Instrument Type	Manufacturer	Model	Autosampler	Age
Germanium Gamma Detector	Tennelec	CNVDs30		6
Germanium Gamma Detector	Tennelec	CNVDs30		6
Germanium Gamma Detector	Tennelec	CNVDs30		6
Germanium Gamma Detector	Tennelec	CNVDs30		6
Germanium Gamma Detector	GEM-20200	Ortec		6
Germanium Gamma Detector	GEM-20200	Ortec		6
Liquid Scintillation Spectrometer	Hewlett Packard	2000 CA/LL		6
Liquid Scintillation Spectrometer	Beckman	LS 3801		6
Alpha/Beta Counting System (manual)	Tennelec	4000-16		6
Alpha/Beta Counting System (manual)	Tennelec	4000-16		6
Alpha/Beta Counting System (manual)	Tennelec	4000-16		6
Alpha Spectrometer	Tennelec	48 Chambers		6
Alpha Spectrometer	Ortec	16 Chambers		2

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APPENDIX

OAK RIDGE-3

STANDARD OPERATING PROCEDURE LIST

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
1001	Control and Retention of Client Related Contractual Information
2101	Operation of the Ludlum Model 3
2102	Operation of the Ludlum Model 12
2103	Operation of the Ludlum Model 1000
2105	Operation of the Ludlum Model 12S
2106	Operation of the Ludlum Model 2000
2107	Operation of the Ludlum Model 19
2111	Operation of the Ludlum Model 177 With Pancake GM Probe
2301	On-site Weekly Radiological Survey
2302	Inventory and Leak Testing of Sealed Sources
2303	Personnel Monitoring for Radioactive Contamination
2304	Surface Contamination Limits
2305	Radiation Work Permit
2306	Health Physics Training Program
2307	Sample Receipt & Radioactive Material Receipt/Shipment Surveys
2308	Issuance of Personnel Dosimetry
2312	Radiological Sample Screening and Classification
2313	Radiation Safety Training
2600	Site Safety Committee
2601	Monthly Fire Extinguisher Inspection
2602	Monthly Safety Shower/Emergency Eyewash Inspection
2603	IT-ORL Supervisory Commitment to Health and Safety
3001	Nonconformance and Corrective Actions
3002	Refrigeration Unit Installation/Maintenance
3003	Calibration Check for Thermometers
3004	Calibration Check for Automatic Pipettes
3005	Certification and Recall of Class S Weights
3006	Audits

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List
Continued

SOP NO.	SOP TITLE
3007	Preparation and Review of Control Charts
3008	Quality Assurance Orientation for New Employees
3009	Quarterly Calibration and Daily Balance Check Procedure
3011	Training and Qualifications of Laboratory Analysts
3012	Software Validation
3013	Procedure Preparation
3014	Laboratory Water Quality Assurance
3015	Quality and Operation Records Management
3016	Procurement Control and Documentation
3017	Instrument Repair and Preventive Maintenance
3018	Project Quality Assurance Summary
3020	Glassware Cleaning
3021	Documentation of Sample Condition Upon Receipt
3023	Document Storage
3024	Data Review Requirements for the Chemical Laboratories
3025	Document Control and Distribution
3027	Acquisition and Use of Standard Reference Materials for Radiochemical Standards
3028	External Intercomparison Study Performance Evaluation Program
4030	Waste Accumulation and Collection
4120	Radiological Classification of Liquid Waste
4200	Solidification/Treatability Studies
4210	In-Drum Waste Solidification
4310	Vehicle Operation and Maintenance
4320	Electrical Equipment Lock-Out/Tag-Out
4400	Site Security
5000	Sample Receiving
5001	Sample Log-In and Tracking
5002	Initiation of QC
5004	Internal Chain of Custody

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List
Continued

SOP NO.	SOP TITLE
5006	Sample Preservation Verification
5200	Electronic Data Transfer
5201	Data Packaging
5203	Computer Generated Certificate of Analysis
5401	Receiving and Reveiwing Subcontract Data
6000	Alkalinity Analyses: Total, Bicarbonate, Carbonate, and Hydroxide Alkalinity
6001	Filterable Residue Analysis (Gravimetric, Dried at 180°C)
6002	Non-Filterable Residue (Gravimetric, Dried at 103-105°C)
6003	Analysis of Total Cyanide in Water, Soil and Sediment Media by USEPA-CLp Protocol (Automated)
6004	Chloride by Flow Injection Analysis
6005	Sulfate by Flow Injection Analysis (Automated, Methylthymol Blue, AAII)
6006	Total and Ortho Phosphorus by Flow Injection Analysis
6007	Nitrate/Nitrite by Flow Injection Analysis (Automated, Cadmium Reduction)
6008	Analysis of Total Organic Carbon in Water (UV Promoted, Persulfate Oxidation)
6009	Analysis of Total Petroleum Hydrocarbons (TPH) and Oil & Grease (Gravimetric)
6010	Ammonia Nitrogen Analysis (Nesslerization)
6011	Determination of Total Organic Nitrogen (TON)
6012	Analysis of pH in Water and Soil Samples
6014	Total Kjeldahl Nitrogen (TKN) by Nesslerization
6015	Analysis of Total Organic Carbon in Soils, Sludge, or Non-soil Solids Matrix (Persulfate Oxidation)
6016	Fluoride Analysis by Ion Selective Electrode (ISE)
6017	Analysis of Sulfides in Waters (Titrimetric, Iodine)
6020	Analysis of Total Organic Halides (TOX)
6022	Analysis of Sulfite in Water
6030	Hexavalent Chromium in Water and Soil
6031	Analysis of Phenolic Compounds in Water and Soils (Automated)
6035	Phenolphthalein Alkalinity Analysis
6038	Conductivity

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List
Continued

SOP NO.	SOP TITLE
6040	Ignitability by Penske-Martens Closed Flash Tester
6041	Ignitability of Liquids by Setaflash
6046	Heat of Combustion of Liquids
6050	Color Retention
6051	Silica
6058	Silfate (Turbidimetric)
6200	ICAP-AES Method for Trace Element Analysis of Water and Wastes
6201	The Analysis of Trace Metals by Furnace Atomic Absorption Spectroscopy by CLP
6202	Flame Atomic Absorption Method for Potassium Analysis - CLP SOW 3/90
6203	Analysis of Mercury in Liquid Waste by CLP and SW-846 Method
6204	Analysis of Mercury in Solid or Semisolid Waste by CLP Method
6205	Analysis of Mercury in Solid and Semisolid Waste by SW846
6207	Acid Digestion of Water Samples for Total Recoverable or Dissolved Metals for Analysis by Flame AA or ICAP-AES
6208	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame AA or ICAP-AES
6209	Acid Digestion of Aqueous Samples and Extracts for Total Metals Analysis by Graphite Furnace
6210	Acid Digestion of Sediments, Sludges, and Soils
6211	Sample Preparation for Metals Analysis by CLP Method: SOW 3/90
6219	Modification A to USEPA CLP SOW ILMO1.0, Statement of Work for Inorganic Analysis, Multimedia, Multiconcentration
6220	Modification B to USEPA CLP SOW ILMO1.0, Statement of Work for Inorganic Analysis, Multimedia, Multiconcentration
6408	GC Data Package Production
6602	Organic Solvent Check for GC Analysis
6604	% Moisture of Solid Matrices
6605	Extraction of Non-Volatile Organics from Soil and Sediment
6610	Extractions of Base/Neutral and Acid Extractables from Water and Effluent
6611	CLP Extraction of Base/Neutral and Acid Extractables from Water and Effluent

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List
Continued

SOP NO.	SOP TITLE
6614	CLP Extraction of Organochlorine Pesticides and Polychlorinated Biphenyls from Water and Effluent
6615	Extraction of Pesticides and PCPs from Water and Effluent
6617	Extraction of Polychlorinated Biphenyls (PCBs) from Tissues and Eggs
6618	Extraction Procedure for PCB Wipe Samples
6620	Concentration of Organic Extracts by Zymark Turbovap Concentrator
6640	Cleanup by Florisil
6650	Cleanup by Alumina
6655	Dilution of Non-Aqueous Waste Samples
6660	Cleanup by Gel Permeation Chromatography
6665	Extraction of Herbicides from Soil and Sediment
6670	Extraction of Herbicides from Water and Effluent
6690	Toxicity Characteristic Leaching Procedure for Semivolatiles, Metals, Pesticides, PCBs, and Herbicides
6695	Zero Headspace Extraction of the Toxicity Characteristic Leachate Procedure for Volatile Organics
6697	Extraction Procedure Toxicity
6800	GC/MS Data Package Production
6801	GC/MS Standards Tracking
6803	Modification D, Modification to USEPA CLP SOW OLMO1.8, Statement of Work for Organic Analysis, Multi-media, Multi-concnetration
6821	GC/MS Semivolatile Organic Analysis by USEPA Methods for Evaluating Solid Wastes, 3rd Edition, Method 8270
6823	GC/MS Semivolatile Organic Analysis by USEPA CLP Document # OLMO1.0, Revisions OLMO1.1 through OLMO1.8
6831	GC/MS Volatile Organic Analysis by USEPA SW-846, Method 8240, 3rd Edition
6834	GC/MS Volatile Organic Analysis by USEPA CLP Document # OLMO1.0, Revisions OLMO1.1 through OLMO1.8
6872	Mass Calibration of Finnigan OWA GC/MS
7001	Removal of Iron from Soil or Metallic Samples
7002	Preparation of Solid Samples Through Pulverizing, Drying, and Grinding to Achieve a Uniform Solid Matrix

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List
Continued

SOP NO.	SOP TITLE
7003	Preparation of Samples Which Require Gamma Spectroscopic Analysis
7004	Preparation of Samples Which are to be Processed for Isotopic Alpha Analysis and Strontium Analysis
7006	Instructions for Preparation of Samples for Radiochemical Analysis
7100	Sequential Determination of Radium-226 and Radium-228
7101	Determination of Radium-228 in Aqueous Samples
7102	Determination of Strontium-89 and Strintium-90
7103	Sequential Determination of Selected Alpha Emitting Isotopes
7104	Determination of Technetium-99 Activity
7105	Prepartion and Analysis of Samples for Gross Alpha and/or Beta Radioactivity
7107	Direct Counting of Tritium, Carbon-14, Calcium-45
7108	Preparation and Determination of Tritium in Aqueous Media
7111	Determination of Calcium-45 in Aqueous Samples after Chemical Separation
7112	Preparation and Determination of Carbon-14 in Aqueous Media
7113	Determination of Iron-55 in Aqueous Samples
7114	Determination of Promethium-147 in Aqueous, Environmental Samples and in Urine Samples
7116	Instructions for the Determination of Lead-210 in Aqueous Media
7119	Operating Instructions for Prolabo Model A-300
7121	Tritium by Cryogenic Distillation
7124	Actinide Coprecipitation for Alpha Spectrometry
7125	Determination of Plutonium and Americium in Small Soil and Fresh Water
7126	Total Uranium by Gross Alpha Counting
7127	Determination of Uranium in water by Pulsed-Laser Phosphorimetry
7128	Self Adsorption Curve Standardization
7130	Polonium in Environmental Soils and Waters
7132	Determination of Tritium in Aqueous Samples by Distillation
7137	Determination of Iodine-131 Activity in Milk and Water Samples
7203	Determination of Count Reproducibility and Background Stability of Liquid Scintillation Counting Samples

TABLE OR-3-1
ITAS-OAK RIDGE LABORATORY
Standard Operating Procedure (SOP) List
Continued

SOP NO.	SOP TITLE
7204	Operation of Low Background Alpha/Beta Counting Instrumentation
7206	Initial Calibration and Daily Counts Reproducibility Check for Low Background Alpha/Beta Counting
7210	Energy Calibration/Linearity Check of Computer Assisted Germanium Spectroscopy Systems
7212	Operation of Gamma Spectroscopy Systems
7213	Efficiency Calibration of Germanium Gamma Spectroscopy System
7214	Determination of Germanium Gamma Detector Count Reproducibility
7215	Background Determination of a Germanium Detector System
7217	Operation of Liquid Scintillation Counting Instruments
7223	Process Controls for Daily Checks of Counting Room Instrumentation
7231	Sample Counting Using Computer Controlled Alpha Spectroscopy Systems
7232	Count Reproducibility Determination in Computer Controlled Alpha Spectroscopy Systems
7233	Background Determination in Computer Controlled Alpha Spectroscopy Systems
7234	Energy Calibration Verification of Computer Controlled Alpha Spectroscopy Systems
7235	Efficiency Calibration Verification of Computer Controlled Alpha Spectroscopy Systems
7301	Radiochemical Data Review

APPENDIX

OAK RIDGE-4

ANALYTICAL METHODS

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Classical Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Acidity	Water	Method 305.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Alkalinity	Water	Method 310.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Ammonia	Water	Method 350.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Bromide	Water	Method 300.0	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Cation Exchange Capacity	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9081	Not Applicable	Not Applicable
Chloride	Water	Method 300.0[1] Method 325.2[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Chromium VI Hexavalent	Water	Not Applicable	Method 7196	Not Applicable	Standard Method, 17th Ed., Method 3500-Cr[4] D
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable		Not Applicable	
Conductivity	Water	Method 120.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Cyanide (Amenable)	Water	Not Applicable	Method 9012	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 9012	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Free)	Water	Not Applicable	Not Applicable	Not Applicable	Standard Methods 412 H
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Standard Methods 412 H
Cyanide	Water	Method 335.3[2]	Method 9010/9012	CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 1311 to obtain leachate Method 9010/9012 for Leachate	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	CLP ILMO2.1	Not Applicable
Flashpoint	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 1010/1020	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Fluoride	Water	Method 300.0[1] Method 340.2[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Hardness	Water	Method 130.2	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Nitrite (NO_2)	Water	Method 300.0[1] (non-preserved) Method 354.1/353.2[2] (preserved)	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nitrate (NO_3)	Water	Method 300.0[1] (non-preserved) Method 352.1/353.2[2] (preserved)	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Nitrate plus Nitrite	Water	Method 353.2[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Nitrogen, Total Kjeldahl (TKN)	Water	Method 351.3 Method 351.4	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nitrogen, Total Organic (TON)	Water	Method 353.1 and 350.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Oil and Grease	Water	Method 413.1	Method 9070	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Method 9071	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9071	Not Applicable	Not Applicable
pH	Water	Method 150.1	Method 9040	Method CLP	Not Applicable
	Liquid	Not Applicable	Method 9040	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 9040	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Method 9045	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9045	Not Applicable	Not Applicable
Phenol	Water	Method 420.2[2]	Method 9060[2]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Phosphate, Ortho & Total	Water	Method 300.0[1] Method 365.1[1]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phosphate (Total)	Water	Method 365.1[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phosphorus (Total)	Water	Method 365.1[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Reactivity	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Section 7.3 Only Applicable to solid waste	Not Applicable	Not Applicable
	Soil	NA	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Residual Chlorine	Water	Method 330.4 Method 330.5	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Settable Matter	Water	Method 160.5[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Sulfate (SO_4)	Water	Method 300.0[1]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Sulfide (SO)	Water	Method 376.1[3]	Method 9030[4]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Sulfite (SO_3)	Water	Method 377.1[1]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Dissolved Solids (TDS)	Water	Method 160.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Organic Carbon (TOC)	Water	Method 415.2[2]	Method 9060[5]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Organic Halides (TOX)	Water	Not Applicable	Method 9020[6]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Total Solids	Water	Method 160.3[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Suspended Solids	Water	Method 160.2[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Turbidity	Water	Method 180.1[4]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-1
ITAS-OAK RIDGE LABORATORY
Inorganic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Volatile Residue	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Method 160.4	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters

[5]Includes drinking and surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters

TABLE OR-4-2
ITAS-OAK RIDGE LABORATORY
Metals Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Toxicity Characteristic Leaching Procedure (TCLP)	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	40 CFR Part 268
	Soil	Not Applicable	Not Applicable	Not Applicable	40 CFR Part 268
ICAP Metals	Water	Method 200.7	Method 3005 Method 3010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Proper pretreatment is described in Section 9 of Method 200.7	Method 3050	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3050	Method CLP ILMO2.1	Not Applicable
CVAA Mercury	Water	Method 245.1	Method 7470	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Method 7470	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Method 7471	Not Applicable	Not Applicable
	Soil	Method 245.5	Method 7471	Method CLP ILMO2.1	Not Applicable
Flame AA Metals	Water	Element Method Potassium 258.1	Element Method Potassium 3005 3010	Element Method Potassium CIP ILMO2.1 Lithium CLP MOD-A	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE OR-4-2
ITAS-OAK RIDGE LABORATORY
Metals Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Flame AA Metals (continued)	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Element Method Potassium 3050	Not Applicable	Not Applicable
	Soil	Not Applicable	Element Method Potassium 3050	Element Method Potassium CLP ILMO2.1 Lithium CLP MOD-A	Not Applicable
GFAA Metals	Water	Element Method Arsenic 206.2 Antimony 204.2 Lead 239.2 Selenium 270.2 Thallium 279.2	Element Method Arsenic 3020 & 7060 Antimony 7041 & 3010 Lead 3020 Selenium 3020 & 7740 Thallium 3020 & 7841	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 3020	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3020	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment		Element Method Arsenic 3050 Antimony 7041 Lead 3050 Selenium 3050 Thallium 3050	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3050	Method CLP ILMO2.1	Not Applicable

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters.

[5]Includes drinking and surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters.

[7]Includes ground waters, drinking, surface and saline waters.

TABLE OR-4-3
ITAS-OAK RIDGE LABORATORY
Organic Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Volatiles by GC/MS	Water	Not Applicable	Method 5030	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 5030	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 5030	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 5030	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 5030	Method CLP OLMO1.8	Not Applicable
Semivolatiles by GC/MS	Water	Not Applicable	Method 3510 Method 3520	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 3580	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3520	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 3550 Method 3640	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3550 Method 3640	Method CLP OLMO1.8	Not Applicable
Pesticides/ PCBs by GC	Water	Not Applicable	Method 3510 Method 3620	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 3580	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3510 Method 3620	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 3550 Method 3640 Method 3620	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3550 Method 3640 Method 3620	Method CLP OLMO1.8	Not Applicable

TABLE OR-4-3
ITAS-OAK RIDGE LABORATORY
Organic Sample Preparation Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Herbicides by GC	Water	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8150	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8150	Not Applicable	Not Applicable
Includes drinking, surface and saline water					

TABLE OR-4-4
ITAS-OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Aluminum	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Antimony	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Arsenic	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Barium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Barium (continued)	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Beryllium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Bismuth	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Boron	Water	Method 200.7	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable

[1] This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Calcium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Cadmium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Cobalt	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Chromium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Chromium (continued)	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Copper	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Iron	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Lead	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

[1] This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Magnesium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMLO2.1	Not Applicable
Manganese	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Molybdenum	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Nickel	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable

[1] This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nickel (continued)	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Selenium	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Silicon	Water	Method 200.7	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Silver	Water	Method 200.7	Method 6010	CLP Method ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 4 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable

This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Sodium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Tin	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Titanium	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Vanadium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 Requires proper pretreatment	Method 6010	Not Applicable	Not Applicable

[1] This method is not recommend for this matrix.

TABLE OR-4-4
OAK RIDGE LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Vanadium (continued)	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable
Zinc	Water	Method 200.7[1]	Method 6010	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO2.1	Not Applicable

[1]Includes drinking, surface and saline water, domestic and industrial waste effluents.

Oak Ridge Laboratory can recommend appropriate methodologies and can provide analysis for additional metals upon request.

This method is not recommend for this matrix.

TABLE OR-4-5
ITAS-OAK RIDGE LABORATORY
Flame Atomic Absorption Inorganic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Flame AA Metals Lithium Potassium	Water	Element Method Potassium 258.1	Element Method Potassium 7610	Element Method Potassium CIP ILMO2.1 Lithium CLP MOD-A	Not Applicable
	Liquid	Not Applicable	Element Method Potassium 7610	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment Soil	Not Applicable	Element Method Potassium 7610	Not Applicable	Not Applicable
		Not Applicable	Element Method Potassium 7610	Element Method Potassium CIP ILMO2.1 Lithium CLP MOD-A	Not Applicable

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters

[5]Includes drinking and surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters

[illegible]es ground waters, drinking, surface and saline waters

TABLE OR-4-6
ITAS-OAK RIDGE LABORATORY
Graphite Furnace Atomic Absorption Methods

Parameter	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Antimony	Water	Method 204.2[1]	Method 7041	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 7041	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 204.2 **Requires proper pretreatment.**	Method 7041	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7041	Method CLP ILMO1.2	Not Applicable
Arsenic	Water	Method 206.2[1]	Method 7060	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 7060	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 206.2 **Requires proper pretreatment**	Method 7060	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7060	Method CLP ILMO2.1	Not Applicable
Lead	Water	Method 239.2[1]	Method 7421	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 7421	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 239.2 **Requires proper pretreatment**	Method 7421	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7421	Method CLP ILMO2.1	Not Applicable
Selenium	Water	Method 270.2[1]	Method 7740	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 7740	Not Applicable	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE OR-4-6
OAK RIDGE LABORATORY
Graphite Furnace Atomic Absorption Methods
Continued

Parameter	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Selenium (continued)	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 270.2 **Requires proper pretreatment**	Method 7740	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7740	Method CLP ILMO2.1	Not Applicable
Thallium	Water	Method 279.2[1]	Method 7841	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Method 7841	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 279.2 **Requires proper pretreatment**	Method 7841	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7841	Method CLP ILMO2.1	Not Applicable

[1] Includes drinking, surface and saline waters

This method is not recommend for this matrix.

TABLE OR-4-7
ITAS-OAK RIDGE LABORATORY
Cold Vapor Atomic Absorption Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
CVAA Mercury	Water	Method 245.1	Method 7470	Method CLP ILMO2.1	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Method 7470	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 7471	Not Applicable	Not Applicable
	Soil	Method 245.5	Method 7471	Method CLP ILMO2.1	Not Applicable

TABLE OR-4-8
ITAS-OAK RIDGE LABORATORY
Organic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Volatiles by GC/MS	Water	Method 624[1]	Method 8260	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 8260	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8260	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8260	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8260	Method CLP OLMO1.8	Not Applicable
Semivolatiles by GC/MS	Water	Method 625[1]	Method 8270	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 8270	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8270	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8270	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8270	Method CLP OLMO1.8	Not Applicable
Pesticides/ PCBs	Water	Method 608[1]	Method 8080	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 8080	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8080	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8080	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8080	Method CLP OLMO1.8	Not Applicable
Herbicides	Water	Method 615[1]	Method 8150	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8150	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8150	Not Applicable	Not Applicable

TABLE OR-4-8
OAK RIDGE LABORATORY
Organic Methods
Continued

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Herbicides (continued)	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Soils	Not Applicable	Method 8150	Not Applicable	Not Applicable

[1]Includes drinking, surface and saline water

TABLE OR-4-9
ITAS-OAK RIDGE LABORATORY
Radiological Methods

Analytical Parameters	Matrix	Method
Gross Alpha/Beta	Water	Direct Determination by Gas Flow Proportional Alpha/Beta Counting
	Soil	Direct Determination by Gas Flow Proportional Alpha/Beta Counting
	Filter	Direct Determination by Gas Flow Proportional Alpha/Beta Counting
Americium-241	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
Carbon-14	Water	Direct Determination by Liquid Scintillation Counting Sample Distillation and Liquid Scintillation Counting
	Soil	Combustion of Sample, Collection of CO_2 and Determination by Liquid Scintillation Counting
	Other Matrices	Combustion of Sample, Collection of CO_2 and Determination by Liquid Scintillation Counting
Calcium-45	Water	Direct Determination by Liquid Scintillation Counting Chemical Separation and Liquid Scintillation Counting
	Soil	Not Applicable
	Other Matrices	Not Applicable
Curium-242	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Sample Digestion, Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
Gamma Emitters Actinides, as applicable, Co-60, Cs-137, K-40, Mn-54, and other fission/activation products	Water	Direct Determination by Gamma Spectroscopy
	Soil	Direct Determination by Gamma Spectroscopy
	Vegetation	Direct Determination by Gamma Spectroscopy
Iodine 131	Water	Direct Determination by Gamma Spectroscopy or Separation by Ion Exchange and Determination by Gas Flow Proportional Bet Counting
	Soil	Direct Determination by Gamma Spectroscopy
	Other Matrices	Matrix Dependent

TABLE OR-4-9
ITAS-OAK RIDGE LABORATORY
Radiological Methods
Continued

Analytical Parameters	Matrix	Method
Iron-55	Water	Separation by Ion Exchange and Determination by Liquid Scintillation Counting
	Soil	Not Applicable
	Other Matrices	Not Applicable
Lead-210	Water	Separation by Ion Exchange and Determination by Gas Flow Proportional Beta Counting of the Bi-210 Daughter
	Soil	Direct Determination by Gamma Spectroscopy
	Other Matrices	Not Applicable
Neptunium-237	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Matrix Dependent
Promethium-147	Water	Organic Extraction and Determination by Gas Flow Proportional Beta Counting Organic Extraction and Determination by Liquid Scintillation Counting
	Soil	Not Applicable
	Other Matrices	Not Applicable
Plutonium-238,239/240	Water	Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Ion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Matrix Dependent
Radium-226	Water	Sequential Determination of Ra-226,228 by Co-precipitation and Determination by Alpha Spectrometry
	Soil	Determination by Gamma Spectroscopy of Lead-214 and Bismuth-214 Daughters
	Other Matrices	Matrix Dependent
Radium-228	Water	Sequential Determination of Ra-226,228 by Co-precipitation and Determination by Gas Flow Proportional Beta Counting
	Soil	Determination by Gamma Spectroscopy of the Actinium-228 Daughter
	Other Matrices	Matrix Dependent
Strontium-89,90 and Total Strontium	Water	Precipitation and Determination by Gas Flow Proportional Beta Counting
	Soil	Sample Digestion, Precipitation and Determination by Gas Flow Proportional Beta Counting
	Other Matrices	Not Applicable
Technetium-99	Water	Organic Extraction and Determination by Gas Flow Proportional Beta Counting
	Soil	Sample Leach or Digestion, Organic Extraction and Determination by Gas Flow Proportional Beta Counting
	Other Matrices	Not Applicable

TABLE OR-4-9
ITAS-OAK RIDGE LABORATORY
Radiological Methods
Continued

Analytical Parameters	Matrix	Method
Thorium-227,228,230,232	Water	Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Sequential Separation by Anion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Not Applicable
Total Uranium	Water	ASTM:D5174-90; Determination by Pulsed-Laser Phosphorimetry
	Soil	Not Applicable
	Other Matrices	Not Applicable
Tritium	Water	Direct Determination by Liquid Scintillation Counting Cryogenic Distillation and Determination by Liquid Scintillation Counting Sample Distillation and Determination by Liquid Scintillation Counting
	Soil	Cryogenic Distillation and Determination By Liquid Scintillation Counting
	Other Matrices	Matrix Dependent
Uranium-233 234,235/236	Water	Separation by Anion Exchange and Determination by Alpha Spectrometry
	Soil	Sample Digestion, Separation by Anion Exchange and Determination by Alpha Spectrometry
	Other Matrices	Matrix Dependent
Uranium-238	Water	Separation by Anion Exchange and Determination by Alpha Spectrometry
	Soil	Direct Determination by Gamma Spectroscopy of Thorium-234 (Assumes secular equilibrium between ^{238}U and ^{234}Th)
	Other Matrices	Matrix Dependent

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APPENDIX

OAK RIDGE-5

PRACTICAL QUANTITATION LIMITS AND METHOD DETECTION LIMITS

TABLE OR-5-1
ITAS-OAK RIDGE LABORATORY
Method Detection Limits for Wet Chemistry

PARAMETER	METHOD DETECTION LIMIT (mg/L)
Total Organic Carbon	1.00
Nitrate	0.10
Total Suspended Solids	1.00
Sulfide	0.50
Nitrite	0.10
Chloride	0.50
Total Dissolved Solids	1.00
Hexavalent Chromium	0.05
Total Phosphate	0.02
Sulfate	2.00
Total Kjeldahl Nitrogen	0.10
Total Organic Halogens	0.01
Ammonia	0.10
Cyanide	0.002
Total Organic Nitrogen	0.10
Phenol	0.01

TABLE OR-5-2
ITAS-OAK RIDGE LABORATORY
ICAP Metals
Contract Required Detection Limits (CRDL),
Contract Laboratory Program (CLP)
Method Detection Limits (MDL),
and Practical Quantitation Limits (PQL)

Element	CAS Number	Water CRDL[1] (ug/L)	Soil CRDL[1] (mg/Kg)	Water MDL (ug/L)	Soil MDL (mg/Kg)	Water PQL (ug/L)	Soil PQL (mg/Kg)
Aluminum	7429-90-5	200	40	30	6	300	60
Antimony	7440-36-0	60	12	100	20	1000	200
Arsenic	7440-38-2	10	2	50	10	500	100
Barium	7440-39-3	200	40	5	1	50	10
Beryllium	7440-41-7	5	1	5	1	50	10
Boron	7440-42-8	**		60	12	600	120
Bismuth		**					
Cadmium	7440-43-9	5	1	5	1	50	10
Calcium	7440-70-2	5000	1000	25	5	250	50
Chromium	7440-47-3	10	2	12.5	2.5	125	25
Cobalt	7440-48-4	50	10	10	2	100	20
Copper	7440-50-8	25	5	25	5	250	50
Iron	7439-89-6	100	20	30	6	300	60
Lead	7439-92-1	3	0.6	50	10	500	100
Lithium	7439-93-2	*		100	20	1000	200
Magnesium	7439-95-4	5000	1000	50	10	500	100
Manganese	7439-96-5	15	3	10	2	100	20
Molybdenum	7439-98-7	*		10	2	100	20
Nickel	7440-02-0	40	8	25	5	250	50
Platinum	7440-06-4	N/A	N/A	N/A	N/A	N/A	N/A
Potassium	7440-09-7	5000	1000	1000	200	10000	2000
Selenium	7782-49-2	5	1	80	16	800	160
Silicon	7440-21-3	*		200	40	2000	4000
Silver	7440-22-4	10	2	10	2	100	20
Sodium	7440-22-4	5000	1000	100	20	1000	200

TABLE OR-5-2
OAK RIDGE LABORATORY
ICAP Metals
Contract Required Detection Limits (CRDL),
Contract Laboratory Program (CLP)
Method Detection Limits (MDL),
and Practical Quantitation Limits (PQL)

Element	CAS Number	Water CRDL[1] (ug/L)	Soil CRDL[2] (mg/Kg)	Water MDL (ug/L)	Soil MDL (mg/Kg)	Water PQL (ug/L)	Soil PQL (mg/Kg)
Thallium	7440-28-0	10	2	250	50	2500	500
Tin	7440-31-5	**					
Vanadium	7440-62-2	50	10	10	2	100	20
Zinc	7440-66-6	20	4	10	2	100	20

[1]Higher detection limits may be utilized under the following circumstances.

If the sample concentration exceeds five (5) times the detection limit of the instrument, the values may be reported even though the instrument detection limit may not equal the contract required detection limit.

[2]Estimated detection limit based on a one (1) gram sample diluted to two hundred (200) milliliters.

* Client-specific method, not CLP

** Due to instrument change, MDLs are in process of being determined

TABLE OR-5-3
ITAS-OAK RIDGE LABORATORY
GFAA Metals
Contract Required Detection Limits (CRDL)
Contract Laboratory Program (CLP),
Method Detection Limits (MDL), and
Practical Quantitation Limits (PQL)

Element	CAS Number	Water CRDL[1] (ug/L)	Soil CRDL[2] (mg/Kg)	Water MDL (ug/L)	Soil MDL (mg/Kg)	Water PQL (ug/L)	Soil PQL (mg/Kg)
Arsenic	7440-38-2	10	2	10	2	100	20
Lead	7439-92-1	3	0.6	4.5	0.9	45	9
Selenium	7782-49-2	5	1	7.5	1.5	75	15
Thallium	7440-28-0	10	2	5	1	50	10
Mercury[3]	7439-97-6	0.2	0.1	0.2	0.1	2	1

[1]Higher detection limits may be utilized under the following circumstances.

If the sample concentration exceeds five (5) times the detection limit of the instrument, the values may be reported even though the instrument detection limit may not equal the contract required detection limit.

[2]Estimated detection limit based on a one (1) gram sample diluted to two (2) hundred milliliters.

[3]Analyzed by Cold vapor AA

TABLE OR-5-4
ITAS-OAK RIDGE LABORATORY
CLP or Hazardous Substance List for Volatile Organics
with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[1,2] and Practical Quantitation Limits (PQL)[1,3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/Kg)
Chloromethane	74-87-3	10	10	7.0	11.6	70	116
Bromomethane	74-83-9	10	10	3.3	4.0	33	40
Vinyl Chloride	75-01-4	10	10	5.2	9.6	52	96
Chloroethane	75-00-3	10	10	3.2	4.3	32	43
Methylene Chloride	75-09-2	10	10	3.4	7.8	34	78
Acetone	67-64-1	10	10	7.2	10	72	100
Carbon Disulfide	75-15-0	10	10	3.7	5.4	37	54
1,1-Dichloroethene	75-35-4	10	10	2.9	3.6	29	36
1,1-Dichloroethane	75-34-3	10	10	2.8	3.2	28	32
1,2-Dichloroethene (total)	540-59-0	10	10	3.1	2.5	31	25
Chloroform	67-66-3	10	10	3.0	2.7	30	27
1,2-Dichloroethane	107-06-2	10	10	3.2	2.3	32	23
2-Butanone	78-93-3	10	10	3.6	3.8	36	38
1,1,1-Trichloroethane	71-55-6	10	10	2.9	4.4	29	44
Carbon Tetrachloride	56-23-5	10	10	3.2	5.5	32	55
Vinyl Acetate		10	10	2.6	2.9	26	29
Bromodichloromethane	124-48-1	10	10	3.4	3.5	34	35
1,2-Dichloropropane	78-87-5	10	10	2.7	2.5	27	25
cis-1,3-Dichloropropene	10061-01-5	10	10	2.7	2.0	27	20
Trichloroethene	79-01-6	10	10	3.0	4.8	30	48
Dibromochloromethane	75-27-4	10	10	3.5	3.4	35	34
1,1,2-Trichloroethane	79-00-5	10	10	3.4	3.7	34	37
Benzene	71-43-2	10	10	3.0	4.8	30	48
trans-1,3-Dichloropropene	10061-02-6	10	10	2.6	1.7	26	17
Bromoform	75-25-2	10	10	3.5	4.9	35	49
4-Methyl-2-Pentanone	108-10-1	10	10	4.1	4.3	41	43
2-Hexanone	591-78-6	10	10	5.2	6.0	52	60
Tetrachloroethene	127-18-4	10	10	2.8	1.8	28	18
Toluene	108-88-3	10	10	3.3	4.2	33	42

TABLE OR-5-4
OAK RIDGE LABORATORY
CLP or Hazardous Substance List for Volatile Organics
with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[1,2] and
Practical Quantitation Limits (PQL)[1,3]
Continued

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/Kg)
1,1,2,2-Tetrachloroethane	79-34-5	10	10	3.3	4.7	33	47
Chlorobenzene	108-90-7	10	10	3.0	2.8	30	28
Ethylbenzene	100-41-4	10	10	3.0	2.9	30	29
Styrene	100-42-5	10	10	3.2	3.1	32	31
Xylene (total)	1330-20-7	10	10	3.3	3.8	33	38

[1]Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable

[2]The Method Detection Limit study was performed on 1/12/93 & 3/22/93.

[3]Practical Quantitation Limits were arrived at by 10 x MDL per CLP SOW OLM01.8

[4]Quantitation limits listed for soil are based on wet weight. The quantitation limits based on dry weight as required, will be higher.

TABLE OR-5-5
ITAS-OAK RIDGE LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[1,2] and Practical Quantitation Limits (PQL)[1,3]

Analyte	CAS Number	Water CRQL (ug/L)	Soil CRQL[4] (ug/Kg)	Water MDL (ug/Kg)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/L)
Phenol	108-95-2	10	330	4.1	181	41	1810
bis(2-Chloroethyl)ether	111-44-4	10	330	3.4	180	34	1800
1,3-Dichlorobenzene	541-73-1	10	330	2.8	160	28	1600
1,4-Dichlorobenzene	106-46-7	10	330	2.7	172	27	1720
Benzyl Alcohol	100-51-6	10	330	3.2	367	32	3670
1,2-Dichlorobenzene	95-50-1	10	330	2.6	183	26	1830
2-Methylphenol	95-48-7	10	330	3.4	208	34	2080
bis(2-chloroisopropyl)ether	108-60-1	10	330	3.0	242	30	2420
4-Methylphenol	106-44-5	10	330	3.3	249	33	2490
n-Nitroso-di-n-Propylamine	621-64-7	10	330	3.5	169	35	1690
Hexachloroethane	67-72-1	10	330	2.5	206	25	2060
Nitrobenzene	98-95-1	10	330	5.2	140	52	1400
Isophorone	78-59-1	10	330	4.2	182	42	1820
2-Nitrophenol	88-75-5	10	330	3.3	186	33	1860
2,4-Dimethylphenol	150-67-9	10	330	3.8	175	38	1750
Benzoic Acid	65-85-0	10	330	9.7	491	97	4910
bis(2-Chloroethoxy) Methane	111-91-1	10	330	3.0	164	30	1640
2,4-Dichlorophenol	120-83-2	10	330	3.7	250	37	2500
1,2,4-Trichlorobenzene	120-82-1	10	330	3.0	228	30	2280
Naphthalene	91-20-3	10	330	2.7	203	27	2030
4-Chloroaniline	106-47-8	10	330	1.3	34	13	340
Hexachlorobutadiene	87-68-3	10	330	2.8	197	28	1970
4-Chloro-3-Methylphenol	59-50-7	10	330	3.5	258	35	2580
2-Methylnaphthalene	91-57-6	10	330	3.3	203	33	2030
2-Chlorophenol	95-57-8	10	330	3.6	212	36	2120
Hexachlorocyclopentadiene	77-47-4	10	330	N/A	152	N/A	1520
2,4,6-Trichlorophenol	*88-06-2*	*10*	*330*	*3.8*	*238*	38	2380
2,4,5-Trichlorophenol	95-95-4	25	800	4.0	243	40	2430
2-Chloronaphthalene	91-58-7	10	330	3.5	203	35	2030

TABLE OR-5-5
ITAS-OAK RIDGE LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[1,2] and Practical Quantitation Limits (PQL)[1,3]

Analyte	CAS Number	Water CRQL (ug/L)	Soil CRQL[4] (ug/Kg)	Water MDL (ug/Kg)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/L)
2-Nitroaniline	88-74-4	25	800	2.1	147	21	1470
Dimethyl Phthalate	31-11-3	10	330	2.4	207	24	2070
Acenaphthylene	208-96-8	10	330	3.0	205	30	2050
2,6-Dinitrotoluene	606-20-2	10	330	2.5	286	25	2860
3-Nitroaniline	99-09-2	25	800	1.7	149	17	1490
Acenaphthene	83-32-9	10	330	3.0	210	30	2100
2,4-Dinitrophenol	51-28-5	25	800	14	359	140	3590
4-Nitrophenol	100-02-7	25	800	7.5	276	75	2760
dibenzofuran	132-64-9	10	330	3.4	222	34	2220
2,4-Dinitrotoluene	121-14-2	10	330	2.9	219	29	2190
Diethylphthalate	84-66-2	10	330	2.1	187	21	1870
4 Chlorophenyl-phenylether	7005-72-36	10	330	2.7	201	27	2010
Fluorene	96-73-7	10	330	2.8	208	28	2080
4-Nitroaniline	100-01-6	25	800	2.0	223	20	2230
4,6-Dinitro-2-Methylphenol	534-52-1	25	800	13	375	130	3750
n-Nitrosodiphenylamine	96-30-6	10	330	2.7	239	27	2390
4-Bromophenyl-phenylether	101-55-3	10	330	2.1	188	21	1880
Hexachlorobenzene	118-74-1	10	330	2.1	203	21	2030
Pentachlorophenol	87-86-5	25	800	6.9	275	69	2750
Phenanthrene	85-01-8	10	330	1.7	257	17	2570
Anthracene	120-12-7	10	330	2.3	260	23	2600
Di-n-Butylphthalate	84-74-2	10	330	1.7	205	17	2050
Fluoranthene	206-44-0	10	330	21	227	210	2270
Pyrene	129-00-0	10	330	1.9	331	19	3310
Butylbenzylphthalate	85-68-7	10	330	2.0	192	20	1920
3,3'-Dichlorobenzidine	91-94-1	10	330	4.2	185	42	1850
Benzo(a)anthracene	56-55-3	10	330	2.1	262	21	2620
Chrysene	218-01-9	10	330	1.9	271	19	2710
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	2.2	252	22	2520
Di-n-Octylphthalate	117-84-0	10	330	2.8	270	28	2700

TABLE OR-5-5
ITAS-OAK RIDGE LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[1,2] and Practical Quantitation Limits (PQL)[1,3]

Analyte	CAS Number	Water CRQL (ug/L)	Soil CRQL[4] (ug/Kg)	Water MDL (ug/Kg)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/L)
Benzo(b)fluoranthene	205-99-2	10	330	2.4	172	24	1720
Benzo(k)fluoranthene	207-08-9	10	330	3.3	300	33	3000
Benzo(a)pyrene	50-32-8	10	330	2.2	248	22	2480
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	2.4	265	24	2650
Dibenzo(a,h)anthracene	53-70-3	10	330	2.1	270	21	270
Benzo(g,h,i)perylene	191-24-2	10	330	1.8	242	18	2420

[1]Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

[2]The Method Detection Limit study was performed on 2/4/93 & 3/5/93.

[3]Practical Quantitation Limits were arrived at by MDL x 10 per CLP SOW OLM01.8

[4]Quantitation limits listed for soil are based on wet weight. The quantitation limits based on dry weight as required, will be higher.

TABLE OR-5-6
ITAS-OAK RIDGE LABORATORY
CLP (3/90) or Hazardous Substance List for Pesticides and PCBs with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[1,2], and Practical Quantitation Limits (PQL)[1,3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/Kg)
α-BHC	319-84-6	0.05	1.7	0.01	0.40	0.1	4
β-BHC	319-85-7	0.05	1.7	0.02	0.80	0.2	8
δ-BHC	319-86-8	0.05	1.7	0.02	1.1	0.2	4
γ-BHC (Lindane)	58-89-9	0.05	1.7	0.02	0.40	0.2	4
Heptachlor	76-44-8	0.05	1.7	0.02	0.60	0.2	6
Aldrin	309-00-2	0.05	1.7	0.01	0.80	0.1	8
Heptachlor Epoxide	1024-57-3	0.05	1.7	0.01	0.80	0.1	8
Endosulfan I	959-98-8	0.05	1.7	0.02	0.60	0.2	6
Dieldrin	60-75-1	0.10	3.3	0.02	1.2	0.2	12
4,4'-DDE	72-55-9	0.10	3.3	0.02	1.5	0.2	15
Endrin	72-20-8	0.10	3.3	0.02	1.4	0.2	14
Endosulfan II	33213-65-9	0.10	3.3	0.05	1.8	0.5	18
4,4'-DDD	72-54-8	0.10	3.3	0.02	0.80	0.2	8
Endosulfan sulfate	1031-07-8	0.10	3.3	0.07	3.7	0.7	37
4,4'-DDT	50-29-3	0.10	3.3	0.02	1.4	0.2	14
Methoxychlor	72-43-5	0.50	17	0.02	1.4	0.2	14
Endrin Ketone	53494-70-5	0.10	3.3	0.04	1.4	0.4	14
α-Chlordane	5103-71-9	0.05	1.7	0.02	1.3	0.2	13
γ-Chlordane	5103-74-2	0.05	1.7	0.01	1.0	0.1	10
Toxaphene	8001-35-2	5.0	170.0	0.80	54	8	540
Aroclor 1016	12674-11-2	1.0	33.0	0.12	32	1.2	320
Aroclor 1221	11104-28-2	2.0	67.0	0.29	36	2.9	360
Aroclor 1232	11141-16-5	1.0	33.0	0.28	12	2.8	120
Aroclor 1242	53469-21-9	1.0	33.0	0.31	31	3.1	310
Aroclor 1248	12672-29-6	1.0	33.0	0.52	27	5.2	270

TABLE 7.3-6
OAK RIDGE LABORATORY
CLP (3/90) or Hazardous Substance List for Pesticides and PCBs
with Contract Required Detection Limits (CRDL)[1],
Method Detection Limits (MDL)[1,2], and
Practical Quantitation Limits (PQL)[1,3]
Continued

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL (ug/Kg)	Water PQL (ug/L)	Soil PQL (ug/Kg)
Aroclor 1254	11097-69-1	1.0	33.0	0.17	25	1.7	250
Aroclor 1260	11096-82-5	1.0	33.0	0.15	26	1.5	260

Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

[2]The Method Detection Limit study was performed on 2/15/93 - 3/8/93.

[3]Practical Quantitation Limits were arrived at by MDL x 10 per CLP SOW OLM01.8.

[4]Quantitation limits listed for soil are based on wet weight. The quantitation limits based on dry weight as required, will be higher.

FIGURE OR-5-1
ITAS-OAK RIDGE LABORATORY
Radiochemical Method Detection Limit Determinations

The minimum detectable activity for radiochemical analyses is given by:

$$MDA = \frac{4.65 * S_b + 2.71/T}{E}$$

where: MDA = minimum detectable activity (dpm)

S_b = the standard deviation in the count rate of a blank including all experimental variations as obtained by replicating the entire measurement of the appropriate blank, not just the Poisson component of the square root of the count.

T = count time

E = efficiency factor (cpm/dpm)

2.71 = Poisson factor

Detector characteristics, count time, sample volume and matrix effects that influence chemical yield affect the minimum detectable concentration. Count durations and sample volumes can be optimized in order to meet client required detection limits. Matrix effects, including high levels of other radionuclides in the sample, may cause the sample detection limit for the target radionuclide to exceed the required limit.

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APPENDIX

OAK RIDGE-6

PERFORMANCE EVALUATION STUDIES

TABLE OR-6-1
ITAS-Oak Ridge Laboratory
Performance Evaluation Studies

PE Sample Program Description	Analysis Performed	Frequency of Participation
USEPA Water Supply Performance Evaluation Study- Environmental Monitoring Systems Laboratory- Cincinnati	Metals, Nutrients, Demands, Classical chemistry, Purgeable Organics, Extractable Organics, Pesticides, PCBs, Herbicides, in Water.	Quarterly
USEPA Water Poilution Performance Evaluation Study - Environmental Monitoring Systems Laboratory - Cincinnati	Metals, Nutrients, Demands, Classical Chemistry, Purgeable organics, Extractable Organics, Pesticides, PCBs in Water.	Bi-Annually
USEPA Organic Quarterly Blind Performance Evaluation Samples - Environmental Monitoring Systems Laboratory - Las Vegas	Purgeable and Extractable Organic Compounds in Water. TCL[1]	Bi-Annually
USEPA Inorganic Performance Evaluation Study - Environmental Monitoring Systems Laboratory - Las Vegas	Metals in Water and Soil. TAL[2]	Quarterly
USEPA Environmental Radioactivity Laboratory Intercomparison Studies Program - Environmental Monitoring Systems Laboratory - Las Vegas	Gamma Emitters: ^{90}Sr, ^{226}Ra, ^{228}Ra, ^{238}U, and H_3 in water.	Monthly
Department of Energy Environmental Measurements Laboratory (DOE-EML) Office of Environmental Restoration and Waste Management, Quality Assessment Program - New York	Gamma Emitters: ^{90}Sr, ^{239}Pu, ^{241}Am, and U-Total in Air. Gamma Emitters: 90Sr, ^{239}Pu, ^{241}Am and U-Total in Soil. Gamma Emitters: ^{90}Sr, ^{239}Pu, ^{241}Am and U-Total in vegetation. H_3, ^{90}S, ^{239}Pu, ^{241}Am, and U-Total in Water.	Bi-Annually

[1] Target Compound List USEPA CLP 0LM01.8

[2] Target Analyte List USEPA CLP ILM02.1

APPENDIX

OAK RIDGE-7

PREVENTIVE MAINTENANCE SCHEDULES

TABLE OR-7-1
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Gas Chromatography[1]

As Needed	Semi-annually
Replace front portion of column packing or break off front portion of capillary columns. Replace column if this action fails to restore performance of the column or when column performance (*e.g.* peak tailing, poor resolution, high backgrounds, etc.) indicates it is required.	Perform ECD wipe test.
Change glass wool plug in injection port and/or replace injection port liner with cleaned liner when front portion of column packing is changed or front portion of capillary column is removed.	Replace carbon filters at instrument effluent sites.
Replace septum (usually approximately every 100 injections).	
Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).	
Replace or repair flow controller if constant gas flow cannot be maintained.	
Change fuse when performance indicates fuse has blown.	
Reactivate external carrier gas dryers when blue indicator changes to pink.	
Clean detectors when baseline indicates contamination or when response is low.	
Reactivate flow controller filter dryers when presence of moisture is suspected.	
Tekmar purge and trap devices: replace traps and columns when poor response or disappearance of reactive or poorly trapped compounds.	

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE OR-7-2
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Gas Chromatography/Mass Spectrometry (GC/MS)

As Needed	Daily	Bi-Weekly	Quarterly	Bi-Annualy
Remove, disassemble, clean source and rods	Change/clean/silanize injector port liner	Check fluid levels in Cool flow chillers and add glycol-water mix as needed	Clean or change all air filters.	Change vacuum pump oil
Replace filaments	Check and change gas supply cylinder when tank pressure ≤ 500 psi main gauge			
Change guard column	Change gas flows in each GC			
Change column				
Change injection septa when opened				
Replace multiplier				
Change carrier gas dryer tube				

TABLE OR-7-3
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Mass Spectrometers[1]

Instrument	As Needed	Monthly	Annually
Mass Spectrometer	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between service contract maintenance.	Not Applicable	Not Applicable
	Electron multiplier: replace when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.		
	Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.		
Neslab Chiller	Check coolant level. Add coolant as required to maintain cooling.	Vacuum outside chiller to prevent dust from clogging filters	Clean on-line filter in Neslab

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations

TABLE OR-7-4
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Graphite Furnace Atomic Absorption[1]

Daily	Monthly	Semi-annually
Clean Optical Windows	Check coolant level in cooling unit. Add coolant if error message appears	Visual inspection
Inspect contact cylinders. Replace if contact surface is pitted or excessively worn.		Check power connections
		Sensitivity check
		General cleaning
		Check optics
		Inspect graphite rings and graphite tube
		Check power supply
		Check temperature calibration of HGA
		Check absorbance screens - calibrate if needed
		Check Zeeman phasing
Clean contact cylinders		Check gas flows
Check tubes and platform, replace if corroded, flaking, or if low absorbance results		
Check autosampler alignment		
Check fluid levels in rinsate bottles and refill if needed		
Check and change gas supply cylinder when tank pressure ≤ 100 psi main gauge		

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations

TABLE OR-7-5
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Ion Chromatography[1]

As Needed	Daily	Weekly	Monthly	Semi-annually
Change column, check flow valve, washers and tubing if changes in chromatography are observed	Check plumbing	Check pump heads for leaks	Clean conductivity cell	Replace gradient pump piston seal
Change fuses when power problems occur	Check UV/VIS detector for leaks	Check filter (inlet)	Check conductivity cell for calibration	Clean high pressure valve
Change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated.			Check all air and liquid lines for discoloration and crimping, if indicated.	
Degas pump head when flow is erratic				

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE OR-7-6
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
ICP[1]

As Needed	Daily	Weekly	Monthly	Semi-annually
Check and clean nebulizer, mixing chamber and torch	Check the pump winding, replace if needed	Check torch assembly and clean if needed	Clean intelligence controller filters	Change vacuum pump oil
Check tuning and RF generator (by service engineer)	Check gas flows and change gas supply cylinder when tank pressure ≤ 100 psi main gauge	Check peristaltic pump assembly and tubing and replace as needed	Clean optical path windows	
Check torch alignment	Check coolant flow		Clean RF generator filters	
Check work coil	Check drain reservoir and empty when near full		Check the pump capillary tubing and auto sampler tubing, clean or replace if needed.	

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE OR-7-7
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Total Organic Carbon Analyzer[1]

As Needed	Daily	Weekly	Bi-monthly
Repair of all TOC electronics and optical assemblies	Check oxygen supply	Check liquid-flow-rate-pump-tubing conditions	Change pump tubing
Replace combustion tube catalyst	Check persulfate supply	Check for moisture in LiOH tube.	
Replace combustion tube	Check acid supply	Check injection port septum.	
Replace UV lamp	Check printer paper.		
Change Sn and Cu.	Check Sn and Cu scrubber		
Replace tubing	Add a few drops of H_3PO_4 to GLS.		
	Check carrier gas flow rate ($\approx$ 200 cc/min).		

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE OR-7-8
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Total Organic Halide Analyzer[1]

As Needed	Daily	Weekly	Monthly	Annualy
Change quartz wool in exit tube.	Check exit tube and quartz wool.	Measure gas flow.	Check o-rings, replace if worn.	Perform electronic test.
	Check for gas bubbles in titration sidearm.			
	Check inlet area for GAC spills			
	Check electrolyte level, add if needed			
	Clean quartz boat.			
	Perform cell performance check.			

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE OR-7-9
ITAS-OAK RIDGE LABORATORY
Maintenance Schedule
Radiological Analysis Equipment[1]

Instrument	As Needed	Weekly	Monthly	Annually
Gas Flow Proportional Counters	As carrier gas is consumed, change P-10	Not Applicable	Not Applicable	Not Applicable
Germanium Gamma Detector	Not Applicable	Fill liquid nitrogen Dewars	Not Applicable	Not Applicable
Alpha Spectrometers	Not Applicable	Not Applicable	Check vacuum pump oil level, fill if necessary.	Change vacuum pump oil.
Liquid Scintillation Counter	Not Applicable	Not Applicable	Normalize PM tubes	Not Applicable

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations

APPENDIX

OAK RIDGE-8

ADDITIONAL OPERATION-SPECIFIC INFORMATION

TABLE OR-8-1
ITAS-OAK RIDGE LABORATORY
Summary of Radiological Instrument Calibrations

Detector	Type	Minimum Frequency	Criteria
Germanium Gamma Detectors	Initial Calibration	Annually	Efficiency spike total error within 5% of NIST established value for source
	Check Source	Daily	Within 3 standard deviations established from control chart
	Background	Daily	10 minute counts ± 3 Standard Deviations established from control chart
Gas Flow Proportional Counters	Initial Calibration	Annually	Efficiencies determined by counting standard at operating (plateau) voltage
	Self-Absorption Curves	Every 3 years	Determination of dependence of counting efficiency as a function of source weight over a range of weights representative of the analyses
	Self-Absorption Curve Check	Annually	Check curve at 3 points. Error of checks overlap error of curve.
	Check Source	Daily	±3 Standard Deviations established from Control Chart
	Background	Daily	±3 Standard Deviations established from Control Chart
Alpha Spectrometers	Initial Calibration	Quarterly	Determine efficiency at ^{234}U peak at minimum of 2000 counts
	Pulser Check	Daily	Peak Centroid within ± 30 KeV
	Energy Calibration	Quarterly	Peak Resolution at FWHM (Full Width at Half Maximum Height) ≤ 21 KeV
	Background	Weekly	1000 minute count < 100 counts over entire spectrum < 10 counts in any region
Liquid Scintillation Counters	Self Normalization	Daily	Pass or Fail against Instrument Internal System Check
	Count Reproducibility Check	Daily	± 3 Standard Deviations established from control charts
	Background	Daily	± 3 Standard Deviations established from control charts
	Quench Curve Check	Weekly	± 3 Standard Deviations established from control charts

TABLE OR-8-2
ITAS-OAK RIDGE LABORATORY
Kinetic Phosphorescent Analyzer Calibrations

Detector	Type	Minimum Frequency	Criteria
Kinetic Phosphorescent Analyzer	Initial Calibration	Daily	4 low and 4 high standards; $r^2 \geq 0.96$; lifetime between 100-340 μs
	Calibration Check	Daily	1 low and 1 high; must be within 2σ error
	Background	Daily	$r^2 \geq 0.96$; lifetime between 100-340 μs

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APPENDIX C

IT ANALYTICAL SERVICES
OAK RIDGE LABORATORY
STANDARD OPERATING PROCEDURE
TITLE: SEQUENTIAL DETERMINATION OF RADIUM-226 AND RADIUM-228

INTERNATIONAL TECHNOLOGY CORPORATION

IT Analytical Services

Oak Ridge Laboratory
Standard Operating Procedure

Title: Sequential Determination of Radium-226 and Radium-228

Prepared by: James M. Dillard Date: 12-20-91

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Key Words:

Revision #	0	1					
Date	12/20/91	04/30/92					

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HISTORY OF PROCEDURE REVISION

REVISION NO.	DATE	PAGES AFFECTED	REASON FOR REVISION
0	12/20/91	ALL	NEW PROCEDURE
1	4/30/92	ALL	INCORPORATION OF REVIEW COMMENTS

1.0 Purpose and Application

1.1 Purpose

To provide detailed instructions for the sequential determination of dissolved radium-228 and radium-226 by quantification of beta emission from the actinium-228 daughter after chemical separation and by alpha spectroscopy, respectively for radium-226.

1.2 Application

This method is applicable to an aqueous matrix with no suspended solids. This method may also be used in conjunction with sample preparation procedures which act to dissolve the radium in an aqueous matrix.

1.3 Responsibilities

1.3.1 It is the responsibility of the Radiation Safety Officer (RSO), or his/her designee, to indicate to the analyst any necessary precaution that should be taken to protect his/her health and safety based on sample classification into hazardous and radioactive categories.

1.3.2 It is the responsibility of the Laboratory Manager, or his/her designee, to delegate the performance of this procedure to personnel that are experienced with the procedure and with the equipment associated with implementation of the procedure.

1.3.3 It is the responsibility of the analyst to heed any precautions noted by the procedure, to adhere to the instructions contained in the procedure, to report any deviation from this procedure, and to perform this procedure independently only when formally qualified.

1.3.4 It is the responsibility of the analysts performing this procedure to inspect worksheets for accuracy and completeness, inspect sample for proper volume and size, inspect labels and tags for accuracy, inspect equipment for proper operation, and inspect balances to ensure that the calibration is not out of date.

2.0 References

2.1 "Quality Assurance Program Requirements for Nuclear Facilities," ANSI/ASME NQA-1, 1989.

2.2 "Quality Assurance for Radiological Monitoring Program (Normal Operations) - Effluent Streams and the Environment," USNRC Regulatory Guide 4.15.

2.3 "Handbook for Analytical Quality Control in Radioanalytical Laboratories," L. G. Kanipe, EPA-600/7-77-088, August 1977

2.4 "Establishing a Quality Assurance Program for Analytical Chemistry Laboratories Within the Nuclear Industry," Annual Book of ASTM Standards, Volume 12, C1009-83

2.5 ITAS Quality Assurance Manual (latest revision)

2.6 ITAS-RSL Quality Assurance Manual, Laboratory Specific Attachment (latest revision)

2.7 1991 Annual Book of ASTM Standards, Section 11, Water and Environmental Technology, Volume 11.02 Water (II). "Standard Test Method for Radionuclides of Radium in Water." D2460-90, 1991.

2.8 "Upgrading Environmental Radiation Data," J. E. Watson, EPA-520/1-80-012, August 1980

2.9 "Environmental Radioactivity Laboratory Intercomparison Studies Program," EPA-600/4-81-004, latest revision

2.10 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," Method 904.0, EPA-600/4-80-032, August 1980.

3.0 Associated SOPs

3.1 OR-3011, Training and Qualification of Radiological Laboratory Associates

3.2 OR-7006, Sample Preparation

3.3 OR-7007, Acquisition and Use of Standard Reference Materials

3.4 OR-7101, Determination of Dissolved Radium-228

3.5 OR-7202, Operation of Alpha Spectrometer Systems

3.6 OR-7204, Operation of Low Background Alpha/Beta Counting Instruments

3.7 OR-7212, Operation of Germanium Gamma Spectroscopy Systems

4.0 Definitions

4.1 Type I, deionized water is water containing less than 0.1 mg/L total dissolved matter and no detectable dissolved silica, having an electrical conductivity of less than 0.06 umho/cm at 25° C (equivalent to an electrical resistivity minimum of 16.67 Mohm at 25° C), and indicating a minimum color retention of potassium permanganate of 60 minutes. Type I water conductivity shall be monitored at the deionizing system with the internal conductivity meter when water is drawn. Monthly, samples shall be collected from each water deionizing system producing Type I water and these sample submitted for the required Type I verification analyses.

5.0 Procedure

5.1 Summary

Radium isotopes are collected by co-precipitation with barium and lead sulfates from an alkaline citrate solution, and purified by re-precipitation from EDTA solution. Both radium-226 and radium-228 are collected in this manner. For radium-226 determination, radium is co-precipitated on barium sulfate and counted by alpha spectrometry. The Ra-226 yield is determined through initial addition of a Ba-133 tracer. Ra-228 is also co-precipitated on barium sulfate, then after a 36-hour ingrowth of actinium-228 from radium-228, the actinium-228 is carried with yttrium, purified, precipitated as yttrium oxalate and beta counted. The Ra-228 yield is determined gravimetrically from the yttrium oxalate.

5.2 Interference

5.2.1 Samples containing barium in excess of 1 mg per aliquot may cause interference when counting the Ra-226 by alpha spectroscopy.

5.2.2 Performance studies of the EPA 904.0 method indicate that the presence of Sr-90 in the sample gives a positive bias to any measured radium-228 activity because the Sr-90 is not completely separated from the Ac-228.

5.3 Sample Handling, Preservation, and Holding Time

5.3.1 All applicable safety and compliance guidelines set forth by IT Corporation and by federal, state and local regulations shall be followed during performance of this procedure. Work shall be stopped in the event of a known or potential compromise to the health and/or safety of any ITAS employee, and shall be reported immediately to a laboratory supervisor.

5.3.2 The sample container should be glass or polyethylene.

5.3.3 Samples should be preserved by the client at the time of collection by the addition of 2 ml of 16 N HNO_3 for each liter of water collected.

5.3.4 During sample processing, lids and tubes should be properly labeled, as appropriate.

5.4 Required Equipment/Materials

5.4.1 Equipment

5.4.1.1 Magnetic stirrer-hot plate

5.4.1.2 Centrifuge

5.4.1.3 Heat Lamp

5.4.1.4 Analytical balance (4- or 5-place)

5.4.1.5 Alpha spectrometer

5.4.1.6 Air displacement pipetter (50 µl and 250 µl)

5.4.1.7 Vortex stirrer

5.4.1.8 Membrane filtering apparatus

5.4.1.9 Gamma Spectroscopy system

5.4.1.10 Low background alpha/beta counting system

5.4.1.11 Other general laboratory equipment

5.4.1.12 pH meter

5.4.2 Materials

5.4.2.1 Disposable pipets to deliver 2, 4, 5, and 10 ml

5.4.2.2 Transfer pipets

5.4.2.3 Appropriate size beakers or equivalent

5.4.2.4 50 ml centrifuge tubes

5.4.2.5 pH indicator strips (pH 0 - 6 and 7 - 14)

5.4.2.6 Tuffryn membrane filters (HT-200, 25 mm - 0.2 μm) or equivalent

5.4.2.7 Membrane filters (0.45 μm)

5.4.2.8 Round self-adhesive labels (approximately 1 inch diameter)

5.4.2.9 Petri dishes

5.4.2.10 Syringe, plastic disposable (20 cc)

5.4.2.11 Syringe filters (HT Tuffryn, 25mm, 0.45 micron) or equivalent

5.4.2.12 Whatman #42 filter paper

5.4.2.13 Other general laboratory supplies

5.5 Reagents/Standards

5.5.1 Reagents

CAUTION: Refer to Material Safety Data Sheets (MSDS) for specific safety information on chemicals and reagents prior to use or as needed.

5.5.1.1 <u>Acetic Acid</u> (17.4 N, 99%), glacial CH_3COOH, Reagent Grade

5.5.1.2 Ammonium Hydroxide (15 N, 28%), concentrated NH_4OH, Reagent Grade

5.5.1.3 Ammonium Oxalate - $(NH_4)_2C_2O_4.H_2O$, Reagent Grade crystals

5.5.1.4 Ammonium Sulfate - $(NH_4)_2SO_4$, Reagent Grade crystals

5.5.1.5 Ammonium Sulfide - $(NH_4)_2S$, (20 - 24%) Reagent Grade solution

5.5.1.6 Barium Nitrate - $Ba(NO_3)_2$, Reagent Grade crystals

5.5.1.7 Citric Acid - anhydrous Reagent Grade crystals

5.5.1.8 Ethylenedinitrilotetracetic acid, disodium salt dihydrate (EDTA - $C_{10}H_{14}O_8N_2N_2.2H_2O$), Reagent Grade powder

5.5.1.9 Lead Nitrate - $Pb(NO_3)_2$, Reagent Grade crystals

5.5.1.10 Metacresol Purple Indicator (MCP) m-cresolsulfonephthalein, Reagent Grade powder

5.5.1.11 Nitric Acid (16 N, 70%), concentrated (HNO_3), Reagent Grade

5.5.1.12 Sodium Hydroxide - NaOH, anhydrous Reagent Grade pellets

5.5.1.13 Strontium Nitrate - $Sr(NO_3)_2$, Reagent Grade crystals

5.5.1.14 Sulfuric Acid (36 N, 98%), H_2SO_4, concentrated Reagent Grade

5.5.1.15 Yttrium Oxide - Y_2O_3, Reagent Grade powder

5.5.2 Prepared Reagents

NOTE: Only reagent grade chemicals shall be used in preparation of solutions for this procedure unless otherwise stated.

NOTE: Prepared reagents shall be acceptable for use for one year unless otherwise stated.

NOTE: Only deionized water, TYPE I, shall be used to make solution and to perform analyses unless otherwise stated.

CAUTION: During preparation of reagents, employees shall wear lab coat, gloves, safety glasses with side shields, face shield (discretionary) and laboratory approved shoes as a minimum.

CAUTION: Prepare reagents in a fume hood when required.

CAUTION: Refer to Material Safety Data Sheets (MSDS) for specific safety information on chemicals and reagents prior to use or as needed.

NOTE: Unless otherwise stated, reagents shall be good for one year.

CAUTION: Prepare ammonium hydroxide solutions in a fume hood.

5.5.2.1 Ammonium Hydroxide (7.5 N) - Purchase preprepared solution or prepare as follows. In an appropriate size graduated cylinder, add 500 ml of concentrated NH_4OH to 450 ml deionized water. Stir and dilute to 1 L with deionized water.

5.5.2.2 Ammonium Oxalate (5%) - In an appropriate size graduated cylinder, dissolve 5 g $(NH_4)_2C_2O_4.H_2O$ in a small quantity of deionized water. Dilute to 100 ml with deionized water.

5.5.2.3 Ammonium Sulfate (200 mg/ml) - In a 100-ml graduated cylinder, dissolve 20 g of $(NH_4)_2SO_4$ in deionized water. Dilute to 100 ml with deionized water.

5.5.2.4 Ammonium Sulfide (2%) - In a 100-ml graduated cylinder, dilute 10 ml of $(NH_4)_2S$ (20 - 24%), to 100 ml with deionized water.

5.5.2.5 Barium Carrier (1 mg/ml, Ba) - In a 1-L volumetric flask, dissolve 1.9 g of barium nitrate $Ba(NO_3)_2$ in deionized water. Stir and dilute to 1 L with deionized water.

5.5.2.6 Citric Acid (350 g/L, 1.8 M) - In a 1-L graduated cylinder, dissolve 350 g of anhydrous citric acid in 700 ml of deionized water. Stir and dilute to 1 L with deionized water.

CAUTION: Wear face shield when preparing solutions containing sodium hydroxide. Solutions may produce excessive heat.

5.5.2.7 Ethylenedinitrilotetracetic acid, disodium salt dihydrate (EDTA - $C_{10}H_{14}O_8N_2N_2.2H_2O$) (93 g/L, 0.25 M containing 20 mg/ml NaOH) - In a 1-L graduated cylinder, dissolve 20 g of sodium hydroxide in 800 ml of prechilled deionized water. While stirring, slowly add 93 g of EDTA. Continue to stir until dissolved and the solution is cool. Dilute to 1 L with deionized water.

NOTE: Mix EDTA Complexing Solution just prior to use.

5.5.2.8 EDTA Complexing Solution - Add together 100 ml of deionized water, 100 ml of 0.25 M EDTA and 40 ml of 7.5 N NH_4OH.

5.5.2.9 Lead Carrier (15 mg/ml, Pb) - In a 100-ml volumetric flask, dissolve 2.497 g $Pb(NO_3)_2$ in a small amount of deionized water. Add 0.5 ml of 16 N nitric acid and dilute to 100 ml with deionized water.

5.5.2.10 Lead Carrier (1.5 mg/ml, Pb) - In a 100-ml volumetric flask, dilute 10 ml of lead carrier (15 mg/ml) to 100 ml with deionized water.

NOTE: Color range of the metacresol purple indicator is: At pH 1.2 - 2.8 = red to yellow color; pH 7.4 - 9.0 = yellow to purple color.

5.5.2.11 Metacresol Purple Indicator (MCP) (0.1%) - In an appropriate size graduated cylinder, dissolve 0.25 g of m-cresolsulfonephtha-lein in deionized water. Add 2 ml of 5 N NaOH and dilute to 250 ml with deionized water.

5.5.2.12 Nitric Acid (6 N) - Purchase preprepared solution or prepare as follows. To a 1-L graduated cylinder, add 375 ml concentrated nitric acid to 500 ml prechilled water. After the solution has cooled to room temperature, dilute to 1 L with deionized water.

5.5.2.13 Nitric Acid (1 N) - Purchase preprepared solution or prepare as follows. To a 1-L graduated cylinder, add 63 ml concentrated nitric acid to 500 ml prechilled water. After the solution has cooled to room temperature, dilute to 1 L with deionized water.

CAUTION: Wear face shield when preparing NaOH solutions. Solutions may produce excessive heat.

5.5.2.14 Sodium Hydroxide (18 N) - Purchase preprepared solution or prepare as follows. In a 1500-ml beaker (or equivalent size container), CAREFULLY and SLOWLY dissolve 720 g of NaOH pellets in approximately 400 ml of prechilled deionized water. After cooling, dilute to 1 L with deionized water.

5.5.2.15 Sodium Hydroxide (10 N) - Purchase preprepared solution or prepare as follows. In a 1500-ml beaker (or equivalent size container), CAREFULLY and SLOWLY dissolve 400 g of NaOH pellets in approximately 400 ml of prechilled deionized water. After cooling, dilute to 1 L with deionized water.

5.5.2.16 Sodium Hydroxide (5 N) - Purchase preprepared solution or prepare as follows. In a 1500-ml beaker (or equivalent size container), CAREFULLY and SLOWLY dissolve 200 g of NaOH pellets to 400 ml of prechilled deionized water. After cooling, dilute to 1 L with deionized water.

5.5.2.17 Strontium-Yttrium Mixed Carrier (1.0 mg/ml, Sr^{+2} and 1.0 mg/ml, Y^{+3})

5.5.2.17.1 Solution A - In a 100-ml volumetric flask, dilute 10 ml of yttrium carrier (20 mg/ml, Y) to 100 ml with deionized water.

5.5.2.17.2 Solution B - In a 100-ml volumetric flask, dissolve 0.483 g of $Sr(NO_3)_2$ in deionized water and dilute to 100 ml with deionized water.

5.5.2.17.3 Mixed Carrier - Combine Solutions A and B and label.

CAUTION: Wear face shield when preparing sulfuric acid solutions. Solutions may produce excessive heat.

5.5.2.18 Sulfuric Acid (18 N) - Purchase preprepared solution or prepare as follows. In a 1500-ml beaker (or equivalent size container), and with stirring, SLOWLY and CAREFULLY add 500 ml of concentrated sulfuric acid to 400 ml prechilled deionized water. When cooled, dilute to 1 L with deionized water.

5.5.2.19 Sulfuric Acid (0.5 N) - In a 1500-ml beaker (or equivalent size container), and with stirring, SLOWLY and CAREFULLY add 15 ml of concentrated sulfuric acid to 400 ml prechilled deionized water. When cooled, dilute to 1 L with deionized water.

CAUTION: Exercise extreme caution when adding concentrated acids to boiling solutions.

5.5.2.20 Yttrium Carrier (20 mg/ml, Y) - Add 25.4 g Y_2O_3 to a 1-L Erlenmeyer flask containing 20 ml of deionized water.

5.5.2.21 Heat to boiling and continue to stir with a magnetic stirrer-hot plate while adding SLOWLY and CAUTIOUSLY, small amounts of concentrated nitric acid.

NOTE: Usually 30 ml concentrated nitric acid will be needed to dissolve the Y_2O_3. Small additions of water may also be needed to replace that lost by evaporation.

5.5.2.22 After the Y_2O_3 has dissolved, add 70 ml concentrated nitric acid and dilute to 1 L with deionized water.

5.5.2.23 Yttrium Carrier (10 mg/ml, Y) - In a 100- ml volumetric flask, dilute 50 ml of the yttrium carrier (20 mg/ml, Y) to 100 ml using deionized water. See Step 5.6.2 for standardization of yttrium carrier.

5.5.3 Standards

5.5.3.1 Ba-133 Tracer - National Institute of Standards and Technology (NIST) traceable solution.

5.5.3.2 Sr-89 Standard - NIST traceable solution

5.5.3.3 Radium-226 - NIST traceable solution

5.5.3.4 Radium-228 - NIST traceable solution

5.6 Calibration

5.6.1 On the day of use, the analytical balance must be checked and be within its control limits prior to use. (SOP OR-3005)

5.6.2 Yttrium Carrier Standardization

NOTE: Run in triplicate or until three consecutive determinations (batch) are within 2% deviation from the mean. Utilize mean standardization values.

5.6.2.1 Add 5 ml deionized water to a 50-ml centrifuge tube.

5.6.2.2 Add 2 ml concentrated nitric acid.

5.6.2.3 Add 1 drop of MCP indicator (0.1%).

5.6.2.4 Add 1.0 ml of yttrium carrier (10 mg/ml, Y) using a Class A pipette.

5.6.2.5 Add 5 ml of 0.4 M oxalic acid.

5.6.2.6 CAREFULLY add concentrated ammonium hydroxide dropwise until a reddish yellow end point is obtained.

NOTE: The pH must be between 1.7 - 1.9 to assure a uniform $9H_2O$ hydrate yttrium oxalate precipitate.

NOTE: The yttrium oxalate will have precipitated.

5.6.2.7 Heat the solution for approximately 5 minutes in a hot water bath.

5.6.2.8 Cool the solution for approximately 5 minutes in an ice water bath.

5.6.2.9 Pre-weigh a filter and record the tare weight on the sample worksheet.

5.6.2.10 Filter the solution onto the pre-weighed filter.

5.6.2.11 Rinse the centrifuge tube with approximately 3 ml of yttrium wash solution.

5.6.2.12 Pour centrifuge wash onto filter and suction.

5.6.2.13 Wash the precipitate on the filter with 1 ml deionized water.

5.6.2.14 Wash the precipitate on the filter with 5 ml acetone.

5.6.2.15 Dry the filter under a heat lamp for approximately 5 minutes.

5.6.2.16 Cool for approximately 5 minutes.

5.6.2.17 Weigh sample to determine yttrium yield.

5.6.2.18 Repeat heating and cooling until a constant weight is obtained as determined by two consecutive weighings where the weight differences are ± 5% or less.

5.6.2.19 Record gross and final weights.

5.7 Analysis/Operation

5.7.1 Radium-226

5.7.1.1 Initiate appropriate sample worksheet and Laboratory Notebook for the sample to be analyzed.

5.7.1.2 Filter sample aliquot (typically 1 liter) through a 0.45 μm membrane filter into a 1500 ml beaker or equivalent.

5.7.1.3 Add a magnetic stirring bar to the beaker and place on a magnetic stirrer-hot plate.

5.7.1.4 Add 10 drops of MCP indicator solution to the sample.

5.7.1.5 Add 5 ml of citric acid (1.8 M) to the sample aliquot.

5.7.1.6 Add 10 ml of lead carrier (15 mg/ml, Pb).

5.7.1.7 Add 250 µl of the barium carrier (1 mg/ml, Ba).

5.7.1.8 Add 2 ml of the strontium carrier (10 mg/ml, Sr).

5.7.1.9 Add 1 ml of the yttrium carrier (20 mg/ml, Y).

5.7.1.10 Add by weight, a volume containing approximately 1500 dpm Ba-133 tracer.

5.7.1.11 Record on the worksheet, the volume and identification number of the tracer added to the sample.

5.7.1.12 With stirring, heat sample to incipient boiling and maintain at this temperature for approximately 30 minutes.

5.7.1.13 While stirring, slowly add concentrated ammonium hydroxide to the sample until a purple color is just obtained.

NOTE: The color of the solution will change from pink to yellow to purple which corresponds to a pH of approximately 9 - 10. Adjust the pH as necessary to achieve the purple color using concentrated nitric acid or concentrated ammonium hydroxide. Indicator color may fade with heating.

5.7.1.14 While continuing to stir, precipitate the lead, barium and radium sulfates by CAREFULLY and SLOWLY adding 18 N sulfuric acid until the pink color reappears.

5.7.1.15 SLOWLY, add an additional 15 ml excess of 18 N sulfuric acid.

5.7.1.16 Add 5 ml $(NH_4)_2SO_4$ (200 mg/ml) for each liter of sample solution.

5.7.1.17 Keep the sample at a temperature just below boiling while continuing to stir the sample for approximately 30 minutes.

5.7.1.18 Remove sample from the stirrer-hot plate.

5.7.1.19 Remove the magnetic stirring bar from the sample and allow to cool to room temperature.

NOTE: The samples may be covered and left overnight at this point.

5.7.1.20 To obtain the precipitate, filter the solution through a 47 mm metrical membrane filter (0.45 micron pore size).

5.7.1.21 Make a quantitative transfer of precipitate to the filter by rinsing the beaker with washes of 0.5 N sulfuric acid.

5.7.1.22 Discard the eluent solution from Steps 5.7.1.20 and 5.7.1.21 into the appropriate waste container after checking the pH.

5.7.1.23 CAREFULLY place the filter containing the precipitate in the bottom of a 250-ml beaker or equivalent.

5.7.1.24 Add approximately 10 ml of 16 N nitric acid.

5.7.1.25 Heat gently with minimal boiling until the filter completely dissolves.

5.7.1.26 Transfer the precipitate solution to a centrifuge tube using additional 16 N nitric acid.

5.7.1.27 Centrifuge samples at a speed adequate to cause pelleting of the sample for approximately 10 minutes.

5.7.1.28 Discard the supernate into the appropriate waste container, after checking pH.

5.7.1.29 Wash the precipitate with 15 ml of concentrated nitric acid.

5.7.1.30 Centrifuge samples at a speed adequate to cause pelleting of the sample for approximately 10 minutes.

5.7.1.31 Discard supernate into appropriate waste container after checking the pH as needed.

5.7.1.32 Wash the precipitate with 15 ml of concentrated nitric acid.

5.7.1.33 Centrifuge samples for approximately 10 minutes at a speed adequate to cause pelleting of the sample.

5.7.1.34 Discard supernate into appropriate waste container.

5.7.1.35 Dissolve the precipitate by adding 25 ml of the EDTA complexing solution.

5.7.1.36 Heat and vortex as long as necessary to dissolve the precipitate.

NOTE: Add a few drops of 10 N NaOH if the precipitate does not readily dissolve.

5.7.1.37 Filter the dissolved precipitate solution through a 0.45 µm syringe filter into a centrifuge tube.

5.7.1.38 Discard the syringe filters into the appropriate rad waste container.

5.7.1.39 Add 1 ml of the strontium-yttrium mixed carrier (1.0 mg/ml, Sr and 1.0 mg/ml, Y).

5.7.1.40 Add 1 ml of ammonium sulfate (200 mg/ml).

5.7.1.41 Vortex to mix.

5.7.1.42 Add at least 3 ml glacial acetic acid dropwise and vortex until a precipitate forms (barium sulfate).

NOTE: If Ra-228 analysis (Section 5.7.2) is to be performed, record on the worksheet the date and time of the barium precipitation (Step 5.7.1.42) as the start of ingrowth for Ac-228.

5.7.1.43 To prepare the precipitate from Step 5.7.1.42 for counting filter the precipitate with vacuum on to a 0.2 µm Tuffryn membrane filter.

5.7.1.44 Rinse the centrifuge tube thoroughly with deionized water into the filtering funnel.

5.7.1.45 Rinse thoroughly the filtering funnel with deionized water and allow vacuum to pull all of the solution and rinses through the filter.

5.7.1.46 Allow the filter to air dry.

5.7.1.47 Record sample identification and radionuclide on a round self-adhesive label and on a 50 x 9 mm petri dish.

5.7.1.48 Remove filter from filtering apparatus.

5.7.1.49 Secure filter on the appropriately labeled self-adhesive label.

5.7.1.50 Place filter in the appropriately labeled petri dish and submit for counting.

5.7.1.51 Submit sample to count room for counting.

5.7.1.52 Sample is to be counted on the alpha spectrometer to determine Ra-226 activity and on the gamma spectrometer to determine the Ba-133 recovery.

5.7.2 Radium-228

5.7.2.1 After the alpha and gamma counts are complete, place the filter containing the $BaSO_4$ precipitate in a 50 ml centrifuge tube.

5.7.2.2 Add 20 ml of EDTA complexing solution.

5.7.2.3 Digest the sample using a hot water bath and vortex until the precipitate dissolves. A hot water ultrasonic bath may also be used to assist in the dissolution of the precipitate. Add a few drops of NaOH to dissolve sample if necessary.

5.7.2.4 Remove the filter and rinse it with deionized water to remove the excess solution and allow rinse to drain into the centrifuge tube.

5.7.2.5 Using a Class A pipette add 1.0 ml yttrium carrier (10 mg/ml, Y) to the solution.

5.7.2.6 Add 1 ml lead carrier (1.5 mg/ml, Pb).

5.7.2.7 If any precipitate forms, dissolve by adding a few drops of 10 N NaOH.

5.7.2.8 Cap the centrifuge tube.

5.7.2.9 Age the capped samples for at least 36 hours as timed from completion of Step 5.7.1.42 (this was the beginning of the ingrowth). **NOTE:** If 36 hours have already elapsed before reaching this stage, further aging is not necessary.

5.7.2.10 Add 0.3 ml of $(NH_4)_2S$ (ammonium sulfide).

5.7.2.11 Stir well.

5.7.2.12 Add 10 N NaOH dropwise with vortexing until the lead sulfide precipitates, then add 10 drops excess.

5.7.2.13 Vortex for at least 30 seconds per sample. Repeat vortex mixing for each sample.

5.7.2.14 Centrifuge at a speed adequate to achieve pelleting for approximately 10 minutes.

5.7.2.15 Decant supernate into a clean, centrifuge tube.

5.7.2.16 Add 1 ml of lead carrier (1.5 mg/ml, Pb).

NOTE: The yttrium hydroxide precipitation steps (5.7.2.27 to 5.7.2.35) shall be carried out without interruption. **Stop at this point or continue to 5.7.2.35 as rapidly with care as possible - NO INTERRUPTIONS until yttrium hydroxide precipitation is complete.**

5.7.2.17 Add 0.1 ml of $(NH_4)_2S$ (2%).

5.7.2.18 Add several drops of 10 N NaOH.

5.7.2.19 Vortex intermittently for about 10 minutes.

5.7.2.20 Centrifuge at a speed adequate to achieve pelleting for approximately 10 minutes.

5.7.2.21 Filter the supernate through Whatman #42 filter paper into a clean tube.

5.7.2.22 Wash filter with a few ml deionized water.

5.7.2.23 Discard filter into appropriate waste container.

5.7.2.24 Add 5 ml of 18 N NaOH.

5.7.2.25 Vortex to mix well.

5.7.2.26 Digest in a hot water bath until yttrium hydroxide coagulates. **NOTE:**Note the time of yttrium hydroxide coagulation (Step 5.7.2.26). This is the end of the actinium-228 ingrowth time and the beginning of the actinium-228 decay time. **NOTE:** Steps 5.7.2.27 to 5.7.2.35 shall be carried out as rapidly as possible with care without interruption.

5.7.2.27 Centrifuge samples at a speed adequate to achieve pelleting for approximately 10 minutes.

5.7.2.28 Decant supernate into appropriate waste container after check pH.

5.7.2.29 Dissolve the precipitate in 2 ml of 6 N nitric acid.

5.7.2.30 Heat with stirring in a water bath for approximately 5 minutes.

5.7.2.31 Add 5 ml deionized water.

5.7.2.32 Re-precipitate the yttrium hydroxide by adding 3 ml of 10 N NaOH.

5.7.2.33 Heat with stirring in a hot water bath until the precipitate coagulates.

5.7.2.34 Centrifuge at a speed adequate to achieve pelleting for approximately 10 minutes.

5.7.2.35 Discard the supernatant into the appropriate waste container after checking the pH.

5.7.2.36 Dissolve precipitate with 1 ml 1 N nitric acid.

5.7.2.37 Dissolve the precipitate by heating in a hot water bath for several minutes.

5.7.2.38 Dilute the solution in Step 5.7.2.36 to a total of 5 ml using 1 N nitric acid.

5.7.2.39 Add 2 drops of MCP indicator (0.1%).

5.7.2.40 Add 2 ml 5% ammonium oxalate(5%).

5.7.2.41 Heat to coagulate.

5.7.2.42 Centrifuge for approximately 10 minutes at a speed adequate to achieve pelleting.

5.7.2.43 Discard supernate in appropriate waste container after checking the pH.

5.7.2.44 Add 10 ml deionized water.

5.7.2.45 Add 6 drops 1 N nitric acid.

5.7.2.46 Add 2 drops MCP indicator (0.1%).

5.7.2.47 Add 6 drops ammonium oxalate (5%).

NOTE: The pH must be between 1.7 - 1.9 to assure a uniform precipitate of $9H_2O$ hydrate of yttrium oxalate. Add concentrated ammonium hydroxide until a reddish-yellow MCP end point is obtained.

5.7.2.48 Heat with stirring in a hot water bath for several minutes.

5.7.2.49 Centrifuge for approximately 10 minutes at a speed adequate to achieve pelleting.

5.7.2.50 Discard supernate in appropriate waste container after checking the pH.

5.7.2.51 To determine yttrium yield, transfer the precipitate quantitatively to a pre-weighed planchet using a minimum amount of water.

NOTE: Record weight(s) of the planchets (Step 5.7.2.51) on the worksheets.

5.7.2.52 Dry under an infra-red lamp to a constant weight as determined by two consecutive weights with weight differences $\pm$ 5% or less.

5.7.2.53 Record final gross weight on worksheet.

5.7.2.54 Count samples in a low-background beta counter.

5.8 <u>Calculation</u>

5.8.1 Radium-226

5.8.1.1 Calculate the radium-226 activity (pCi/Aliquot volume [V_A] unit)

$$ACT = \frac{(C_S - C_B)}{(2.22 \times t_S \times E \times Y \times V_A)}$$

5.8.1.2 Calculate Ra-226 2-sigma propagated error where Activity (ACT) <> 0; (pCi/V_A unit)

$$TPU = 2 \mid ACT \mid \sqrt{\frac{(C_S + C_B)}{(C_S - C_B)^2} \times 0.0025}$$

5.8.1.3 Calculate Ra-226 2-sigma counting error where ACT <> 0; (pCi/V_A unit)

$$TCU = 2 \mid ACT \mid \sqrt{\frac{C_S + C_B}{(C_S - C_B)^2}}$$

5.8.1.4 Calculate Ra-226 2-sigma propagated error where ACT = 0 (Total Sample Count (C_S) = Background (C_B) and both are > 0); (pCi/V_A unit)

$$TPU = \frac{2}{(2.22)(t_S)(E)(Y)(V_A)} \sqrt{C_S + C_B + 0.0025}$$

5.8.1.5 Calculate Ra-226 2-sigma counting error where ACT = 0 ($C_S = C_B$ and both are > 0); (pCi/V_A unit)

$$TPU = \frac{2}{(2.22)(t_S)(E)(Y)(V_A)} \sqrt{C_S + C_B}$$

5.8.1.6 Calculate Ra-226 2-sigma propagated error where $C_S = 0$ and $C_B = 0$; (pCi/V_A unit).

$$TPU = \frac{2\sqrt{0.0025}}{(2.22)(t_S)(E)(Y)(V_A)}$$

5.8.1.7 Calculate Ra-226 MDC (pCi/V_A unit)

$$MDC = \frac{4.65\sqrt{C_B} + 3}{(2.22)(t_S)(E)(Y)(V_A)}$$

5.8.1.8 Where:

C_S = Total sample counts
C_B = Total background counts
t_S = Count time in minutes for sample (background must have equivalent count time)
E = Counting efficiency (cpm/dpm)
Y = Chemical recovery (dpm ^{133}Ba found vs dpm added)
V_A = Volume of sample aliquot used
ACT = Activity (pCi/aliquot)
TPU = 2-sigma total propagated uncertainty (pCi/aliquot)
TCU = 2-sigma total counting uncertainty (pCi/aliquot)
MDC = Minimum Detectable Concentration (pCi/aliquot)
0.0025= Combined error term
4.65, 3 = Constants (see EPA 520/1-80-012)
2.22 = Conversion factor from dpm to picocuries

5.8.2 Radium-228

5.8.2.1 Calculate the radium-228 concentration (ACT) in pCi/L as follows:

$$ACT = \frac{(C_S) - (C_B)}{(2.22)\,(t_2)\,(SAC)\,(E)\,(V_A)\,(Y_B)\,(Y_Y)} \times$$

$$\frac{\lambda t_2}{(1-e^{-\lambda t_2})} \times \frac{1}{(1-e^{-\lambda t_3})} \times \frac{1}{(e^{-\lambda t_1})}$$

5.8.2.2 Calculate Ra-228 2-sigma propagated error where Activity (ACT) <> 0; (pCi/V_A unit)

$$TPU = 2\,|\,ACT\,|\sqrt{\frac{(C_S + C_B)}{(C_S - C_B)^2} \times 0.0025}$$

5.8.2.3 Calculate Ra-228 2-sigma counting error where ACT <> 0; (pCi/V_A unit)

$$TCU = 2\,|\,ACT\,|\sqrt{\frac{C_S + C_B}{(C_S - C_B)^2}}$$

5.8.2.4 Calculate Ra-228 2-sigma propagated error where ACT = 0 (Total Sample Count (C_S) = Background (C_B) and both are > 0); (pCi/V_A unit)

$$TPU = \frac{2}{(2.22)\,(t_S)\,(E)\,(SAC)\,(Y_B)\,(Y_Y)\,(V_A)}\sqrt{C_S + C_B + 0.0025}$$

5.8.2.5 Calculate Ra-228 2-sigma counting error where ACT = 0 (C_S = C_B and both are > 0); (pCi/V_A unit)

$$TPU = \frac{2}{(2.22)(t_S)(E)(SAC)(Y_B)(Y_Y)(V_A)} \sqrt{C_S + C_B}$$

5.8.2.6 Calculate Ra-228 2-sigma propagated error where C_S = 0 and C_B = 0; (pCi/V_A unit).

$$TPU = \frac{2\sqrt{0.0025}}{(2.22)(t_S)(E)(SAC)(Y_B)(Y_Y)(V_A)}$$

5.8.2.7 Calculate Ra-228 MDC (pCi/V_A unit)

$$MDC = \frac{4.65\sqrt{C_B} + 3}{(2.22)(t_S)(E)(SAC)(Y_B)(Y_Y)(V_A)}$$

5.8.2.8 Where:

C_S = Sample count
C_B = Background count
E = Counter efficiency for Ac-228 or comparable beta energy nuclide
SAC = self absorption correction
V_A = Volume of sample aliquot used
Y_B = Fractional chemical yield of barium carrier
Y_Y = Fractional chemical yield of yttrium carrier
lambda= Decay constant for Ac-228 (0.001884 min^{-1})
t_1 = Time interval (minutes) between the first yttrium hydroxide precipitation and the start time of the counting time.
t_2 = Time interval of counting (minutes)
t_3 = Ingrowth time of Ac-228 (in minutes) measured from the last barium sulfate precipitation to the first yttrium hydroxide precipitation.
TPU = 2-sigma total propagated uncertainty (pCi/aliquot)
TCU = 2-sigma total counting uncertainty (pCi/aliquot)
MDC = Minimum Detectable Concentration (pCi/aliquot)
0.0025= Combined error term
4.65, 3 = Constants (see EPA 520/1-80-012)
2.22 = Conversion factor from dpm to picocuries

5.9 Quality Control

5.9.1 Traceability to internationally recognized authorities shall be documented for each standard.

5.9.2 The Laboratory Manager, or designee, shall review the data generated from this procedure for completeness and adequate quality.

5.9.3 If the laboratory control sample (LCS) analysis results are not within the calculated 2-sigma error, then the Laboratory Manager, or designee, shall be notified.

6.0 Nonconformance and Corrective Action

6.1 Any deviation from this procedure must be approved by the Laboratory Manager and/or Laboratory Technical Director and documented on a procedure change/development form.

6.2 Any unauthorized deviation from this procedure shall be documented as a nonconformance, with a cause and corrective action described.

7.0 Records Management/Documentation

7.1 All manufacturer-supplied documentation, including Certificates shall be retained as quality documents in the Quality and Operations files.

7.2 All laboratory documentation generated in Section 5.5, 5.7, and 5.8 shall be retained as quality documents per Section 7.1.

7.3 Worksheets used to track samples through the analysis shall be retained in the project files to which they are associated.

7.4 Quality control records associated with particular groups/batches of samples shall be filed in the appropriate project files along with the sample records.

7.5 Nonconformance reports shall be filed in the appropriate project files to which they refer.

APPENDIX D

IT ANALYTICAL SERVICES
OAK RIDGE LABORATORY
STANDARD OPERATING PROCEDURE
TITLE: SEQUENTIAL DETERMINATION OF SELECTED ALPHA EMITTING ISOTOPES

INTERNATIONAL TECHNOLOGY CORPORATION

IT Analytical Services

Oak Ridge Laboratory Standard Operating Procedure

Title: SEQUENTIAL DETERMINATION OF SELECTED ALPHA EMITTING ISOTOPES

Prepared by: _____ Date: April 2 1992

Reviewed by: _____ Date: April 17, 1992
Technical Specialist

_____ Date: June 15, 1992
Quality Control Coordinator

_____ Date: 6/26/92
Director, Quality and Compliance, ITAS

_____ Date: 7/6/92
Director, Health and Safety, ITAS

Approved by: _____ Date: 6/17/92
Laboratory Director

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Controlled Copy No: _____

Key Words: Alpha, Isotopic, Uranium, Thorium, Plutonium, Neptunium, Americium, Curium

Revision #	0	1				
Date	12-20-91 ~~12-20-91~~	04-02-92				

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HISTORY OF PROCEDURE REVISION

REVISION NO.	DATE	PAGES AFFECTED	REASON FOR REVISION
0	12/20/91	ALL	NEW PROCEDURE
1	04/02/91	ALL	LABORATORY TESTING

1.0 Purpose and Application

1.1 Purpose

To provide detailed instructions for determination of dissolved uranium 233/234, 235/236 & 238; thorium 227, 228, 230 & 232; neptunium 237; plutonium 238 & 239/240; americium 241; and curium 242 radioactivity in aqueous samples after chemical separation.

1.2 Application

This method is applicable to the determination of uranium, thorium, neptunium, plutonium, americium and curium in samples requiring alpha isotopic analysis in an aqueous matrix with no suspended solids and containing less than 500 ppm dissolved solids. This method may also be used in conjunction with sample preparation procedures which act to dissolve the alpha-emitting radionuclides in an aqueous matrix.

1.3 Responsibilities

1.3.1 It is the responsibility of the Radiation Safety Officer (RSO), or his/her designee, to indicate to the analyst any necessary precaution that should be taken to protect his/her health and safety based on sample classification into hazardous and radioactive categories.

1.3.2 It is the responsibility of the Laboratory Manager, or his/her designee, to ensure that this procedure is followed during the analysis of all samples requiring alpha isotopic activity determination.

1.3.3 It is the responsibility of the Laboratory Manager, or his/her designee, to delegate the performance of this procedure to personnel who are experienced with this procedure and with the equipment associated with implementation of this procedure.

1.3.4 It is the responsibility of the analyst to heed any precautions noted by the procedure, to adhere to the instructions contained in this procedure, to report any deviation from

this procedure, and to perform this procedure independently, only when formally qualified.

1.3.5 It is the responsibility of the analysts performing the analysis described by this procedure to inspect worksheets for accuracy and completeness, inspect samples for proper volume and size, inspect labels and tags for accuracy, inspect equipment for proper operation, and inspect balances to ensure that the calibration is not out of date.

2.0 References

2.1 U. S. Nuclear Regulatory Commission, Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment."

2.2 "Quality Assurance Program Requirements for Nuclear Facilities," ANSI/ASME NQA-1, 1989.

2.3 ITAS Quality Assurance Manual

2.4 ITAS-RSL Quality Assurance Manual, Laboratory Specific Attachment.

2.5 "Radioisotope Techniques," R. T. Overman and H. M. Clark, McGraw-Hill Book Co. Inc., New York, Chapter 6, 1960.

2.6 "Procedures for Determination of Stable Elements and Radionuclides in Environmental Samples," Public Health Service Publication 999-RH-10, January 1965.

2.7 "The Radiochemistry of Uranium," J. E. Grindler, NAS-NS-3050, National Academy of Sciences, 1962.

2.8 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," H. L. Krieger and E. L. Whittaker, EPA-600/4-80-032, August 1980.

2.9 "Standard Methods for the Examination of Water and Waste Water," APHA, AWWA, WPCF, American Public Health Association, Washington, D. C.

2.10 "Annual Book of ASTM Standards," Section 11.02, Water and Environmental Technology, American Society for

Testing and Materials, Philadelphia, PA 19103, 1991.

2.11 "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," L. A. Currie, NUREG/CR-4007, U. S. Nuclear Regulatory Commission, September, 1984.

2.12 "Handbook for Analytical Quality Control in Radioanalytical Laboratories," L. G. Kanipe, EPA-600/7-77-088, August 1977.

2.13 "Establishing a Quality Assurance Program for Analytical Chemistry Laboratories Within the Nuclear Industry," Annual Book of ASTM Standards, Volume 12, C1009-83.

2.14 "Radiometric Method for the Determination of Uranium in Water: Single Laboratory Evaluation and Interlaboratory Collaborative Study," C. T. Bishop, V. R. Casella, and A. A. Glosby, EPA-600/7-79-093, U. S. Environmental Protection Agency, April 1979.

2.15 "The Radiochemistry of Neptunium," G. A. Burney and R. M. Harbour, NAS-NS-3060, National Academy of Science, December, 1974.

2.16 "The Radiochemistry of Plutonium," G. H. Coleman, NAS-NS-3058, National Academy of Sciences, September, 1965.

2.17 "The Radiochemistry of Thorium," E. K. Hyde, NAS-NS-3004, National Academy of Science, January 1960.

2.18 Guseva, L. I., and Tikhomirova, G. S.; Radiokhimiya, 16, 152-156, 1974.

3.0 Associated SOPs

3.1 OR-3010, Performing Intralaboratory Quality Control Analysis

3.2 OR-3011, Training and Qualification of Radiological Laboratory Associates

3.3 OR-7004, Preparation of Samples for Alpha Isotopic and Strontium Analysis

3.4 OR-7006, Sample Preparation

3.5 OR-7114, Promethium Determination

4.0 Definitions

4.1 Water, Type I, deionized is water containing less than 0.1 mg/L total dissolved matter and no detectable dissolved silica, having an electrical conductivity of less than 0.06 umho/cm at 25° C (equivalent to an electrical resistivity minimum of 16.67 Mohm at 25° C), and indicating a minimum color retention of potassium permanganate of 60 minutes. Type I water conductivity shall be monitored at the deionizing system with the internal conductivity meter when water is drawn. Monthly, samples shall be collected from each water deionizing system producing Type I water and these sample submitted for the required Type I verification analyses.

5.0 Procedure

5.1 Summary

5.1.1 This procedure provides for the sequential separation of various alpha emitting radionuclides by elution from anion/cation exchange resin columns. Separation is based on the differences in adsorption and chemical properties of the radionuclides of interest.

5.1.2 The analyst must have at a minimum a Bachelor's degree in chemistry or equivalent scientific disipline or an Associate's degree with five years work experience in an analytical laboratory in a related area.

5.1.3 Initial training on this method will be performed by personnel qualified on this method and will as a minimum consist of an oral review of the method followed by at least one manual demonstration.

5.1.4 The analyst trainee will then conduct several analyses of known and unknown qualification spikes and blank samples under direct oversight of the qualified personnel.

5.1.5 After correct results are achieved with direct oversight the analyst will then proceed to perform analyses of four blind samples without assistance of qualified personnel.

5.1.6 Qualification is achieved by performance of analyses of known and unknown qualification spikes and blank samples to within three sigma of the normalized deviation for these samples established by laboratory control charts.

5.2 Interferences

5.2.1 Dissolved solids greater than 500 ppm may interfere with the ion exchange separation.

5.2.2 Reducing agents in the matrix may prevent achieving the proper oxidation state for loading, eluting, complexation and coprecipitation of the elements of interest.

5.2.3 Excessive quantities of single isotopes or elements may result in separation and spectral interferences if decontamination is not adequately achieved.

5.2.4 Fractionation may occur during the co-elution of Americium and Curium.

5.3 Sample Handling, Preservation, and Holding Time

5.3.1 All applicable safety and compliance guidelines set forth by IT Corporation and by federal, state and local regulations shall be followed during performance of this procedure. Work shall be stopped in the event of a known or potential compromise to the health and/or safety of any ITAS employee, and shall be reported immediately to a laboratory supervisor.

5.3.2 Approved safety glasses with side shields, approved shoes and an approved laboratory coat shall be worn when this method is performed.

5.3.3 The sample container should be glass or polyethylene.

5.3.4 Samples should be preserved by the client at the time of collection by the addition of 2 ml of 16 N (concentrated) nitric acid for each liter of water collected.

5.3.5 Samples should be prepared in accordance with the instructions contained in Procedure OR-7004, Preparation of Samples for Alpha Isotopic and Strontium Analysis.

5.3.6 During sample processing, lids and tubes should be properly labeled, as appropriate.

5.4 Required Equipment/Materials

5.4.1 Equipment

5.4.1.1 Hot Plate

5.4.1.2 Analytical balance (4- or 5- place)

5.4.1.3 Column support

5.4.1.4 Disposable 20 ml polypropylene columns with 35 µm porous polyethylene frit

5.4.1.5 Centrifuge

5.4.1.6 Alpha spectroscopy system

5.4.1.7 Germanium gamma spectroscopy system

5.4.1.8 Low-Background Alpha/Beta counting system

5.4.1.9 Liquid scintillation counter

5.4.1.10 Other general laboratory equipment

5.4.2 Materials

5.4.2.1 Anion exchange resin, Bio-Rad AG 1-X8, 100 - 200 mesh (chloride form) or equivalent

5.4.2.2 Cation exchange resin, Bio-Rad AG 50-4X, 100 - 200 mesh (hydrogen form) or equivalent

5.4.2.3 Membrane filters, 47 mm

5.4.2.4 Membrane filters, 0.1 µm pore size (25mm); must withstand exposure to HF.

5.4.2.5 Whatman 540, 15 cm or equivalent

5.4.2.6 Plastic Centrifuge tubes

5.4.2.7 Other general laboratory supplies

5.5 Reagents/Standards

5.5.1 Reagents

5.5.1.1 Ammonium Iodide - (NH_4I) - Reagent grade crystals

5.5.1.2 Ammonium Thiocyanate - (NH_4)SCN) - Reagent grade crystals

5.5.1.3 Hydrochloric Acid (37%, 12 N) - (HCl), concentrated, reagent grade

5.5.1.4 Hydrofluoric Acid (48%, 29 N) - (HF), concentrated, reagent grade

5.5.1.5 Hydrogen Peroxide (30%) - (H_2O_2), reagent grade

5.5.1.6 Nitric Acid (90%) - (HNO_3), fuming

5.5.1.7 Nitric Acid (70%, 16 N) - (HNO_3), concentrated, reagent grade

5.5.1.8 Perchloric Acid (71%, 12 N) - ($HClO_4$), concentrated, reagent grade

5.5.1.9 Silver Nitrate - ($AgNO_3$) - Reagent grade crystals

5.5.1.10 Sodium Hydroxide - (NaOH), pellets

5.5.1.11 Sulfuric Acid (95%, 36 N) - (H_2SO_4), concentrated, reagent grade

5.5.1.12 Titanous Chloride (20%) - Reagent grade

5.5.2 Prepared Reagents

NOTE: Only reagent grade chemicals shall be used in preparation of solutions for this procedure unless otherwise stated.

NOTE: Prepared reagents shall be acceptable for use for one year unless otherwise stated.

NOTE: Only deionized water, TYPE I, shall be used to make solutions and to perform analyses.

CAUTION: During preparation of reagents, employees shall wear lab coat, gloves, safety glasses with side shields, face shield (discretionary) and laboratory approved shoes.

CAUTION: Prepare reagents in a fume hood when required.

CAUTION: Refer to Material Safety Data Sheets (MSDS) for specific safety information on chemicals and reagents prior to use or as needed.

NOTE: Shelf life of the following ammonium thiocyanate solution is one (1) day

5.5.2.1 Ammonium Thiocyanate (1 M) - To a 100-ml graduated cylinder, dissolve 7.6 g ammonium thiocyanate $(NH_4)SCN$ in 90 ml of deionized water and dilute to 100 ml with deionized water. Mix thoroughly.

5.5.2.2 Carbon Suspension - To an appropriate size beaker or flask, dissolve 6 membrane filters (47 mm) in 5 ml concentrated sulfuric acid. Dilute the filter solution to a final volume of 50 ml by adding the filter/sulfuric acid solution to deionized water.

5.5.2.3 Carbon Substrate Preconditioned Filter - To a 500-ml graduated cylinder, add approximately 400 ml deionized water. To the deionized water, add 20 ml concentrated HCl, 10 ml concentrated HF, and 10 ml Nd carrier (1 mg\ml, Nd). Dilute to a final volume of 500 ml with deionized water. Add 5 ml carbon suspension to the mixture. Precondition

the 0.1μm membrane filter by passing 10 ml of this solution through it.

5.5.2.4 Hydrochloric Acid (8 N) - Purchase preprepared solution or prepare as follows. In a 1-L graduated cylinder, with stirring, SLOWLY and CAREFULLY add 667 ml concentrated hydrochloric acid to 300 ml deionized water. Upon cooling to room temperature, dilute to a final volume of 1 L with deionized water.

5.5.2.5 Hydrochloric Acid (6.5 N) - Purchase preprepared solution or prepare as follows. In a 1-L graduated cylinder, with stirring, SLOWLY and CAREFULLY add 542 ml concentrated hydrochloric acid to 400 ml deionized water. Upon cooling to room temperature, dilute to a final volume of 1 L with deionized water.

5.5.2.6 Hydrochloric Acid (1 N) - Purchase preprepared solution or prepare as follows. In a 1-L graduated cylinder, with stirring, SLOWLY and CAREFULLY add 84 ml concentrated hydrochloric acid to 900 ml deionized water. Upon cooling to room temperature, dilute to a final volume of 1 L with deionized water.

5.5.2.7 Hydrochloric Acid (0.5 N) - Purchase preprepared solution or prepare as follows. In a 1-L graduated cylinder, with stirring, SLOWLY and CAREFULLY add 42 ml concentrated hydrochloric acid to 900 ml deionized water. Upon cooling to room temperature, dilute to a final volume of 1 L with deionized water.

NOTE: Shelf life of the Hydrochloric Acid-Ammonium Iodide Solution is one (1) day.

5.5.2.8 Hydrochloric Acid-Ammonium Iodide Solution (8 N HCl + 0.1 M NH_4I) - In an appropriate size beaker or equivalent container, and on stirrer hot plate, dissolve 3 g of ammonium iodide in 150 ml of 8 N HCl. Mix thoroughly. Dilute to

200 ml with 8 N HCl.

5.5.2.9 Hydrochloric Acid-Hydrofluoric Acid Solution (6.5 N HCl + 0.04 N HF) - In a 1-L graduated cylinder, add 1.5 ml concentrated HF to 1 L of 6.5 N HCl. Mix thoroughly.

5.5.2.10 Neodymium Carrier (1 mg/ml, Nd) - Commercial neodymium carrier, spectroscopy grade

5.5.2.11 Nitric Acid (8 N) - Purchase preprepared solution or prepare as follows. To a 1-L graduated cylinder containing 400 ml deionized water, add 506 ml concentrated HNO_3. Mix and after cooling to room temperature, dilute to a final volume of 1 L with deionized water.

5.5.2.12 Silver Nitrate (0.1 M) - Purchase as preprepared solution or prepare as follows. To 100 ml of deionized water add 1.7 grams of $AgNO_3$ and mix thoroughly. Store in an amber dropper bottle.

CAUTION: Wear face shield when preparing NaOH solutions. Solutions may produce excessive heat.

5.5.2.13 Sodium Hydroxide (5 N) - (NaOH) Purchase preprepared solution or prepare as follows. In a 1-L graduated cylinder, SLOWLY and CAREFULLY dissolve 200 g sodium hydroxide pellets in 800 ml prechilled, deionized water. Cool solution to prevent over heating. After cooling to room temperature, dilute to a final volume of 1 L with deionized water.

5.5.3 Standards

5.5.3.1 Blanks and Spikes for Pu-241

5.5.3.1.1 Prepare an analytical spike using a H-3 or Pu-241 standard, if available, and using the same

reagents as those used in sample preparation.

5.5.3.1.2 Spiked Quality Control samples must be spiked prior to the initial preparation and must follow the same procedure as the sample batch.

5.5.3.2 Traceability

Standards shall be traceable to the National Institutes of Standards and Technology (NIST).

5.6 Calibration

On the day of use, the analytical balance shall be checked and be within its control limits prior to use. (SOP OR-3005)

5.7 Analysis/Operation

5.7.1 Initiate appropriate worksheet and laboratory notebook for the sample to be analyzed and complete as required.

5.7.2 Prepare the aqueous sample in accordance with the instructions contained in OR-7004, Preparation of Samples for Alpha Isotopic and Strontium Analyses.

5.7.3 Prepare the solid matrix samples in accordance with the instructions contained in OR-7002, Drying and Grinding of Solid Matrix Samples, as well as Procedure OR-7004, Preparation of Samples for Alpha Isotopic and Strontium Analyses.

5.7.4 To the residues from Steps 5.7.2 or 5.7.3, add 5 ml of concentrated HNO_3 and 100 μL of 30% H_2O_2. Evaporate to dryness using a hot plate on low heat.

NOTE: If U, Am/Cm or Pm analyses only are requested, go to Step 5.7.33.

5.7.5 Dissolve residue from Step 5.7.2 and 5.7.3 in 20 ml 8 N HNO_3.

5.7.6 Heat as necessary to dissolve the sample.

5.7.7 Add seven drops of hydrogen peroxide to the sample, place a watch glass over the beaker and place on a hotplate on low heat for one hour. The sample is now ready to charge the column.

5.7.8 Cool to room temperature.

5.7.9 Centrifuge or filter as needed to eliminate any insoluble material in the sample.

5.7.10 Discard precipitate in the appropriate solid waste container.

5.7.11 Add 10 ml AG 1-X8 (100 - 200 mesh) anion exchange resin to a column.

5.7.12 Pre-condition the column by passing 100 ml 8 N HNO_3 through the column.

5.7.12.1 Test last ml of preconditioning eluent with one drop of 0.1 M silver nitrate solution. Any significant cloudiness indicates the presence of chloride from the resin. If cloudiness in test is observed repeat 5.7.12 and retest.

5.7.13 Discard preconditioning wash in appropriate waste container.

5.7.14 Collect the eluent from the next step (5.7.15) in a appropriately labeled 250 ml beaker.

NOTE: Since U, Am/Cm, and Pm are not adsorbed on the column, they will wash through the column in the eluent.

5.7.15 Quantitatively transfer sample to pre-conditioned, AG 1-X8 column. Allow the solution to pass through the column. Wash the container walls three times with small amounts (~ 5 ml) of 8 N HNO_3 and add wash to the column.

5.7.15.1 If the sample was centrifuged because of insoluble material in step 5.7.9, wash

the walls of the centrifuge tube and the residue with a small amount (~ 5 ml) of 8 N HNO_3. Centrifuge and add the solution to the column. Wash a total of three times.

5.7.15.2 If the sample requires filtering because of insoluble material in step 5.7.9, filter through a Whatman 540 or equivalent directly into the column. Allow the solution to pass through the column. Wash the container walls three times with small amounts (~ 5 ml) of 8 N HNO_3 and add to the column. Wash the filter three times from the top down with small amounts (~ 15 ml) of 8 N HNO_3.

5.7.16 Wash the column with an additional 100 ml 8 N HNO_3, collecting the eluent in the beaker used in Step 5.7.15.

5.7.17 Once the eluent and wash have been collected (Steps 5.7.15 and 5.7.16), transfer the beaker to a hot plate on low heat.

5.7.18 Add 1 ml hydrogen peroxide (30%).

5.7.19 Evaporate to dryness using a hot plate on low heat.

5.7.20 Based on the radionuclides that are to be quantified in the sample, do the following:

5.7.20.1 For Am/Cm and/or Pm only, proceed to Step 5.7.34.

5.7.20.2 For Uranium only or for U, Am/Cm and/or Pm only, proceed to Step 5.7.33.

5.7.20.3 If samples are expected to contain low or environmental levels of Uranium go to step 5.7.30 for elution of Thorium, Plutonium and Neptunium. If samples are expected to contain significant quantities of Uranium continue.

5.7.21 Elute Th, Pu and Np together with 50 ml of 0.5 N HCl. Collect in one clean labeled 250 ml

beaker. Transfer beaker to low heat hot plate and evaporate to dryness.

5.7.22 Dissolve residue in at least 20 ml of concentrated HNO_3. Evaporate to dryness on a low heat hot plate. Repeat once.

5.7.23 Dissolve residue in 20 ml of 8 N HNO_3.

5.7.24 Add seven drops of hydrogen peroxide to the sample, place a watch glass over the beaker and place on a hotplate on low heat for one hour. The sample is now ready to charge the column.

5.7.25 Add 10 ml AG 1-X8 (100 - 200 mesh) anion exchange resin to a column.

5.7.26 Pre-condition the column by passing 100 ml 8 N HNO_3 through the column.

5.7.26.1 Test last ml of preconditioning eluent with one drop of 0.1 M silver nitrate solution. Any significant cloudiness indicates the presence of chloride from the resin. If cloudiness in test is observed repeat 5.7.26 and retest.

5.7.27 Discard preconditioning wash in appropriate waste container.

5.7.28 Quantitatively transfer the solution to the column prepared above. Discard preconditioning waste and eluent in an appropriate waste container.

5.7.29 Allow the solution to pass through the column. Wash the container walls three times with small amounts (~ 15 ml) of 8 N HNO_3 and add to the column. Discard wash waste in an appropriate waste container.

5.7.30 To Elute Thorium

5.7.30.1 Collect eluent in an appropriately labeled 250 ml beaker.

5.7.30.2 Elute thorium from the column with 50 ml

8 N HCl.

5.7.30.3 Evaporate eluent to dryness using a hot plate on low heat.

5.7.30.4 To mount the thorium, proceed to Step 5.7.35.

5.7.31 To Elute and Prepare Plutonium

5.7.31.1 Collect eluent in an appropriately labeled 250 ml beaker.

5.7.31.2 Elute Pu from the column with 50 ml of the hydrochloric acid+ammonium iodide solution (8N HCl + 0.1M NH_4I).

5.7.31.3 Add 1 ml concentrated HNO_3.

5.7.31.4 Evaporate to dryness using a hot plate on low heat.

5.7.31.5 Add 5 ml concentrated HCl.

5.7.31.6 Evaporate to dryness using a hot plate on low heat.

5.7.31.7 To mount the plutonium, proceed to Step 5.7.35.

5.7.32 To Elute and Prepare Neptunium

5.7.32.1 Collect the Np eluent in an appropriately labeled teflon beaker.

5.7.32.2 Elute Np from the column with 50 ml of the hydrochloric acid + hydrofluoric acid solution (6.5N HCl + 0.004N HF).

5.7.32.3 Evaporate to dryness using a hot plate on low heat.

5.7.32.4 Add 8 ml concentrated HCl to the eluent.

5.7.32.5 Evaporate to dryness using a hot plate on low heat.

5.7.32.6 To mount the neptunium, proceed to Step

5.7.35.

5.7.33 To Prepare the U and the Am/Cm and Pm Samples

5.7.33.1 To the dried residue from Steps 5.7.2, 5.7.3, and/or 5.7.20, add 5 ml concentrated HCl.

5.7.33.2 Evaporate to dryness using a hot plate on low heat.

5.7.33.3 Dissolve the residue in 25 ml of 8 N HCl.

5.7.33.4 Heat as necessary to dissolve.

5.7.33.5 Cool to room temperature.

5.7.33.6 Centrifuge or filter as necessary to eliminate any insoluble material in the sample.

5.7.33.7 Wash precipitate 2ml 8N HCl and add wash to solution. Discard the precipitate in the appropriate waste container.

5.7.33.8 Add a few drops of hydrogen peroxide to the sample, warm the sample slightly and allow the peroxide to effervesce. At the conclusion of effervescence the sample is ready to charge the column.

5.7.33.9 Add 10 ml AG 1-X8 (100 - 200 mesh) anion exchange resin to a column.

5.7.33.10 Pre-condition the column by passing 15 ml 8 N HCl through the column.

5.7.33.11 Discard pre-conditioning acid in the appropriate waste container.

5.7.33.12 Collect the eluent of the next step, Step 5.7.33.13, in a beaker for Am/Cm or Pm analysis.

5.7.33.13 Quantitatively transfer sample to pre-conditioned, AG 1-X8 column. Allow the solution to pass through the column. Wash the container walls three times with

small amounts (~ 5 ml) of 8 N HCl and add wash to the column.

5.7.33.14 If the sample was centrifuged because of insoluble material in step 5.7.33.6, wash the walls of the centrifuge tube and the residue with a small amount (~ 5 ml) of 8 N HCl. Centrifuge and add the solution to the column. Wash a total of three times.

5.7.33.15 If the sample requires filtering because of insoluble material in step 5.7.33.6, filter through a Whatman 540 or equivalent directly into the column. Allow the solution to pass through the column. Wash the container walls three times with small amounts (~ 5 ml) of 8 N HNO_3 and add to the column. Wash the filter three times from the top down with small amounts (~ 5 ml) of 8 N HCl.

5.7.33.16 If Am/Cm and Pm analyses are required, elute the column with 15 ml 8 N HCl.

5.7.33.17 Evaporate eluent and combined washes to dryness using a hot plate on low heat.

5.7.33.18 To complete preparation of the Am/Cm and/or Pm radionuclides, go to Step 5.7.34.

5.7.33.19 To elute the uranium from the column, wash the column with the following solutions, discarding all washes in the appropriate waste container.

5.7.33.20 Wash column with 35 ml of the hydrochloric acid + ammonium iodide solution (8N HCl + 0.1N NH_4I) .

5.7.33.21 Wash column with 35 ml of the hydrochloric acid + hydrofluoric acid solution (6.5N HCl + 0.004N HF).

5.7.33.22 Wash the column with 10 ml of 6.5 N HCl.

5.7.33.23 Elute the uranium with 50 ml of 0.5 N HCl into an appropriately labeled 250 ml

beaker.

5.7.33.24 Evaporate to dryness using a hot plate on low heat.

5.7.33.25 To mount the uranium, proceed to Step 5.7.35.

5.7.34 To Prepare the Am/Cm and Pm Radionuclides

5.7.34.1 Write the sample number on the beaker from Steps 5.7.20 and/or Step 5.7.33.18 with a high temperature marker.

5.7.34.2 Add 5 ml of concentrated HCl to the beaker.

5.7.34.3 Evaporate to dryness using a hot plate on low heat.

5.7.34.4 Place the sample in a muffle oven at 525°C for 8 hours.

5.7.34.5 Dissolve the muffled residue in 10 ml of 0.5 N HCl.

5.7.34.6 Heat as needed to dissolve the residue.

5.7.34.7 Cool to room temperature.

5.7.34.8 Add 10 ml of AG 50-X4 (100 - 200 mesh) cation exchange resin to a column.

5.7.34.9 Pre-condition the column by passing 85 ml of 0.5 N HCl through the column.

5.7.34.10 Discard the pre-conditioning eluent in the appropriate waste container.

5.7.34.11 Quantitatively transfer the dissolved sample to the column, collecting eluent in a 250 ml beaker for Pm analysis.

5.7.34.12 Wash the walls of the transfer container three times with a small amount (~ 5 ml) of 0.5 N HCl and add wash to the column.

5.7.34.13 If Pm is required, collect eluent in

following step in a clean beaker. If Pm is not required the eluent in the following step may be discarded in the proper container.

5.7.34.14 Wash the column with 50 ml 0.5 N HCl and collect in the beaker of Step 5.7.34.11. The eluent contains the Pm radionuclide.

5.7.34.15 Take eluent to dryness using a hot plate on low heat.

5.7.34.16 Complete Pm analysis in accordance with OR-7114, Promethium Determination.

5.7.34.17 If Pm is not required, discard eluent and continue.

5.7.34.18 Wash the column with 5 ml of 1 M NH_4SCN to remove any iron.

5.7.34.19 Repeat 5 ml washes of 1 M NH_4SCN until the red-colored band of the iron complex has been eluted from the column.

NOTE: After collecting the thiocyanate washes, neutralize with 5 N NaOH until neutral or basic before discarding in the appropriate waste container.

5.7.34.20 Wash the column with 70 ml of 1 N HCl to remove calcium and magnesium.

5.7.34.21 Discard the eluent in the appropriate waste container.

5.7.34.22 Elute Am/Cm with 50 ml of 6.5 N HCl into a beaker.

5.7.34.23 Evaporate to dryness using a hot plate on low heat.

5.7.34.24 To mount the Am/Cm, proceed to Step 5.7.35.

5.7.35 Mounting of Sample Fractions

5.7.35.1 Dissolve the dried residue(s) (Steps 5.7.30.4, 5.7.31.7, 5.7.32.6, 5.7.33.25,

and 5.7.34.24) in 3-4 ml concentrated HCl and warm slightly to assist the dissolution of the sample.

5.7.35.2 Quantitatively transfer solution to a centrifuge tube.

5.7.35.3 Rinse the beaker three times with small amounts (~ 2-3 ml) of Type I deionized water and transfer a centrifuge tube. Final volume should be less than 15 ml.

5.7.35.4 Add 0.1 ml neodymium carrier.

5.7.35.5 Add 0.3 ml 20% titanous chloride (not necessary for Am and Cm).

5.7.35.6 Mix the solution well.

5.7.35.7 Allow to stand at least 5 minutes in a hot water bath.

5.7.35.8 Add 5 ml concentrated hydrofluoric acid and swirl carefully to mix.

5.7.35.9 IMMEDIATELY cool in an ice water bath for at least 10 minutes to quench reaction.

5.7.35.10 Filter sample through membrane filter pre-conditioned with carbon substrate as described below.

5.7.35.11 Place a stainless steel support screen in the filter funnel.

5.7.35.12 Place a 0.1 μm filter on the screen and carefully lock the filter funnel chimney to the filter base.

5.7.35.13 Prime the filter with reagent grade alcohol.

5.7.35.14 After applying low vacuum to draw the alcohol through the filter, rinse the filter with deionized water and **Check for leaks!**

5.7.35.15 Mix the carbon substrate solution well.

5.7.35.16 Add 10 ml of the carbon substrate to the filter.

5.7.35.17 Allow to stand for 5 minutes.

5.7.35.18 SLOWLY and CAREFULLY initiate a low vacuum to seat substrate.

5.7.35.19 Stop vacuum when finished filtering.

5.7.35.20 Pour sample on filter and allow it to stand for 5 minutes.

5.7.35.21 SLOWLY and CAREFULLY initiate a low vacuum.

5.7.35.22 When the sample has finished filtering, rinse sample container three times with ~ 5 ml of deionized water and add to the filter.

5.7.35.23 Wash the filter chimney down with ~ 5 ml of deionized water.

5.7.35.24 Take the filter out of the filtering apparatus and allow it to air dry.

5.7.35.25 Mount the filter for counting on doubled 1 inch circular prelabeled labels, place into prelabeled petri dish and submit to counting room.

5.7.36 Plutonium-241 Analysis

5.7.36.1 If plutonium-241 analysis is required after initial alpha counting, place membrane filter mounts in a small beaker and ash at 525 °C for 8 hours.

5.7.36.2 Disperse ash and add 5 ml of concentrate HNO_3.

NOTE: Use care when using perchloric acid. Perform all operations in the perchloric acid hood.

5.7.36.3 Add 1 ml perchloric acid.

5.7.36.4 Evaporate to dryness using a hot plate on low heat.

5.7.36.5 Add 5 ml concentrated nitric acid.

5.7.36.6 Evaporate to dryness using a hot plate on low heat.

5.7.36.7 Dissolve the dry residue in 1 ml of 1 N HNO_3.

5.7.36.8 Quantitatively transfer solution to a plastic, liquid scintillation vial to a total volume of 5 ml deionized water.

5.7.36.9 Add 10 ml scintillation cocktail to the vial.

5.7.36.10 Mix well.

5.7.36.11 Submit sample to the counting room.

5.7.36.12 Prepare an efficiency spike using a H-3 or Pu-241 standard if available.

5.7.36.13 Add the spike to a plastic liquid scintillation vial labeled appropriately for Pu-241 analysis.

5.7.36.14 Add 1 ml of 1 N HNO_3.

5.7.36.15 Mix well.

5.7.36.16 Submit spikes to counting room for quantitation.

5.8 Calculations

5.8.1 Calculate alpha spectrometry isotopic region activity (pCi/L).

$$ACT_{TSC} = \frac{(TSC - BKG)(SDPM)}{(2.22)(SC - SBC)(AVOL)}$$

5.8.2 Calculate 2-sigma Error Term where region activity <> 0

$$ERR_{TSC} = (2)\,|ACT_{TSC}|\sqrt{\frac{TSC + BKG}{(TSC - BKG)^2} + \frac{SC + SBC}{(SC - SBC)^2} + 0.0025}$$

5.8.3 Calculate 2-sigma Error Term where region activity = 0 and TSC = BKG.

$$ERR_{TSC} = \frac{(2)(SPDM)}{(2.22)(SC - SBC)(AVOL)} \times$$

$$\sqrt{(TSC + BKG) + \frac{SC + SBC}{(SC - SBC)^2} + 0.0025}$$

5.8.4 Calculate the Lower Limit of Detection (LLD) for region activity.

$$LLD_{TSC} = \frac{[4.65\sqrt{BKG} + 3]\,SPDM}{(2.22)(SC - SBC)(AVOL)}$$

5.8.5 Calculate Np-237 region activity

$$ACT_{TSC} = \frac{(TSC - BKG)}{(2.22)(CTIME)(EFF)(YLD)(AVOL)}$$

5.8.6 Calculate Np-237 region 2-sigma Error Term for ACT <> 0

$$ERR_{TSC} = (2)\,|ACT_{TSC}|\sqrt{\frac{(TSC + BKG)}{(TSC - BKG)^2} + 0.0025}$$

5.8.7 Calculate Np-237 2-sigma Error Term where ACT = 0 and both region count and region background = 0.

$$ERR_{TSC} = \frac{0.1}{(2.22)(CTIME)(EFF)(YLD)(AVOL)}$$

5.8.8 Calculate Np-237 2-sigma Error Term where ACT = 0 and region counts = region background counts.

$$ERR_{TSC} = \left[\frac{2}{(2.22)\,(CTIME)\,(EFF)\,(YLD)\,(AVOL)}\right]\sqrt{TSC + BKG + 0.0025}$$

5.8 9 Calculate Np-237 region LLD term.

$$LLD_{TSC} = \frac{4.65\sqrt{BKG} + 3}{(2.22)\,(CTIME)\,(EFF)\,(YLD)\,(AVOL)}$$

Where:

TSC	=	Total sample region counts
BKG	=	Total sample region background counts
SDPM	=	Standard dpm
SC	=	Standard counts
SBC	=	Standard background counts
CTIME	=	Count time (min)
EFF	=	Counter efficiency
YLD	=	Chemical yield
AVOL	=	Aliquot volume
4.65,3,0.1	=	Constants
0.0025	=	Cumulative error

5.9 Quality Control

5.9.1 Traceability to internally recognized authorities shall be documented for each standard.

5.9.2 The Laboratory Manager, or designee, shall review the data generated from this procedure for completeness and adequate quality.

6.0 Nonconformance and Corrective Action

6.1 Any deviation from this procedure must be approved by the Laboratory Manager and Laboratory Technical Director and documented on a procedure change/development form.

6.2 Any unauthorized deviation from this procedure shall be documented as a nonconformance, with a cause and corrective action described.

7.0 Records Management/Documentation

7.1 All manufacturer-supplied documentation, including Certificates shall be retained as quality documents in the Quality and Operations files.

7.2 All laboratory documentation generated in Section 5.7, and 5.8 shall be retained as quality documents per Section 7.1

7.3 Worksheets used to track samples through the analysis shall be retained in the project files to which they are associated.

7.4 Quality control records associated with particular groups/batches of samples shall be filed in the appropriate project files along with the sample records.

7.5 Nonconformance reports shall be filed in the appropriate project files to which they refer.

APPENDIX E

IT CORPORATION PERSONNEL

James W. Dillard, Ph.D.

Professional Qualifications

Dr. Dillard brings over 17 years of experience in analytical and radiochemistry to the management team of the IT Oak Ridge Laboratory. As the Laboratory Technical Director, Dr. Dillard has made innovative technical, quality and productivity contributions to laboratory operations. His experience with IT Corporation includes method development of new technologies such as robotics and open-vessel microwave digestion. He has made contributions to the designing, equipping, and managing of the laboratory during a period of rapid expansion. As a Technical Associate, he supports the regional and national technical needs of IT Corporation.

While at the Tennessee Valley Authority, Dr. Dillard gained valuable experience in nuclear power operations. His experience included nuclear quality assurance as a lead auditor, design of a nuclear plant laboratory and support systems, and designing, equipping, and managing a radioanalytical environmental laboratory.

At Colorado State University, Dr. Dillard served as a post-doctoral fellow under the direction of the distinguished researcher Dr. Robert A. Osteryoung. Dr. Dillard has published an presented numerous papers and was inducted as a member of the American Chemical Society and has participated in the ACS Chemistry Outreach program through the local ACS section.

Education

Ph.D., Analytical Chemistry, North Carolina State University, Raleigh, North Carolina, 1976.
B.S., Chemistry, University of Arizona, Tucson, Arizona, 1970.

Experience and Background

1987 - Present

Technical Director, IT Corporation, Oak Ridge Laboratory, Oak Ridge, Tennessee. Provides technical overview of the laboratory activities., Directs method development, reviews procedure revisions, contributes to technical review of proposals and contracts and provides technical training. Also represents IT through presentations at national scientific meetings and through publication of papers and articles in scientific journals. Serves on company-wide committees in promoting method standardization and automation at IT laboratories. As an IT Corporation Technical Associate, Dr. Dillard supports IT regional and national technical programs. Has also been contracted by outside firms to be a technical expert during assessments of U.S. Department of Energy (DOE) and U.S. Department of Defense (DOD) facilities. Also managed the radioanalytical laboratory during a period of rapid expansion at the IT Oak Ridge Laboratory Site.

1987 - 1989 Chemical Engineer, Tennessee Valley Authority, Knoxville, Tennessee. Served in both a technical and management capacity at TVA's Eastern and Western Radiological Laboratories. Provided technical direction for research and development of radiological and provided direction for design and implementation of a computer laboratory information management system. Provided oversight on the design, construction, and equipping of TVA's Eastern Area Radiological Laboratory and managed the analytical section at that facility. Also served as manager of TVA's Western Area Radiological Laboratory quality control section.

As an ANSI qualified lead auditor for TVA's nuclear power program, Dr. Dillard performed evaluations of nuclear plant chemical, radiochemical, and health physics. In 1986, he was assigned as a chemical specialist to a technical review task force for assessing technical specification compliance at TVA Nuclear Plants.

1975 - 1977 Post-Doctoral Fellow, Colorado State University, Fort Collins, Colorado. Research involved development of on-line computer systems for electrochemical applications. Emphasis was on data acquisition, analysis and theoretical finite difference simulations of electrochemical systems.

Professional Affiliations

American Chemical Society
ACS Division of Analytical Chemistry
Sigma Xi, The Scientific Research Society of North America

Audits and Technical Reports

"Energy Systems Bioassay Program Review", MMESI, 1989.

"Radiological Environmental Monitoring and Radiological Assessment and Review Committee," TVA. Quality Audit Branch Report No. CH-8400-15, 1984, and Report No. QSS-A-85-0016, 1985.

"Radiological Effluent Monitoring, Environmental Dose Assessment, and RARC," RVA. Quality Audit Branch Report No. CH-8400-18, 1984.

"Health Physics Training and Staff Qualifications," TVA. Quality Audit Branch Report No. BF-8400-15, 1984, and Report No. CH-8400-14, 1984.

"Watts Bar Nuclear Plant Readiness Review," TVA, Operations Quality Assurance Branch, 1984.

"Radioactive Waste Management and Process Control Program," TVA. Operations Quality Assurance Branch Audit Report No. BF-8400-10, 1984.

J.T. Harvey and J.W. Dillard, "A Review of Current Laboratory Services Branch Methodology for Charcoal Filter Monitoring and Analysis, TVA. Laboratory Services Branch Report No. 5, 1982.

J.W. Dillard, "Regeneration of AG1-X8 Anion Resin," TVA. Laboratory Services Branch Report No. 2, 1981.

J.W. Dillard and W. Raines, "Determination of Strontium-89, 90 in Air Filters," Tva. Laboratory Services Branch Report No. 1, 1981.

Invited Talks and Papers

Dillard, J.W., "Automation of Radioanalytical Sample Preparation," 1992, International Symposium on Laboratory Automation and Robotics, Boston, Massachusetts.

Dillard, J.W., T. Geisler, and J.T. Harvey, "Incorporation of Robotics in the design and Construction of Radiochemistry and Mixed Waste Laboratories," 1992 Technology Exchange Symposium, Scottsdale, Arizona.

Dillard, J.W. and R.E. Gladd, 1991, "Improved Evaluation of Environmental Radiochemical Inorganic Solid Matrix Replicate Precision: Normalized Range Analysis Revisted," 7th Annual Waste Testing and Quality Assurance Symposium, Washington, D.C.

Dillard, J.W. and R.E. Gladd, "Improved Evaluation of Environmental Radiochemical Inorganic Solid Matrix Replicate Precision: Normalized Range Analysis Revisted," 36th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Oak Ridge, Tennessee, October 22-26, 1990.

Dillard, J.W., R.E. Gladd, and V. Hutton, 1988, "Laboratory Software Applications Development: Quality Assurance Considerations," 34th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Las Vegas, Nevada.

Dillard, J.W., "Digital Simulation of a Coated Mercury Film Electrode," Metal Speciation Workshop, Jekyll Island, Georgia, May 20-22, 1987.

Dillard J.W., and B.B. Hobbs, 1979, "Galvanic Deposition of Po-210 at a Rotating Nickel Disk Electrode, "Twenty-Third Conference on Analytical Chemistry in Energy Technology, Gatlinburg, Tennessee.

Dillard J.W., and K.W. Hanck, 1976, "Complexing Capacity of Natural Waters'" The Electrochemical Society, Rocky Mountain Section, Colorado State University, Fort Collins, Colorado.

Dillard J.W., 1975, "Determination of the Complexing Capacity of Natural Waters for Pollution Studies," Sigma Xi Lecture, Appalachian State University, Boone, North Carolina.

Publications

Dillard, J.W. and L.K. Rawlins, 1992, "Receiving Mixed Signals," Environmental Laboratory, Vol. 4, No. 3, pp.36.

Dillard J.W. and B.B. Hobbs, 1980, "Galvanic Deposition of Po-210 at a Rotating Nickel Disk Electrode," Nuclear Instruments and Methods, Vol. 169, pp. 627.

Dillard, J.W., J.J. O'Dea and R.A. Osteryoung, 1979, "Analytical Implications of Differential Pulse Polarography of Irreversible Reactions from Digital Simulation," Analytical Chemistry, Vol. 51, pp. 115.

Dillard, J.W., J.A. Turner, and R.A. Osteryoung, 1977, "Digital Simulation of Differential Pulse Polarography with Incremental Time Change," Analytical Chemistry, Vol. 49, pp. 1246.

Hanck, K.W. and J.W. Dillard, 1977, "Determination of the Complexing Capacity of Natural Water by Cobalt (III) Complexation," Analytical Chemistry, Vol. 49, pp. 404.

Hanck, K.W. and J.W. Dillard, 1977, "Evaluation of Micromolar Complexometric Titrations for the Determination of the Complexing Capacity of Natural Water," Analytica Chemica Acts, Vol. 89, pp. 329.

Deanhardt, M.L., J.W. Dillard, K.W. Hanck, and W.L. Switzer, 1977, "Determination of Lead and Cadmium in Pottery Using Anodic Stripping Voltammetry," Journal of Chemical Education, Vol. 54, pp. 55.

Dillard, J.W. and K.W. Hanck, 1976, "Digital Simulation of Differential Pulse Polarography," Analytical Chemistry, Vol. 48, pp. 218.

Hanck, K.W. and J.W. Dillard, 1973, "Determination of the Complexing Capacity of Natural Waters, "Water Resources Research Institute of the University of North Carolina, Report No. 85.

LARRY G. KANIPE

Professional Qualifications

Dr. Kanipe's qualifications include twelve years in environmental nuclear measurements; six years in health physics instrument calibration; and ten years of project management. During that time, he has developed an extensive background in these areas: laboratory supervision and organization of work, quality assurance/quality control, nuclear counting instrumentation, gamma-ray spectroscopy, analytical method development, and health physics instruments.

Education

University of North Carolina, completed all course work for MSPH in Health Physics in May 1985 (thesis must be completed for award of degree).

University of Alabama, earned Ph.D., in physical chemistry in 1974.

University of Virginia, Post-graduate study in Chemistry, 1966-1968.

Belmont Abbey College, earned B.S. in Chemistry in 1966.

Vanderbilt University, Undergraduate study 1962-1963.

Professional Affiliations

American Chemical Society
Health Physics Sociaty

Experience and Background

3/91 - Present: Laboratory Director, International Technology Corporation, Oak Ridge, TN. Establishes sales and profit objectives and business plans for the laboratory. Develops client contacts, participates in proposal development and preparation. Evaluates and reviews analytical and technical needs of clients. Evaluates personnel, facilities, instrumentation, and training needs for the laboratory. Ensures employee compliance with safety and quality assurance programs.

1/90 - 3/90 Manager, Chemical Research Department, National Fertilizer & Environmental Research Center (NFERC), Tennessee Valley Authority (TVA). Managed programs of basic and applied chemical with the goal of developing methods for remediation of contaminated chemical sites/and improving the usability of lower quality phosphate raw materials. Managed the delivery of analytical services, glass blowing, and materials characterization services to NFERC, other TVA organizations, and outside TVA clients. Department had staff of 60 and budget of approximately $4 million.

Served as initial project manager for an multidisplinary team working to develop "Waste Treatment and Site Remediation Technologies for Fertilizer Dealers." Staff of 20 (part time) and budget of $400,000 for FY90.

12/87 - 1/90 Manager, Separations Science Laboratory (SSL) and General Analytical Laboratory (GAL-since July 1, 1988), NFERC-TVA. Designed, constructed, and staffed SSL. Developed research program for SSL. Provided analytical services to NFERC, TVA power organizations, and clients outside TVA. Supported NFERC's research, technology development, and environmental projects and programs. Provided method development services for GAL clients. Developed analytical and sampling capabilities for RCRA RFI program. Developed QA/QC program for the GAL

12/86 - 11/87 Research Chemist, Chemical Research Department, TVA Operated and maintained X-ray fluorescence spectrometer. Developed calibration standards for phosphate containing materials. Developed quality control procedures for XRF. Conducted research projects.

7/85 - 12/86 Supervisor, Instrument Calibration and Quality Control Section, TVA. Oversaw calibration of 7500 and repair of 2000 portable health physics and industrial hygiene instruments per year. Managed the quality assurance program for department. Specified/purchased all portable health physics instruments for TVA. Responsible for the Department's three NRC licenses.

10/83 - 7/85 Supervisor, Radioanalytical Laboratory, TVA (on leave 9/84-4/85 to attend Univ. of North Carolina.) Managed the radiological environmental monitoring analytical programs for four nuclear power stations, TVA's uranium milling and mining sites, and other TVA and outside TVA clients. Oversaw collection/processing of 12000 samples for 35000 analyses/year. Prepared procedures, technical reports, and publications.

5/79 - 10/83 <u>Supervisor, Western Area Radiological Laboratory, TVA.</u> Supervised the Radioanalytical Laboratory and Instrument Calibration and Quality Control Sections in Muscle Shoals. For duties, see above two positions. The two areas of responsibility were split apart in 1983 as a result of a reorganization.

5/74 - 4/79 <u>Analytical Chemist, Radioanalytical Laboratory TVA</u> Supervised up to 10 professionals and technicians. Developed and conducted the Laboratory's analytical QA/QC program. Conducted research/method development projects in the areas of radiochemistry and nuclear counting instrumentation. Supervised the uranium milling and mining analytical program.

Publications

Sixteen articles and publications.

JACQUELINE M. VAN AUDENHOVE

Professional Qualifications

After graduating from Memphis State University with a Bachelor of Science degree in Microbiology (minor in Chemistry), Jacqueline worked as a Research Coordinator at the University of Tennessee at Memphis for three years. Subsequently, she moved to Johnson City, TN and worked as a Research Coordinator for East Tennessee State University in the Department of Infectious Diseases.

Education

B. S. in Microbiology; minor in Chemistry, Memphis State University, Memphis, TN; 1987

DOT Hazardous Materials Training (HM 181), VWR, March 11, 1993.

Basic Hazardous Materials Workshop, USDOE, June 28-29, 1993.

Experience and Background

1992 - Present: Chemist I, IT Corporation, Oak Ridge, TN. Manage samples upon receipt including logging and coding samples into the computer and initiating project file.

1990 - 1991: Research Coordinator, East Tennessee State University Johnson City, TN. Conducted clinical trials for pharmaceutical companies, insured that the trials adhered to governmental and hospital regulations, and created data bases for statistical analysis.

1988 - 1990: Research Coordinator, University of Tennessee, Memphis, TN. Initiated and organized clinical research protocols, reviewed medical charts, created data bases, and assisted in manuscript development.

1987 - 1988: Research Assistant, University of Tennessee, Memphis, TN. Provided technical assistance, including laboratory work, animal surgery and data analysis.

1986 - 1987: Technical Clerk, Baptist Memorial Hospital, Memphis, TN. Received and dispatched laboratory specimens and data entry of laboratory results.

1984 - 1985: Pharmacy Technician, Clark Tower Pharmacy, Memphis, TN. Assisted in filling prescriptions and billing customers.

CHRISTOPHER J. BAGGETT

Professional Qualifications

Mr. Baggett has 9 years of experience in analytical chemistry including 3 years of work in a high-level radiation analytical laboratory. He has a strong background in instrumental analysis, especially in atomic spectroscopy techniques. His experience also encompasses a wide variety of wet chemistry and radiometric techniques.

Education

Analytical Chemistry Division, Inhouse Radiochemistry Course, ORNL 4/89 - 6/89

Perkin-Elmer Course in Atomic Absorption Spectroscopy (user course in flame and graphite furnace and advanced graphite furnace course), Ridgefield, Connecticut; 7/88

Perkin-Elmer course in inductively coupled plasma spectroscopy (user and advanced course), Ridgefield, Connecticut; 2/88

Radiochemistry/safe use if radionuclides, Oak Ridge Associated Universities, Oak Ridge, TN; 7/87

Vanderbilt University, Nashville, TN, Degree: BA, Chemistry, Cum Laude, May 1982 - Minor: Molecular Biology, University Scholarship 1978-1982.

Experience and Background

1991 - Present — <u>IT Corporation, Oak Ridge, TN; Metals Team Leader.</u> Schedule work priorities for analysts in the group. Review raw data and data packages for technical accuracy as well as compliance with CLP. Responsible for the preventative maintenance program of the laboratory instrumentation. Provide technical assistance to the analysts as needed. Review QAPPs and write SOPs as needed.

1990 - 1991 — <u>IT Corporation, Oak Ridge, TN; Chemist IV. ICP Metals.</u> Provide metals analysis utilizing a Thermo-Jaryl ash model 61 ICAP. Also responsible for routine maintenance and routine upkeep of this system.

1986 - 1990 Martin Marietta Energy Systems, ORNL, Oak Ridge, TN. Research associate, analytical chemistry division, radiochemistry section. Chemist in charge of atomic spectroscopy at the high level radiation analytical laboratory. Method development, maintenance, and upkeep, and daily operation of: glovebox-enclosed Perking Elmer Model 6500 inductively coupled plasma optical emission spectrometer; and glovebox-enclosed Perkin-Elmer Model 5100 atomic absorption spectrometer including Zeeman graphite furnace and MHS-20 hydride generation system. Analysis of radioactive waste tanks for RCRA metals using EPA SW-846 methodology. Radiochemical analyses of wide variety of sample matrices, Techniques include gross alpha, gross beta, alpha pulse height, Sr-90, and gamma scans. Chemical and physical analyses on a wide variety of alpha and low-level beta/gamma contaminated samples.

1/83 - 10/86 A.E. Staley Manufacturing Company, Loudon, TN; Quality Control Technician. Responsibilities included: Quality process control for the following production processes: Corn wet milling, alcohol production, and high fructose corn syrup refining. This was accomplished by utilizing a variety of microbiological and wet chemistry techniques and instrumental analyses.

ROBERT W. GARBER

Professional Qualifications

Mr. Garber directed inorganic and gas chromatography analysis group for TVA NFERC chemical and environmental analysis section. He was methods development chemist for TVA NFERC. He also conducted basic research into atmospheric chemical processes and effects for TVA and Brookhaven National Laboratory. He set up atmospheric research aircraft for TVA and Brookhaven which required special modification of commercial air quality monitoring instruments and the development of special analytical methods.

Education

Ph.D., Chemistry, University of Pittsburgh, Pittsburgh, PA; 1975

M.S., Chemistry, Saint Joseph College, Philadelphia, PA; 1967

B.S., Chemistry, Philadelphia College of Pharmacy and Science, Philadelphia, PA; 1965

Experience and Background

1992 - Present: Technical Laboratory Director, IT Corporation, Oak Ridge, TN. Develop new or improved methods of analysis for Mixed Waste materials.

1988 - 1992: Research Chemist, Tennessee Valley Authority, National Fertilizer and Environmental Research Center, Muscle Shoals, AL. Conducted research into advanced separation science and analytical chemistry and directed chemical analysis group.

1980 - 1988: Research Chemist, TVA, Air Quality Branch, Muscle Shoals, AL. Conducted field research into atmospheric processes and effects including atmospheric chemistry and terrestrial effect of acid rain.

1975 - 1980: Associate Chemist, Brookhaven National Laboratory, Upton, NY. Developed atmospheric chemistry research aircraft and conducted field studies into atmospheric chemical processes and anthropogenic pollution.

1971 - 1975: Environmental Scientist, TVA, Air Quality Branch, Muscle Shoals, AL. Developed atmospheric chemistry instrument system for use helicopters and conducted studies of atmospheric chemistry of power plant plumes.

Publications

Determination of Atmospheric Sulfur Dioxide by Differential Pulse Polarography, Robert W. Garber and Claude E. Wilson, Anal. Chem. 1972, 11 , 1357-1360

Ambient Air Monitoring for Point Sources, R.W. Garber, G.G. Park, A.E. Owen and T.L. Montgomery in "Industrial Air Pollution Control"' K.E. Noll and J.R. Duncan Eds, Ann Arbor Science Publishers, Inc. 1973.

A Field Evaluation of Ambient Sulfur Dioxide Monitors, R.W. Garber, J.W. Hamby, G.E. Titcomb, and T.L. Montgomery in "Power Generation Air Pollution Monitoring and Control", K.E. Noll and W.T. Davis Eds, Ann Arbor Science Publishers, Inc. 1976.

Separation and Analysis of Aerosol Sulfate Species at Ambient Concentrations, R.L. Tanner, R. Caderwall, R. Garber, D. Leahy, W. Marlow, R. Meyers, M. Phillips and L. Newman, Atmospheric Environment, 1977, 11, 965-966.

Formation of Sulfate, Ammonium and Nitrate in an Oil-Fired Power Plant Plume, J. Forrest, R. Garber, and L. Newman, Atmospheric Environment, 1979, 13, 1287-1297.

Chemical Composition of Sulfate as a Function of Particle Size in New York Summer Aerosol, R.L. Tanner, R.W. Garber, W. Marlow, B.P. Leaderer, and M.A. Layico, Annual of the New York Academy of Sciences, 1979, 322, 99-114.

Filter Material for Sampling of Ambient Aerosols, D.F. Leahy, M.F.Phillips, and R.W. Garber, Anal. Chem., 1980, 52, 1779-1780.

Determination of Ambient Aerosol and Gaseous Sulfur Using a Continuous Flame Photometric System-I: Sampling System for Aerosol Sulfate and Sulfuric Acid, R.L. Tanner, T.D'Ottavio, R.W. Garber and L. Newman, Atmospheric Environment, 1980, 14, 121-127.

Determination of Ambient Aerosol and Gaseous Sulfur Using a Continous Flame Photometric System-II: The Measurement of Low-level Sulfur Concentrations Under Varying Atmospheric Conditions, T.D'Ottavio, R.W. Garber, R.L. Tanner and L. Newman, Atmospheric Environment, 1981, 15, 197-203.

Determination of Ambient Aerosol and Gaseous Sulfur Using a Continous Flame Photometric System-III: Design and Characterization of a monitor for Airborne Applications, R.W. Garber, P.H. Daum, R.F. Doering, T.D'Ottavio and R.L. Tanner; Atmospheric Environment, 1988, 17, 1381-1385.

Measurement of Sulfur Oxides from Airborne Platforms, R.W. Garber and L. Newman, Atmospheric Technology, 1980, 12, 35-39.

Conversion Rates in Power Plant Plumes Based on Filter Pack Data: The Coal Fired Cumberland Plume, Joseph Forrest, Robert W. Garber and Leonard Newman, Atmospheric Environment, 1981, 15, 2273-2282.

Conversion Rates in Power Plant Plumes Based on Filter Pack Data: The Oil Fired Northport Plume, Robert W. Garber, Joseph Forrest and Leonard Newman, Atmospheric Environment, 1981, 15, 2283-2292.

Chemistry of Torsion Lysimeter Water and Lateral Flow in Spruce and Hardwood Stands, J.D. Joslin, P.A. Mays, M.H. Wolfe, J.M. Kelly, R.W. Garber, and P.F. Brewer, Journal of Environmental Quality, 1987, 16, 152-160.

Comparison Particles Taken from the ESP and Plume of a Coal-Fired Power Plant with Background Aerosol Particle, D.S. Kim, P.K. Hopies, G.S. Casuccio, R.J. Lee, S.E. Miller, G.M. Overdrup, and R.W. Garber, Atmospheric Environment, 1989, 25, 81-84.

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PROCEEDINGS AND ABSTRACTS

Airborne Measurement of Aerosol and Sulfate Concentration Discontinuities in Vertical and Horizontal Profiles, R.M. Brown and R.W. Garber, Presented before Third Symposium of Atmos. Turb. and Air Quality, American Meteorological Society, October 19-22, 1976, Raleigh, North Carolina.

Speciation of Sulfate in Ambient Aerosols by Solvent Extraction with Flame Photometric Detection, R.W. Garber, R.L. Tanner, and L. Newman, presented before Division of Environmental Chemistry, American Chemical Society, New Orleans, Louisiana, March 20-28, 1977.

A New Airborne Aerosols Sampler, W.H. Marlow, and R.W. Garber, Presented at the Annual APCA meeting Houston, Texas, June 1978.

Continous Monitoring of Ambient Levels of Aerosol Sulfate Using a Flame Photometric Detection System, R.L. Tanner, T.D'Ottavio, R.W. Garber and L. Newman, Presented at Euroanalysis III, Dublin, August, 1978.

Comparison of Particulate and Gaseous Material Within and Above the Mixed Layer, P.Michael, R.M. Brown, and R.W. Garber, presented at the Fourth Symposium on Turbulence Diffusion, and Air Pollution, American Meteorological Society, Reno, Nevada, January, 1979.

Leachate Solution Chemistry of Red Spruce and Northern Hardwoods Litter, R.W. Garber and E.M. Perdue, presented at the 14th annual Gatlinburg Acid Rain Conference, Gatlinburg, Tennessee, October 1987.

Effects of pH and Aluminum on Early Life Stages of Smallmouth Bass and Rainbow Trout, R.L. Schweinfoeth, J.R. Wright,Jr., R.W. Garber, J.E. Persall, and R.C. Young, Presented at the 14th Annual Gatlinburg Acid Rain Conference, Gatlinburg, Tennessee, October 1987.

The Effects of Leaching Conditions on Acid-Base Chemistry of Organic Acids in Forest Litter Leachats Solutions S.M. Serkig, E.M. Perdue, and R.W. Garber, presented at the 14th Annual Gatlinburg Acid Rain Conference, Gatlinburg, Tennessee, October 1987.

Composition of Acid Particulate Material in a Coal Fired Power Plant plume, G.M. Sverdrup and R.W. Garber, presented American Chemical Society June, 1989.

RONDALYNN SUE MULL

Professional Qualifications

Over eight years as a Radiochemist working for various production oriented companies. Bench work and supervisory duties have encompassed a very wide range of matrices and samples. Throughout the past years have accomplished the completion and utilization of a variety of procedures and isotopes.

Education

B. S., Physical Science/Chemistry, Colorado State University, Fort Collins, CO; 1985

Quality Control and Product Assurance, University of New Mexico, NM; 1986

Radiation Health and Safety, Penn State, 1989

Professional Affiliations

Member of the Rio Grande Health Physics Society
Member of the New Mexico Hazardous Waste Society

Experience and Background

1992 - Present — Analytical Group Leader, IT Corporation, Oak Ridge, TN. Duties include all lab work including sample preparation, chemistry, and mounting. She is also responsible for methods and development and implementation of new methods.

1990 - 1992 — Radiochemistry Supervisor, Eco Tek LSI, Atlanta, GA. Responsibilities included the start, set up and production of the Radiochemistry laboratory. This involved staffing, sop writing and implementing, training, and all other start up, production and supervisory functions.

1986 - 1990 — Radiochemistry Supervisor, TMA Eberline, Albuquerque, NM. Responsibilities encompassed program manager of special needs projects, MSDS and safety implementation. Routine runs of various chemistry procedures for the separation of radionuclides for quantitative analysis in an extensive variety of matrices. Research and development of ion-exchange and matrices. Research and development of ion-exchange and electrodeposition procedures of transuranic isotopes. Also troubleshooting of a variety of radioanalytical analyses.

Her supervisory responsibilities included developing and implementation procedures for both the environmental and bioassay labs. This includes special needs customers and unusual testing requirements. Also responsible for EPA test evaluations.

As radiation chemist she provided technical support for technicians and staff. Supplied all QC laboratory spikes and tracers. Assistant sample coordinator for major contracts. Hazardous waste handling and disposal.

1985 - 1986 Radiochemist, CEP, Santa Fe, NM.
Responsibilities included general bench chemistry and routine analysis.

VICKI L. GRAVES

Professional Qualifications

Ms. Graves has a broad background in the physical sciences and statistics, organic and inorganic sample preparation, sample tracking, quality control records, analytical data review and reporting, sample receipt and test assignment, and management of analytical projects for Department of Energy contracts. She has four years experience dealing with analytical techniques and reporting of analytical data for clients under RCRA, CERCLA, SDWA, and CWA guidelines. Ms. Graves has provided analytical project management services for DOE site projects, including Sandia National Laboratory, Idaho National Engineering Laboratory, and Oak Ridge National Laboratory.

Education

B.A. Mathematics, University of Tennessee, Knoxville, TN; 1987

Professional Affiliations

Quality Assurance Society
American Chemical Society

Experience and Background

1990 - Present: Analytical Project Manager, IT Corporation, Oak Ridge, TN. Responsibilities: Manages analytical projects within the laboratory. Serves as the primary project contact and technical consultant to IT Analytical Services (ITAS) clients. Works with clients for proposal support, preparation of work plans, coordination of analytical requirements, and tracking and scheduling sample analysis and reporting through the laboratory.

1990 -: QA Engineer, Bechtel National, Inc., Oak Ridge, TN. Responsibilities: Worked in the Quality Control department. Performed audits of analytical laboratories. Reviewed QAPPs. Prepared QAPPs.

1989 - 1990: Chemist, IT Corporation, Oak Ridge, TN. Responsibilities: Responsible for defining, tracking, and reviewing analytical data as it moved through the laboratory. Duties included participation in the design and implementation of computerized data systems, monitoring of analysis status, review of holding times, and work order due dates. Responsible for final review of completed data. Major projects during this time were the RI/FS at the Oak Ridge National Laboratory and the RI/FS at Fernald, Ohio.

1988 - 1989 Organic Prep Technician/Sample Receiving Technician, QA Technician, IT Corporation, Oak Ridge, TN.
Responsibilities: Prepared samples for analysis by GC and GC/MS, ICP, and GFAA. Initiated quality control samples into analytical batches. Monitored and maintained refrigerator temperature logs. Calibrated balances.

Received and logged in samples. Distributed project tracking forms to the laboratory. Reviewed data results. Assisted with internal audits. Calibrated pipettes, balances.

1986 - 1988 Chiropractic Assistant, Dr. Shreve Chiropractic Clinic, Knoxville, TN. Responsible for application of physical therapy to patients through the use of a galvanic-med instrument. Instructed patients on the correct office procedures, filled out workman comp and personal injury forms.

1982 - 1985 Retail Sales, Sears, Columbus, MS.
Took Orders via computer and distributed merchandise. Assisted in daily balances and adjustments of each shipment and tallied daily sales by computer.

1980 Waitress, Crosseyed Cricket, Lenoir City, TN.

REBECCA K. TERRY

Professional Qualifications

Education

University of Tennessee at Chattanooga, Chattanooga TN; Bachelor of Arts in Biology, Chemistry minor, 1983.

Experience and Background

9/90 - Present — International Technology Corp., Oak Ridge, TN.; Chemist-Assistant Group Leader. Responsible for performing the following analyses: alpha isotopic, Pb210, Fe55, and Strontium 89/90. Prepare annual qualifying spikes for employees. Compile control charts and run QA/QC checks. Responsible for employees in other sections emergency situations and site security on second shift.

3/89 - 1990 — Hillco Engineering Company, Perry Nuclear Plant, Perry, Ohio; Nuclear Chemistry Technician. Collection and preparation of samples from plant systems and effluents. Monitor discharges to environment. Performance of chemical and radiochemical analyses in accordance with procedures. Ensure chemistry conditions were maintained within required limits. Identify potential problems and initiate corrective action.

1985 - 3/89 — Tennessee Valley Authority, Division of Nuclear Power, Chemical Section, at both Bellefonte (Hollywood, AL) and Sequoyah (Soddy Daisy, TN) Nuclear Plants; Radiochemical Laboratory Analyst. In addition to job description above, also determined radioactive content of samples by using ALPHA, BETA, and GAMMA counting methods. Coordinated and supervised chemistry personnel for primary sampling and chemical additions to various systems. Compiled chemical and radiochemical data for trends reports. Assisted with training of new employees, researched and revised laboratory procedures. Special projects. Calibrated and maintained the following instrumentation:

Hack Turbidimeter
Liquid Scintillation Counter
Carle Gas Chromatograph
Dionex Ion Chromatograph
Chlorine Amperometric Titrator
Fisher and Mettler Boron Titrator
Perkin Elmer Atomic Absorption and Graphite Unit
Nuclear Data 6600 Computer System
Leeds and Northrup and Martek Conductivity Bridge
Bausch and Lomb, Spectronic 501, and Turner Spectrophotometer
Chemtrix, Sargent Welch and Orion pH meter
O.I. and Dohrmann Total Organic/Inorganic Carbon Analyzer
Precision Scientific Flash Point Tester

LEAH K. RAWLINS

Professional Qualifications

Ms. Rawlins is a chemist with 12 years of analytical and quality control laboratory experience. Her experience encompasses the analysis of water, wastewater, geologic and hazardous waste samples. As manager of the Weapons Materials Quality Control Laboratory for the Y-12 Plant, Martin Marietta Energy Systems, Inc., she was responsible for the implementation of the laboratory measurement control programs for depleted and enriched uranium metals and compounds, as well as industrial hygiene and health physics measurement control programs for the facility. Ms. Rawlins is skilled in sampling and sampling plan development and evaluation of results thereof for a variety of materials and systems. Additionally, she has experience in the development of automated analytical systems.

While at ITAS-Oak Ridge Laboratory Ms. Rawlins had been involved in project management in the radiological laboratory, supervision of laboratory personnel and the scheduling of work through the laboratory. The responsibilities of her current position require monitoring and advising with regard to the laboratory's compliance with regulatory agency, client, and ITAS quality control and quality assurance requirements.

Education

B.S. Chemistry, Austin Peay State University, Clarksville, Tennessee; 1980

Coursework in mathematics, graduate statistics, and chemistry, University of Tennessee, Knoxville, Tennessee; 1982-1989

Hazards Communication Training (OSHA 29 CFR 1910.1450) 1989, 1991.

Laboratory Safety Training (OSHA 29 CFR 1910.1000, 1910.1200) 1991

Frontline Leadership Training, IT Corporation, Knoxville, Tennessee; 1991

Quality Assurance of Chemical Measurements, American Chemical Society Course, Philadelphia, Pennsylvania; 1986

Kepner - Tregow Problem Analysis and Decision Making, Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee; 1988

Grassroots Statistics, Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee; 1987

Experience and Background

1991 - Present

Quality Control Coordinator, Oak Ridge Laboratory, IT Corporation, Oak Ridge, TN. Monitors the implementation of the ITAS, ITAS-ORL, client and regulatory agency quality assurance requirements and reports to management on the status of Oak Ridge Laboratory quality assurance/quality control programs.

Performs internal surveillances, responds to client audits, and assists with compliance to program and client requirements. Provides training for the laboratory Associates as it pertains to statistical quality control and Oak Ridge Laboratory quality assurance programs.

Reviews work proposals and QAPP's for quality assurance criteria.

1990 - 1991

Project Manager/Scheduling, Oak Ridge Laboratory, IT Corporation, Oak Ridge, TN. Coordinated the efforts of sample receiving, the radiological laboratory and data reporting for multiple clients. Scheduled all work through the laboratory and prepared progress/status reports. Clients included Bechtel, Oak Ridge, TN; Westinghouse Manufacturing of Ohio, Cincinnati, Ohio; Detroit Edison, Detroit, Michigan; Rocky Flats Plant, Englewood, Colorado; West Valley Nuclear, West Valley, New York; USGS, Arvada, Colorado; Waste Isolation Pilot Plant, Carlsbad, New Mexico; Feed Materials Company of Ohio, Ross, Ohio; Union Electric, Fulton, Missouri.

1985 - 1990

Chemist II, Weapons Materials Quality Control Laboratory, Y-12 Plant, Martin Marietta Energy Systems, Inc. Oak Ridge, TN. Administered the measurement control programs for the production process streams, health physics, environmental, and industrial hygiene programs. Duties encompassed establishing traceability, characterizing materials, coordinating efforts among different departments/divisions within the plant to acquire and/or prepare materials for use as control materials, procedure development, administration of sample exchange programs and data evaluation. Responsible for implementing the safety and material accountability programs for the special nuclear materials that the QC laboratory maintained custody of. Responsible for the supervision and training of technicians. Responsible for control program development and implementation.

1984 - 1985 Chemist I, Environmental Laboratory, Y-12 Plant, Martin Marietta Energy Systems, Inc., Oak Ridge, TN. Developed and implemented procedures and trained analysts in the atomic absorption spectrophotometry laboratory. Coauthorized a paper describing the development of an on-line mercury stream monitor. Maintained the monitor prototype, developed other monitoring sites, evaluated the data generated from the monitors, troubleshot the monitors and trained technicians to maintain them.

Analyst, Environmental Laboratory, Y-12 Plant, Martin Marietta Energy Systems, Inc., Analyzed for mercury in water, sediment, urine and air. Evaluated various mercury digestion procedures and detection instruments in order to determine their applicability to automation.

1980 1984 Chemical Technician, Kenwill, Inc., Maryville, TN. Prepared and analyzed coal samples for sulfur, ash, BTU, moisture content, coking value, and fusibility. Prepared and analyzed water, wastewater, ores, soils, and solid wastes for several inorganic components employing a variety of analytical procedures and techniques. Techniques included colorimetry, electropotentiometry, atomic absorption spectrophotometry, spectroscopy and gravimetry. Performed also bacteriological analysis using sterile techniques. Participated in procedure development and customer relations activities.

1979 - 1980 Laboratory Assistant, Department of Chemistry, Austin Peay State University, Clarksville, TN. Instructed students in the operation of analytical instrumentation and the interpretation of data. Supervised student exercises and experiments in nuclear magnetic resonance, atomic absorption spectrophotometry, infrared, mass spectrometry, gas chromatography, and high pressure liquid chromatography.

Professional Affiliations

American Society for Quality Control

American Chemical Society

Publications

Development of an On-Line Mercury Stream Monitor.

TRACY W. BRYANT

Professional Qualifications

With advanced training in radiation detection principles and computer technology Mr. Bryant oversees day to day operation of our Radioanalytical counting room. His duties include analytical data interpretation and review, personnel supervision and training, developing analytical procedures, productivity scheduling, maintaining instrument quality control records and instrument repair.

Education

VAX/VMS Spectroscopy Algorithms, Canberra Nuclear; 1993.

VAX/VMS Spectroscopy Applications Programming, Canberra Nuclear; 1993.

Radiation & Industrial Safety, Commonwealth Edison Co., Braidwood, Il.; 1988.

Computer Science, L. A. Pierce College; 1984.

Experience and Background

1992-present <u>Team Leader I, IT Corporation, Oak Ridge, TN.</u>
Primary responsibilities include analytical data interpretation and review, personnel supervision and training, developing analytical procedures, productivity scheduling, maintaining instrument quality control records and instrument repair.

* Interpret analytical results from alpha/gamma spectroscopy. Review calculated data to ensure integrity of product.

* Supervise overall effort of counting room personnel and provide training for instrument operation, calibration procedures, repair and data review.

* Write operation, calibration and quality control procedures for all count room functions.

* Work closely with Preparation & Separation depts. to determine samples "In Progress" then establish counting schedules.

* Maintain Quality Control records for all counting equipment including energy/efficiency calibrations, backgrounds, daily source reproducibility checks and instrument maintenance.

1989-1992 Health Physics Technician II, IT Corp., Oak Ridge,TN. Responsible for sample counting, instrument quality control records, instrument repair, analytical procedure development and data interpretation & review.

1987-1989 Systems Technician, Manufacturing and Customer Service, Tennelec Inc., Oak Ridge, Tn. Performed final assembly and test of GM, gas proportional, phoswich and HPGe detectors. Provided installation, customer training and repair for all Tennelec counting systems.

1986-1987 Computer Repair Technician, Systems Maintenance Inc. Knoxville, Tn. Repaired IBM, Compaq, TI, DEC, NEC and Burroughs computers and peripherals.

1984-1986 Test Engineer, Manufacturing,Symbolics Inc.Chatsworth, Ca. Developed diagnostic programs used to troubleshoot main frame computers and peripherals. Acquired statistical information to identify general failures or design faults. Recommended design changes when appropriate. Trained test technicians on new product lines.

1983-1984 Test Engineering Technician, Manufacturing, Tandon Corp. Simi Valley, Ca. Assisted test engineers with development of diagnostic programs used to troubleshoot computers and peripherals. Designed and built vacuum operated "Bed of Nails" test stations for each new product.

1981-1983 Computer Repair Technician, Systems Support, Anaconda Ericsson Information Systems, Chatsworth, Ca. Repaired minicomputers and peripherals. Provided field service installation and maintenance of multi-terminal control systems to sister company Scandinavian Air Lines.

1977-1980 Specialist 4 (E-4), Air Defense Training Center, U.S. Army, Ft. Bliss, Tx. Ensured timely calibration of all test equipment and missile simulators used in The School Brigade. Performed repairs as needed. Held secret clearance. Honorably discharged.

BETTY J. CRUM

Professional Qualifications

Undergraduate and graduate chemistry courses and continuing experience provide Miss Crum with a solid base for her laboratory analysis career. She has gained valuable experience handling radioactive materials, performing laboratory techniques and specific analyses. She is improving her communication skills and supervisory ability through continuing education classes.

Education

B.A., Maryville College, Maryville, TN; 1989

Experience and Background

6/93 - Present — Analytical Team Leader, IT Corporation, Oak Ridge, TN. Responsible for coordinating sample flow. Responsible for providing the physical preparation team with required information and supplies to enable them to complete their work within established holding times. Responsible for preparing, verifying, and recording radioactive standards. Responsible for maintaining personnel and training files on all subordinates.

11/92 - 6/93 — Analytical Team Leader, IT Corporation, Oak Ridge, TN. Responsible for providing the alpha isotopic team with the required information and supplies necessary to complete sample analysis within allotted turn around times. Responsible for maintaining personnel and training files on all subordinates.

5/90 - 11/92 — Chemist I & II, IT Corporation, Oak Ridge, TN. Responsible for performing wet-chemical analysis involving possible low-level radioactive samples. Qualifying proficiency obtained in the following separation analyses: U-238, Th-232, Pu-239, Np-237, Am-241; Po-210; Sr-89,90; Tc-99; C-14; I-129,130,131.

1/90 - 5/90 — Laboratory Technician IV, Cobble Technical Service, Knoxville, TN. Responsible for performing wet-chemical analysis involving possible low-level radioactive samples. Duties included: Separation of H-3; I-129,130,131; and Sr-89,90. Calculating results for the above isotopes.

APPENDIX F

M.J.W. CORPORATION INC.
RADIOLOGICAL CONTROL PROCEDURE NO. 9
CALIBRATION AND OPERABILITY CHECKS
OF RADIOLOGICAL INSTRUMENTS

MJW Corporation, Inc.

RADIOLOGICAL CONTROL PROCEDURE 9

Controlled Copy Number 5

CALIBRATION AND OPERABILITY CHECKS OF RADIOLOGICAL INSTRUMENTS

1.0 PURPOSE

This procedure establishes the minimum requirements necessary to assure proper operability of radiological survey instruments.

2.0 SCOPE

This procedure applies to all survey instruments used by Health Physics personnel. The requirements may be changed to suit the needs of special equipment.

3.0 RESPONSIBILITIES

3.1 A Health Physics Technician will be assigned the task of ensuring that all instruments are operability checked and within the calibration date. The check will be performed on a daily basis during active use, and recorded on the MJW Equipment Operability Checklist (Attachment 1).

3.2 All personnel are required to source check and battery check (if applicable) survey equipment prior to use.

4.0 PROCEDURE

4.1 General

4.1.1 Only instruments with a current calibration label shall be used for conducting surveys.

4.1.2 Instruments suspected of providing incorrect measurements shall be removed from service. Complete a detective equipment tag (Attachment 2), affix it to the instrument and have the instrument repaired as soon as possible.

Approved: David A. Dooley Effective: 6/25/91

Health Physics Director

4.1.3 Calibrate repaired instruments prior to returning them to service.

4.2 Calibration

4.2.1 Portable survey instruments used shall be calibrated and repaired in accordance with procedures given by the instrument manufacturer.

4.2.2 Calibrations shall be performed every six months or upon completion of repair of an instrument.

4.2.3 A copy of the instrument calibration report should be placed in the instrument log book.

4.3 Operability Checks

4.3.1 Perform operability checks according to the following, and record the information on the Equipment Operability Checklist (Attachment 1). File the completed form in the Instrument Log Book.

4.3.2 Calibration Check

A. Verify that a calibration sticker is affixed to the instrument. If not, check the calibration records. If the calibration is current, affix a new calibration sticker.

B. Verify that the calibration has not expired. Have the instrument recalibrated if necessary.

4.3.3 Battery Checks

A. Battery checks for portable monitoring equipment shall be performed to ensure the battery voltage is high enough to permit correct measurements; batteries shall be replaced as necessary.

B. For instruments with a battery check switch, the battery check shall be performed prior to use.

C. For instruments without a battery check switch, the batteries shall be checked at least weekly. Weekly battery check information shall be kept with the instrument.

4.3 Source Response Checks

4.3.1 Radiation survey instruments shall be response checked with a source of known strength to verify that the instruments respond properly to radiation. The meter shall be exposed to the source for sufficient time to permit the meter response to stabilize.

4.3.2 Alpha and beta-gamma friskers and portable alpha survey meters shall be response source checked each time the equipment is used. When these instruments are in continuous use, source response checks should be performed three times each day.

4.3.3 For continuous air monitors (e.g., air particle detectors), source response checks shall be performed when the instrument is placed in operation or, when in operation, once a week. When the instrument is temporarily removed from operation, source response checks are not necessary before operation unless more than one week has elapsed since the last source response check.

4.4 Defective Equipment

4.4.1 Equipment deemed unsuitable for use shall be marked with defective equipment tag (Attachment 2) and removed from service.

4.4.2 The Health Physics Supervisor shall be immediately notified if equipment is found to be defective.

5.0 DEFINITIONS

None

6.0 REFERENCES

6.1 American National Standards Institute, N232-1978, Radiation Protection Instrumentation Test and Calibration.

6.2 International Electrotechnical Commission, (IEC) 846:1989, Beta, X and Gamma Radiation Dose Equivalent and Dose Equivalent Rate Meters for Use in Radiation Protection.

6.3 American National Standards Institute, N42.17A - 1989, Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions.

7.0 ATTACHMENTS

1 - Equipment Operability Checklist

2 - Defective Equipment Tag

3 - Field Source Check Form

ATTACHMENT 1

EQUIPMENT OPERABILITY CHECKLIST

Name:_____Date:_____

Verification/Review:_____

Equipment Manufacturer:_____

Model Number:_____ Serial Number:_____

Probe Used:_____

1.0 Calibration

_____ 1) Calibration date is located on the instrument.

_____ 2) Instrument's calibration date is within the six month limit.

2.0 Battery Check

_____ 3) Battery is within the recommended operational range. (If applicable)

_____ 4) Battery check verification date is located on the instrument. (If applicable)

3.0 Source Check

Source Manufacturer:_____ Source Type:_____

Activity of Source:_____

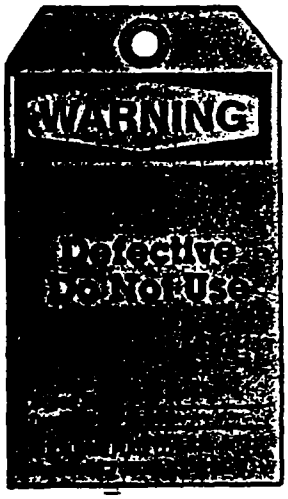
Source Activity Detected by Instrument:_____

$$\% \text{ Efficiency of Instrument} = \frac{\text{Activity Detected(CPM)}}{\text{Activity of Source(DPM)}} \times 100$$

$$\frac{\text{CPM}}{\text{DPM}} \times 100 = \% \text{ EFF}$$

ATTACHMENT 2

DEFECTIVE EQUIPMENT TAG



ATTACHMENT 3

M.J.W. CORPORATION, INC.
FIELD SOURCE CHECK FORM

SITE: _____

DATE: _____ TIME: _____

RATEMETER/SCALER

MODEL NUMBER _____ CAL. DATE _____

SERIAL NUMBER _____ CAL. DUE DATE _____

BATTERY: OK ____ NOT OK ____ OTHER _____

COMMENTS: _____

PROBE

MODEL NUMBER _____ CAL. DATE _____

SERIAL NUMBER _____ CAL. DUE DATE _____

CONVERSIONS _____ OTHER _____

SOURCE

TYPE _____ SOURCE STRENGTH _____

SERIAL NUMBER _____ DATE _____

CAL. DATE _____ OTHER _____

SOURCE CHECK

HV SET @ _____ CAL. HV _____

SOURCE CPM _____ CAL. SOURCE TYPE _____

BACKGROUND CPM _____ CAL. BACKGROUND _____

EFF. (CPM/DPM) _____ CAL EFFICIENCY _____

PERFORMED BY _____

REMARKS _____

_____

APPENDIX G

M.J.W. CORPORATION INC.
RADIOLOGICAL CONTROL PROCEDURE NO. 20
OPERATING AND CALIBRATION INSTRUCTIONS FOR
LUDLUM MODELS 2200 AND
1000 PORTABLE SCALER RATEMETERS

MJW Corporation, Inc.

RADIOLOGICAL CONTROL PROCEDURE 20

Controlled Copy Number 5

OPERATING AND CALIBRATION INSTRUCTIONS FOR LUDLUM MODELS 2200 AND 1000 PORTABLE SCALER RATEMETERS

1.0 PURPOSE

This procedure presents the operating and calibration instructions for the Ludlum Model 2200 Portable Scaler Ratemeter and Model 1000 Portable Scaler.

2.0 SCOPE

The Model 2200 Scaler Ratemeter and the Model 1000 Scaler, are self-contained counting instruments designed to be used with various detectors. The Model 2200 is a Portable Scaler Ratemeter and can be powered by battery or line power. The instrument can, in addition, be used as a single channel analyzer. The Model 1000 functions as a scaler and can only operate using line power. Procedures and instructions contained in this document will pertain to both instruments with the exception of operating instructions for the options available on the Model 2200 (single channel adjustments, threshold, window, battery care and maintenance, etc.) Maintenance and calibration for both scalers will be essentially the same.

3.0 RESPONSIBILITIES

3.1 The Health Physicist is responsible to ensure that the instruments are maintained operational and calibrated.

3.2 The Health Physics Technician is responsible for maintaining the instruments covered by this procedure operational and calibrated.

3.3 The Radiological Control Technician is responsible to operate this instrument in accordance with this procedure and the instrument manual, and arrange for maintenance on the instrument.

Approved: David A. Dooley Effective: 7/19/91
Health Physics Director

4.0 PROCEDURE

4.1 Instrument controls and functions for the Model 2200 Scaler Ratemeter are as follows: (The Model 1000 Scaler controls and functions are as stated in Items 4.1.6, 4.1.7, 4.1.8, 4.1.9 and 4.1.12, only and will be denoted with an *.)

4.1.1 Power Switch - a four position switch: OFF, BAT, LINE, CHG, is provided on the front panel. OFF indicates power is off. LINE provides line power to the unit. BAT provides power from the batteries internal to the unit. CHG indicates that the unit is OFF, but provided the unit is plugged into an active AC outlet, a charging current is provided to the internal rechargeable batteries. SEE CAUTION

CAUTION

The CHG position should only be used when the instrument is provided with rechargeable batteries. Non-rechargeable batteries may explode and damage the instrument.

The instrument shall be marked appropriately, should non-rechargeable batteries be installed.

4.1.2 Response - A two position toggle switch indicating Fast (F) or Slow (S) response is provided. In "F" position, 90 percent full scale deflection of the meter occurs in 2.2 seconds. In "S" position, 90 percent full scale deflection of the meter occurs in 22 seconds.

4.1.3 Range - a four position range selection switch providing range multipliers of x1, x10, x100 and x1k is provided. Therefore, the full scale range of the instrument is 0 to 500k cpm.

4.1.4 Function Switch - a three position function selection switch is provided for RATE, HV, and BAT. These switch functions allow the operator control over the ratemeter readout.

RATE allows the operation to indicate the count-rate of the sample being counted. HV indicates the high voltage going to the detector, and BAT provides the battery check status on the meter.

4.1.5 Zero - The ZERO button, when depressed, resets the meter to zero.

4.1.6* Count - The COUNT button, when depressed, resets and starts the scaler counter. The scaler turns off automatically when the preset time is reached. A count lamp is provided indicating the scaler is in the count cycle.

4.1.7* Hold - The HOLD button stops the count cycle without resetting the scaler.

4.1.8* Scaler - a six digit LED readout is provided as the scaler display.

4.1.9* Timer - a two decade thumbwheel switch is used for presetting the count time. In addition, a four position switch is provided for time base in minutes from 0 to 99 with multiples of x0.1, x1, x10 and EXT for external timing.

4.1.10 Scaler Intensity - a DIM control is provided to vary the intensity of the readout.

4.1.11 Single Channel Analyzer Controls (2200 only)

4.1.11.1 DISCR screw - one turn potentiometer for setting the range of the Threshold.

4.1.11.2 THRESHOLD - ten turn potentiometer for adjusting the base line.

4.1.11.3 WINDOW - ten turn potentiometer for adjusting the window width.

4.1.11.4 ON-OFF - a toggle switch is provided to activate the window.

4.1.12* High Voltage - a ten turn potentiometer control is provided to adjust high voltage from 200 volts to 2500 volts. A scale readout for HV is the only function of the analog scaler on the Model 1000. On the Model 2200, HV must be selected with the function switch to read the high voltage.

4.2 Instrument Operation

4.2.1 Connect the detector to the unit with which it has been calibrated, if not presently connected. The detector to use will be indicated on the calibration sticker. Should an alternate detector be used, the unit shall be calibrated for the alternate detector prior to use.

4.2.2 Select either line or battery operation using POWER SWITCH. Model 1000 scaler is line only.

4.2.2.1 Line Operation - connect the instrument to line power. Turn power switch to LINE and proceed to use.

4.2.2.2 Battery Operation - turn power switch to BAT. Check battery condition by placing the RATE-HV-BAT function switch to BAT. If meter deflection is below the BAT portion of the meter, tag the unit Out of Service and return to Calibration Facility for battery replacement if line operation is not possible.

4.2.3 Set the timer to the desired counting time.

4.2.4 Set the response to "F" or "S" as desired (not available on Model 1000).

4.2.5 Set the RATE-HV-BAT switch to RATE, (not present on the Model 1000).

4.2.6 To start counter, press COUNT button, the red lamp will be lit during the count and extinguish at the end of the count cycle.

4.2.7 To turn unit off, turn POWER SWITCH to OFF.

4.3 Calibration

The Ludlum Model 2200 or Model 1000 may be calibrated for use with scintillation, proportional and G-M detectors. Document calibrations on Attachments to RCP 9.

4.3.1 Determining Instrument Plateau and Selecting Operating Point

4.3.1.1 Set window ON-OFF at OFF (not available on Model 1000).

4.3.1.2 Set x0.1 - EXT at x0.1 and MINUTES thumbwheel switch to 01. This gives a 1/10 minute count.

4.3.1.3 Set THRESHOLD control at 1.0 (not present on Model 1000).

4.3.1.4 With detector shielded from source, turn up high voltage control 100 volts at a time and take a plot of HV versus background count rate until the detector voltage rating is reached. Return HV control to 0.0.

NOTE: If detector voltage reading is reached before any background counts are detected, turn DISCR clockwise to increase sensitivity.

4.3.1.5 Expose detector to source (Sr-90 for Beta/Gamma or Pu-239 or Am-241 for Alpha) and again make a plot of voltage versus count.

4.3.1.6 Plot both sets of data and select the operating point to correspond with maximum source count and minimum background count. Avoid areas of very fast count rate changes with small changes in detector voltage. The optimum operating point for low background detectors is just above the inflection point (or break-over point) of the plateau curve. If background count is irrelevant, shift operating point to the

plateau center for greater stability, calculated as the minimum change in count rate (slope) over a 100 volt increment.

4.3.2 Set DISCR and THRESHOLD for different detectors (omit for Model 1000).

4.3.2.1 For scintillation detectors:

a. Set THRESHOLD on 1.00.

b. Set Pulsar pulse-height at 10 millivolts and attach to the scaler.

c. Adjust DISCR until scaler counts the Pulsar pulse at 10 millivolts and does not count the Pulsar pulse at 9 millivolts. The input sensitivity is now set for 10 millivolts with the THRESHOLD set on 1.00.

d. Proceed to use the instrument with THRESHOLD setting at 1.00 or more.

4.3.2.2 For G-M detectors:

Set THRESHOLD on 7.00 and proceed to use the instrument. The input sensitivity is approximately 35 millivolts.

4.3.2.3 For proportional detectors:

a. Set THRESHOLD on 1.00.

b. Connect the scaler to the Pulsar.

c. Adjust DISCR such that the instrument counts the Pulsar at 1.6 millivolts and does not count at 1.3 millivolts. The input sensitivity is now set for 1.6 millivolts and the THRESHOLD set on 1.00.

d. Proceed to use the instrument with THRESHOLD at 1.00.

4.3.3 Energy Calibration for Scintillation Detectors (omit for Model 1000).

4.3.3.1 Procedure to calibrate THRESHOLD to 10 keV/Turn.

4.3.3.1.1 Initial Model 2200 control settings.

a. Window ON-OFF switch at OFF

b. Ratemeter RANGE selector switch - x10

c. Time Switch - 0.01 x 1

d. THRESHOLD dial - 5.50

e. WINDOW dial - 1.00

f. HV dial - 0.00

4.3.3.1.2 Turn-on

a. Connect scintillation detector to instrument.

b. Turn power switch to appropriate power supply.

4.3.3.1.3 Operation and Calibration

a. Expose calibrated source (i.e., plated Am-241 source) to detector.

b. Increase HV setting until count from source just starts to count.

c. Switch window ON-OFF to ON.

d. Increase HV until source peaks on ratemeter. Increase range switch as necessary.

e. THRESHOLD dial is now calibrated to 10 keV/Turn. The WINDOW control may be widened or narrowed without affecting the THRESHOLD setting.

4.3.2.2 Procedure to calibrate threshold to 100 keV/Turn.

4.3.2.2.1 Initial 2200 control settings:

a. Switch window ON-OFF to OFF

b. Ratemeter RANGE selector switch - x10

c. Time Switch - 0.01 x 1

d. THRESHOLD dial - 6.52

e. WINDOW dial - 0.20

f. HV dial - 0.00

4.3.2.2.2 Turn-On:

a. Connect scintillation detector to instrument.

b. Turn power switch to appropriate power supply.

4.3.2.2.3 Operation and Calibration

a. Expose calibrated source (i.e., Cs-137 source) to detector.

b. Increase HV setting until count from source just starts to count.

c. Switch window ON-OFF switch to ON.

d. Increase HV until source peaks on ratemeter. Increase RANGE switch as needed to prevent meter from exceeding full scale.

e. THRESHOLD dial is now calibrated to 100 keV/Turn. The WINDOW control may be widened or narrowed without affecting the threshold setting. (As now calibrated, the instrument will respond only to radiation energies between 652 keV and 672 keV. Adjust THRESHOLD dial for other energies of interest.

4.3.4 Battery Change (not available on Model 1000 Scalers)

4.3.4.1 Unscrew four screws to battery compartment lid located on rear of instrument.

4.3.4.2 Place four "D" cell batteries into compartment, noting polarity.

4.3.4.3 Replace battery lid and four screws onto instrument.

4.3.4.4 Turn power switch to BAT.

4.3.4.5 Turn RATE-HV-BAT switch to BAT. A downscale deflection indicates battery polarity reversal.

4.3.4.6 Turn power switch to OFF.

4.3.5 Troubleshooting

The Calibration Technician is referred to the Technical Manual for circuit diagrams and test points for troubleshooting problems.

4.3.6 Ratemeter Calibration

4.3.6.1 Connect pulse generator to instrument connector and adjust pulse frequency to provide 2/5 and 4/5 deflection on the x1k scale. Adjust x1k potentiometer as required. Record pulse frequency, actual meter reading, and scaler reading on Calibration Certificate.

4.3.6.2 Decrease pulse frequency by decades and adjust each range calibration potentiometer accordingly (x1, x10, x100). Record pulse frequency, actual meter reading, and scaler reading on Calibration Certificate.

4.3.6.3 A Certificate of Calibration (Attachment 1) shall be completed.

4.3.6.4 A Calibration Sticker shall be affixed to the ratemeter.

4.3.6.5 Calibration of instrument shall be performed following maintenance or repair. Battery replacement does not require recalibration.

4.3.6.6 Calibration shall be performed on a six month cycle for the Ludlum Model 2200 and Model 1000.

4.3.7 Preventative Maintenance Will Be Done During Calibration.

4.3.7.1 The unit shall be checked for integrity, corrosion, and functional condition of physical and electrical components.

4.3.7.2 Components found defective will be cleaned, repaired or replaced.

4.3.7.3 Battery (Model 2200 only) condition shall be checked for corrosion and cleaned, if necessary.

4.3.7.4 Battery contacts shall be cleaned of corrosion, grease, and dirt (Model 2200 only).

4.3.7.5 Preventative maintenance shall be documented on the Certificate of Calibration (CAL-9).

5.0 DEFINITIONS

None

6.0 REFERENCES

6.1 Technical Manual for Ludlum Model 2200 and Model 1000
6.2 RCP-9 Calibration and Operability Checks of Radiological Instruments

7.0 ATTACHMENTS

7.1 Attachment 1 - Calibration Certificate

ATTACHMENT 1

Calibration Certificate

CALIBRATION:

BY _____ DATE _____

DUE _____

APPENDIX H

M.J.W. CORPORATION INC.
RADIOLOGICAL CONTROL PROCEDURE NO. 4
ROUTINE RADIATION AND CONTAMINATION SURVEYS

MJW Corporation, Inc.

RADIOLOGICAL CONTROL PROCEDURE 4

Controlled Copy Number 5

ROUTINE RADIATION AND CONTAMINATION SURVEYS

1.0 PURPOSE

To establish a procedure for performing routine radiation/ contamination surveys.

2.0 SCOPE

This procedure shall be used to ensure uniformity and quality in all radiological surveying being performed by MJW personnel and subcontractors.

3.0 RESPONSIBILITIES

3.1 All surveys are to be performed by Health Physics technicians under the supervision of the Health Physicist. Survey results shall be recorded on MJW Survey Sheets - Attachments 1, 2 and 3.

3.2 Each person conducting a survey shall ensure that these procedures are adhered to and proper documentation is completed.

3.3 The Health Physicist will ensure survey results are properly documented and distributed.

3.4 The Health Physicist will take the following actions if abnormal conditions are detected on the routine survey:

3.4.1 Post the area if necessary per Radiological Controls Manual.

3.4.2 Notify the cognizant MJW Manager.

3.4.3 File a copy of the follow-up survey with the routine survey.

3.5 The Health Physics Technician will ensure that all instruments are operability checked and are within the affixed calibration due date before use.

3.6 The Health Physicist will ensure the review and filing of survey results, inspection of areas posted due to changes in radiological conditions, and expedite reporting and follow-up on action items.

4.0 PROCEDURE

4.1 Radiation Measurements

4.1.1 Whole body penetrating radiation dose-rates should be determined using an ion chamber survey meter. Energy compensated GM detector survey meters may be used but should be verified with an ion chamber survey meter if possible. An exception would be high dose-rate measurements using instruments such as a Teletector. Radiation levels will be expressed in units of µR/hr, mr/hr or R/hr, as appropriate.

4.1.2 Beta dose-rates should be determined using an ion chamber survey meter equipped with a removable beta shield. Readings are taken with the window open and closed, and put through the following formula to calculate beta dose- rates:

Open window reading (beta + gamma)
\- Closed window reading (gamma)
= Beta dose-rate

Beta dose-rates will be expressed in units of mrad/hr.

4.1.3 Alpha direct radiation measurements will be conducted using a detector to surface distance of 0.25 inch. Readings will be reported typically as net cpm.

4.1.4 General area dose-rates will be taken as follows:

- o Take measurements at greater than 18" from all radiation sources.
- o Hold instrument at waist height above floor or ground surface.
- o Always report the distance with the dose-rate, such as: 5 mR/hr, general area, 3 feet above floor.

4.1.5 Contact dose-rates will be taken as follows:

- o Take reading with detector portion of instrument nearly touching the object--DO NOT TOUCH object with survey instrument unless object is known to be contamination-free.

- o Estimate and record the size of the object if less than the window diameter of the survey instrument. Objects smaller in size than the detector may cauuse an <u>under response</u> of the survey instrument. This will result in <u>underestimating</u> the radiation hazard. Notify the Health Physicist of this survey condition so that a geometry correction can be made to the exposure-rate.

4.1.6 Measurement entries such as "background" shall be avoided. If the readings are sufficiently low, < MDA shall be entered as the data point. MDA is defined as the minimum detectable activity of an instrument.

4.1.7 Dose-rate readings differing by ± 50 percent from previous readings will be circled, and a follow up survey conducted.

4.2 Contamination Measurements (Quantitative)

4.2.1 Removable contamination levels will be determined using disc smears (cloth, such as Nucon) wiped over a surface area of 100 cm^2. If the surface area is <100 cm^2, smear the entire area.

4.2.2 Alpha Smears - Field Check (Qualitative)

(1) Smears should be field checked on location at the site where the survey is performed, using a portable ratemeter and any alpha-sensitive probe. The purpose of this on-site field check is to immediately assess the extent/magnitude of any contamination present, not to document surveys.

(2) The probe shall be held within 1/4" of the surface of the smear being careful not to touch the smear to the surface of the probe (thus preventing contaminating or puncturing the probe). Hold the probe in a fixed position over the smear for at least 5 seconds to allow for proper meter response. If meter does respond, allow about 15 seconds for it to stabilize in order to obtain an accurate measurement.

4.2.3 Alpha Smear Analysis (Quantitative)

(1) Do not place smears >10,000 dpm (via field check) into the smear counter.

(2) Use Ludlum 2200 or Ludlum 1000 ratemeter with Ludlum 43-10 alpha detector to count smears that are to be documented for recordkeeping purposes. Ensure it has been source-checked, meets calibration requirements and has had a background and LLD determined for that day (background should generally be 0 to 2 cpm for alpha).

(3) Using tweezers, place smear into aluminum dish and slide into 43-10. Ensure closure lever on 43-10 is in "shut" position, thus preventing light from entering detector and interfering with the count. Count smear for one minute and then, using tweezers, remove and dispose of properly or save for future analysis. Smear data should be entered on Attachment 1, "Removable Contamination

Survey Data Sheet," and their location shall be annotated on a survey map using a circled number (i.e., 1, 2, 3, etc...).

(4) An area shall be considered free of removable alpha contamination if results indicate <33 dpm/100 cm^2 average with a maximum allowable of 100 dpm/100 cm^2 over any one surface.

(5) If results indicate levels above those specified in (4) above, consult the M.J.W. Health Physicist and discuss actions to be taken.

4.2.4 Checking for Fixed Alpha Contamination

(1) Fixed alpha contamination levels will be determined using scintillation-type frisking probes attached to an applicable portable survey ratemeter. M.J.W. currently uses two types of alpha scintillation detectors, the Ludlum 43-5 and Eberline AC-3. These probes are compatible with either the Ludlum 2220 or Eberline ESP-1 ratemeters.

(2) Hold the alpha detector 1/4" from the surface being measured for several seconds - listening for audible clicks and observing meter response. After noting response, position probe to area immediately adjacent to the area that has just been monitored and repeat above process.

NOTE: When measuring for low (i.e., near background) levels of alpha contamination - a scintillation detector may require several seconds to register a response. Thus, if care is not taken to allow for sufficient meter response (i.e., slow frisking rate), accurate results might not be obtained.

(3) Enter all data on the appropriate data sheet (Attachment 2, Fixed Contamination Survey Data Sheet).

(4) An area shall be considered free of fixed alpha contamination if results indicate <1000 dpm/100 cm^2 average with a maximum allowable of 5000 dpm/100 cm^2.

(5) If results indicate levels above those specified in (4) above, consult the M.J.W. Health Physicist and discuss actions to be taken.

4.2.5 Beta/Gamma Smears - Field Check (Qualitative)

(1) Smears should be field checked, on location, at the site where the survey is performed using a portable ratemeter and any beta/gamma sensitive probe. The purpose of this on-site field check is to immediately assess the extent/magnitude of any contamination present, not to document surveys.

(2) The probe shall be held within 1/2 inch of the surface of the smear being careful not to touch the smear to the surface of the probe (thus preventing contaminating or damaging the probe). Hold the probe in a fixed position over the smear for 3-5 seconds to allow for proper meter response. If meter does respond, allow 10-15 seconds for it to stabilize in order to obtain an accurate measurement.

4.2.6 Beta/Gamma Smear Analysis (Quantitative)

(1) Do not place smears >10,000 dpm (via field check) into the smear counter.

(2) Use Ludlum 2200 or Ludlum 1000 ratemeter with a high efficiency beta/gamma sensitive probe to count smears that are to be documented for recordkeeping purposes. Ensure it has been source-checked, meets calibration requirements and has had a background and LLD determined for that day.

(3) Using tweezers, place smear into aluminum dish and position under detector. Count for one minute and remove for disposal or save for further analysis. Smear data should be entered on Attachment 1, Removable Contamination Survey Data Sheet, and their location shall be annotated on a survey map using a circled number (i.e., 1, 2, 3, etc.).

(4) An area shall be considered free of removable beta/gamma contamination if results indicate <222 dpm/100 cm^2 average with a maximum allowable of 1100 dpm/100 cm^2 over any one surface.

(5) If results indicate levels above those specified in (4) above, consult the M.J.W. Health Physicist and discuss actions to be taken.

4.2.7 Checking for Fixed Beta/Gamma Contamination

(1) Fixed beta/gamma contamination levels will be determined using Geiger-Mueller or scintillation-type frisking probes attached to an applicable portable survey ratemeter.

(2) Holding the probe approximately one centimeter from the surface being measured, move probe at a rate of about one-two inches/second. Monitor the meter response closely. If significant meter deflection occurs, hold probe stationary until a peak reading is obtained (approximately 10 seconds). Continue with this method until the entire area has been covered and record results on Attachment 2, Fixed Contamination Survey Data Sheet. A symbol such as # shall be used to denote areas frisked on a survey map.

(3) An area shall be considered free of fixed beta/gamma contamination if results indicate <0.25 mrem/hr at one centimeter from the surface.

(4) If results indicate levels above those specified in (3) above, consult M.J.W. Health Physicist and discuss actions to be taken.

4.3 Large Area Wipes (Qualitative measurements)

4.3.1 Large area wipes of 10,000 cm^2 (1 $meter^2$) will be taken and counted with appropriate calibrated portable survey meters.

4.3.2 Smear locations for large area wipes will be annotated on the survey map with a number beside the letter "L" (for example, L1, L2, etc.). Smears of horizontal surfaces will be indicated with the letter "H" preceding the L'd number (for example, HL1, HL2, etc.).

4.3.3 The minimum number of smears to be taken will be determined by the Health Physicist.

4.3.4 The results shall be recorded as cpm above background and if sufficiently low, shall be recorded as < MDA (in cpm).

4.4 Records

4.4.1 All survey records shall be filed in accordance with MJW Quality Assurance standards.

5.0 DEFINITIONS

5.1 Routine Survey - Surveys which are performed in normally contamination free areas for the purpose of detecting the spread of radioactive contamination.

5.2 Follow-up Survey - Surveys which are performed to ensure that the proper corrective action was taken to remove radioactive contamination from contaminated areas as well as areas normally free of contamination.

6.0 REFERENCES

6.1 WV-RC-2
6.2 12 NYCRR 38, Table 5
6.3 Ludlum 2220 Technical Manual
6.4 Ludlum 43-5 Technical Manual
6.5 Eberline ESP-1 Technical Manual
6.6 Eberline AC-3 Technical Manual

7.0 ATTACHMENTS

7.1 Attachment 1 - Removable Contamination Survey Data Sheet
7.2 Attachment 2 - Fixed Contamination Survey Data Sheet
7.3 Attachment 3 - Radiation/Contamination Survey Map and Data Sheet

M J W Corporation, Inc.

Removable Contamination Survey Data Sheet

MJW Job #:	Surveyor:	Date:	Time:	Survey No:
Location:		Area Surveyed:		

Alpha Counting Instrument	Beta-Gamma Counting Instrument
Scaler Model No.	Scaler Model No.
Serial No.	Serial No.
Probe Model No.	Probe Model No.
Serial No.	Serial No.
Calibration Date	Calibration Date
Percent Efficiency	Percent Efficiency
BKGD (CPM) MDA (DPM)	BKGD (CPM) MDA (DPM)

Smear Type		Smear Number	Sample Location	Counting Time (min)	Gross Counts	Gross CPM	Net CPM	DPM/ 100 cm2	Std. Dev. (x2)
A	B/G								

Sheet _____ of _____	Verification:	Date:

RCP No. 4 Revision: 0 Date: 5/24/91 Attachment 1

M J W Corporation, Inc.

Fixed Contamination Survey Data Sheet

MJW Job #:	Surveyor:	Date:	Time:	Survey No:
Location:		Area Surveyed:		

Alpha Counting Instrument		Beta-Gamma Counting Instrument	
Scaler Model No.		Scaler Model No.	
Serial No.		Serial No.	
Probe Model No.		Probe Model No.	
Serial No.		Serial No.	
Calibration Date		Calibration Date	
Percent Efficiency		Percent Efficiency	
BKGD (CPM)	MDA (DPM)	BKGD (CPM)	MDA (DPM)

Survey Type		Sample Location / Description	Gross CPM	Net CPM	DPM/ 100 cm2	Std. Dev. (x2)
Alpha	B/G					

Sheet _____ of _____	Verification:	Date:

RCP No. 4 Revision: 0 Date: 5/24/91 Attachment 2

RCP4A2.1 RP

M.I.W. Corporation, Inc.

Radiation / Contamination Survey Map and Data Sheet

MJW Job #:	Surveyor:	Date:	Time:

Survey Map (Indicate North)

Survey Location (Description)	Instrument Number	Radiation Levels CPM or mR/hr	Physical Form	Remarks

* Note: All Radiation Readings will be made in the same units noted for the instrument, unless noted otherwise in the remarks column.

Operation-Specific
QUALITY ASSURANCE MANAGEMENT PLAN
IT ANALYTICAL SERVICES DIVISION

ST. LOUIS LABORATORY
APPENDIX

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APPENDIX

ST. LOUIS-0

LIST OF APPENDIX SECTIONS, TABLES, AND FIGURES

LIST OF APPENDIX SECTIONS

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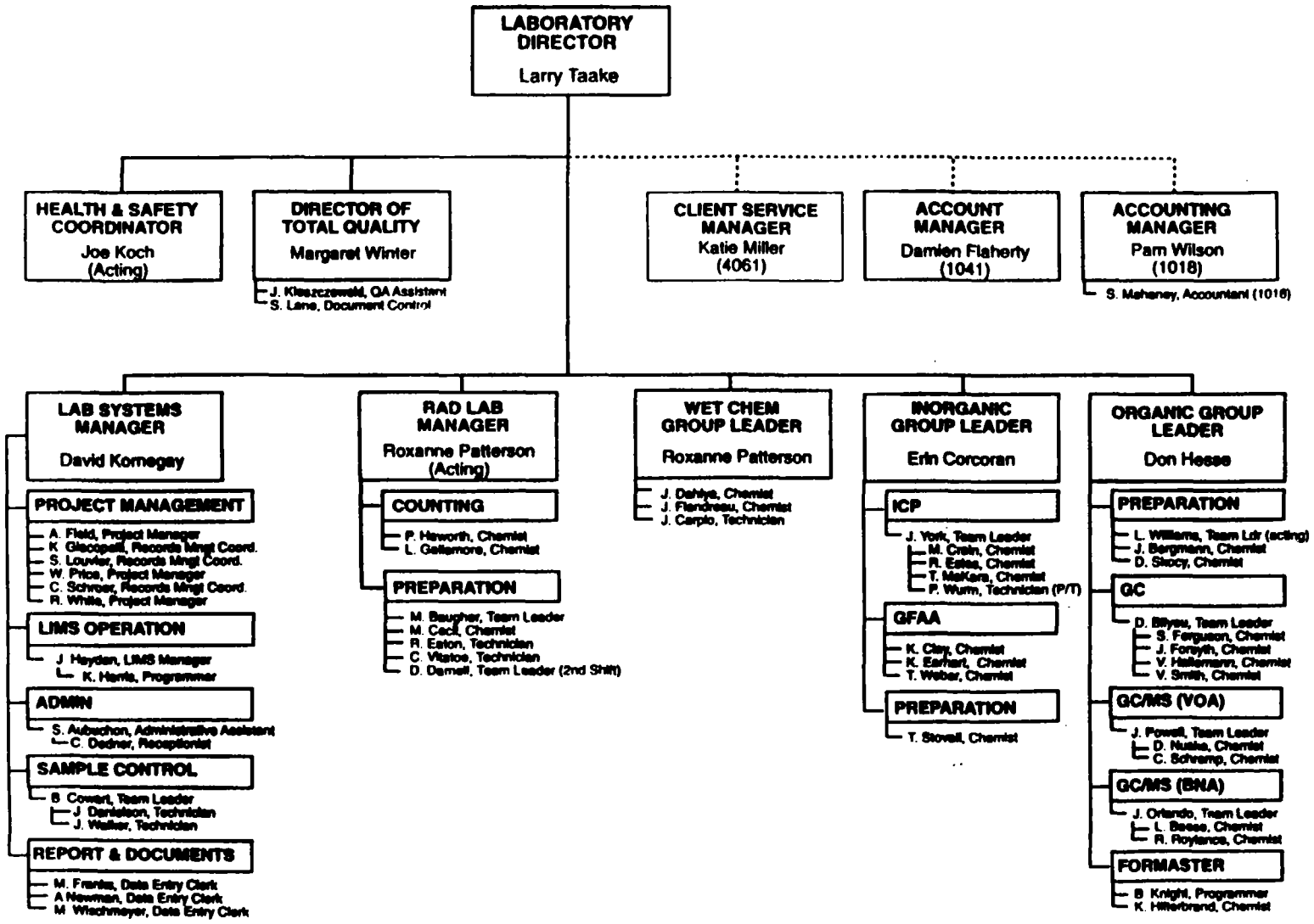
APPENDIX

ST. LOUIS-1

ORGANIZATIONAL CHART

FIGURE SL-1-1

INTERNATIONAL TECHNOLOGY CORPORATION
ANALYTICAL SERVICES
ST. LOUIS/4628



APPENDIX

ST. LOUIS-2

INSTRUMENT LIST

TABLE SL-2-1
ITAS-ST. LOUIS LABORATORY
Instrument List
April, 1993

Instrument Type	Manufacturer (Number)	Model	Autosampler	Age (Yrs.)
Gas Chromatograph/Mass Spectrometer RTE Data System and Library (Wiley/NBS) 9-track magnetic tape Autosampler	Hewlett Packard (2)	5988A		5-7
	Hewlett Packard (6)	5970		7
Purge and Trap ALS/Heated Purge	Tekmar (5)	LSC2000		2-7
Gas Chromatograph Capillary/Packed Column Autoinjector, Autosampler	Hewlett Packard (7)	5890	HP7673A	4
	Hewlett Packard (1)	5880	HP7673A	7
Inductively-Coupled Argon Plasma Vacuum Spectrometer	Thermo Jarrell Ash (1)	1100		7
	Thermo Jarrell Ash (1)	9000		1
Atomic Absorption Spectrometer, Graphite Furnace	Perkin Elmer (2)	5100Z-PC		1
Atomic Absorption Spectrometer, Graphite Furnace/Flame	Perkin Elmer (1)	5100Z-PC		1
Atomic Absorption Spectrometer, Cold Vapor Assembly	Thermo Jarrell Ash (1)	12E		7
Total Organic Carbon Analyzer	Dohrmann-Xertex (1)	DC180		7
Total Organic Halogen Analyzer	Dohrmann-Xertex (1)	DX20A		7
Ion Chromatograph HPLC Module	Dionex (1)	4020i	Dionex	7
High-Pressure Liquid Chromatograph	Perkin Elmer (2)	410	PE ISS-100	7
	SSI (1)	220B	SGE LS3200	4
UV Spectrophotometer	Milton Roy (1)	601		7
Gel Permeation Chromatograph with UV Detector (GPC)	ABC Laboratories (1)	1002A		6

TABLE SL-2-1
ITAS-ST. LOUIS LABORATORY
Instrument List
April, 1993

Instrument Type	Manufacturer (Number)	Model	Autosampler	Age (Yrs.)
IR Spectrophotometer, Ratio Recording	Perkin Elmer (1)	1420		6
Remote Microwave Digestion System	Floyd (1)	RMS 150		3
Gas Proportional Counter, Low Background, 16 Detectors	Tennelec (1)	LB4000		6
Gamma Spectrometer, Intrinsic Germanium Detectors	Princeton (1) Ortec (1) Canberra (1) Tennelec (1)	Multi-component system		1-6
Kinetic Phosphorescence Analyzer (KPA)	Chemchek (1)	Multi-component system		3
Scintillation Detector	Randam (4)	SC-5		3
Liquid Scintillation Detector	Packard (1)	2200CA		6
Alpha Spectrometer Counting System	EG&G Ortec (16) Canberra (4)	Multi-component system		6

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APPENDIX

ST. LOUIS-3

STANDARD OPERATING PROCEDURE LIST

TABLE SL-3-1
ITAS-ST. LOUIS LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
0001	Standards Preparation
1001	Thermometer Calibration
1002	Automatic Pipetter Calibration
1003	Balance Calibration and the Use of Class S Weights
2001	Sample Receipt and Chain of Custody
2003	Release of Samples for Analysis Prior to Complete Login
3001	Cyanide Distillation
3003	Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICAP
3004	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICAP
3005	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Graphite Furnace
3006	Acid Digestion of Sediments, Sludges and Soils
3007	Acid Digestion of Metals Samples (CLP Protocol)
3008	Distillation of Phenols
4001	Total Coliform
4002	Fecal Coliform
4003	Turbidity
4004	Cyanide Analysis of the Technicon TRAACS 800 Autoanalyzer
4005	Percent Solids Determination
4006	Extraction and Analysis of Chlorinated Herbicides
4007	The Analysis of 2,3,7,8-Tetrachlorinated Dibenzo-p-Dioxin
4008	Hardness
4009	Chemical Oxygen Demand (COD)
4011	The Analysis of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans
4012	Total Dissolved Solids Dried at 180°C (Filterable Residue)
4013	Total Solids Dried at 103-105°C (Non-Filterable Residue)
4014	Total Suspended Solids Dried at 103-105°C (Non-Filterable Residue)
4015	Oil and Grease (Partition-Gravimetric Method)

TABLE SL-3-1
ITAS-ST. LOUIS LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
4018	Total Organic Halides (TOX)
4019	Analysis of pH in Water
4020	Analysis of Sulfide in Water
4024	Phosphorus, All Forms
4025	Analysis of Ammonia as Nitrogen
4026	Biochemical Oxygen Demand (BOD)
4027	Total Organic Carbon
4028	Phenolics, Total Recoverable
4029	Acidity of Water and Waste Water
4030	Alkalinity of Water and Waste Water
4031	Total Kjeldahl Nitrogen in Water and Waste Water
4032	The Analysis of Tetrachlorinated Dibenzo-P-Dioxins
4033	Analysis of pH in Soil
4034	Total Petroleum Hydrocarbons (TPH) by IR
4035	Nitrate/Nitrite Analysis by TRAACS 800 (Hydrazine Reduction)
4037	Conductivity in Water
4039	Flash Point by Pensky-Martins Closed Cup Tester
4040	Oil & Grease Recovery from Solids by Soxhlet Extraction
4041	Analysis of Anions by Ion Chromatography (Method 300.0)
4043	The Analysis of Volatile Organics by Gas Chromatography/Mass Spectroscopy, USEPA CLP, 2/88, Scope of Work
4045	Extraction and Analysis of Chlorinated Herbicides by EPA Method 615
4046	Headspace Analysis of Volatile Organics; Screening Method for Estimation of Concentration
4047	GC Analysis of Organochlorine Pesticides and PCBs by SW-846 Method 8080
4048	Extraction of Organophosphorus Pesticides
4049	GC Analysis of Organophosphorus Pesticides by SW-846 Method 8141
4050	The Analysis of Volatile Organics by Gas Chromatography/Mass Spectroscopy, USEPA CLP, 3/90, Scope of Work
4051	CLP GFAA Analysis

TABLE SL-3-1
ITAS-ST. LOUIS LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
4052	CLP ICP Analysis
4053	Extraction and Analysis of Semivolatile Organics by CLP 3/90
4055	Extractable Total Petroleum Hydrocarbons (TPH) by GC
4056	HPLC Analysis of Polynuclear Aromatic Hydrocarbons
4059	Analysis of Volatile Organics by Gas Chromatography/Mass Spectrometry, USEPA CLP, 2/88, Scope of Work
4060	Extraction of PCB's in Oil Samples
5001	Data Reports
5002	Data Packaging
5003	General Procedure for the Creation of Electronic Data Files
6001	Data Review and Verification
7001	Material Procurement and Control
7002	Personnel Training and Evaluation
7004	Software Development
7005	Evaluation of Analytical Accuracy & Precision through the use of Quality Control Charts
7006	Quality Assurance Summary
7007	IDL/MDL Determination
7008	QC Sample Tracking
7009	Quality and Operation Records Maintenance
7010	Autolab Sample Loading Verification
7011	Laboratory Logbook Control and Maintenance
7012	Internal Surveillances
8001	Off-Site Storage of Documentation
8002	Project Records and Document Control
9001	Preventive Maintenance
10001	Glassware Preparation for Organic and Dioxin Analyses
10002	Glassware Preparation for Inorganic and Trace Metal Analyses
10003	Temperature Monitoring
10004	Nonconformance and Corrective Action

TABLE SL-3-1
ITAS-ST. LOUIS LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
10005	Preparation of PUF Plugs Prior to Air Sample Collection
10006	Water Monitoring
10007	Glassware Preparation for Radiochemistry and Radiological Screening Analyses
10008	Laboratory Security Systems
10009	Standard Operating Procedure Development and Control
10010	Preparation of Stainless Steel Planchet for Radiochemistry Analyses
12060	Monitoring Air Flow Rates
12313	Maintenance of Radiation Protection Records
12317	The ALARA Program
12323	Radiation Safety Training
12340	Dosimeter Program for Personnel and Area Monitoring
12350	Area Surveys and Radiation Monitoring
12352	Personnel Monitoring for Radioactive Contamination
12353	Radiation Work Permits
12380	Packaging and Storage of Radioactive Waste
12390	Emergencies Involving Radioactive Waste
12400	Personnel Decontamination
12410	Equipment and Area Decontamination
12420	Accountability of Licensed Radioactive Material
12430	Requisition of Licensed Materials
12440	Calibration and Maintenance of Radiation Survey Instruments
12450	Surveying Radioactive Material Shipments
12452	Receiving Packages with Greater than Type A Quantities of Radioactive Material
12460	Packaging and Transportation of Radioactive Materials
12501	Hazardous Waste Management Program
12502	Collection & Accumulation of Hazardous Waste
12503	Disposal of Samples After Analysis
12504	Hazardous Waste Sampling & Disposal

TABLE SL-3-1
ITAS-ST. LOUIS LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
12505	Guidelines for Disposal to Sewer
12506	Hazardous Waste Manifesting
12507	Safety Inspection of Storage Room
12508	Reporting to Regulatory Agencies
12509	Hazardous Waste Spill Response
12550	Treatability Studies for Waste Solidification
12710	Return of Samples to Client
12801	Contingency Plan
12820	Building Evacuation
12830	Fire Response
12840	Severe Weather/Power Failure Response
12850	Earthquake Response
12950	Lock Out/Tag Out of Hazardous Energy Sources
13001	Actinium 228 in Soil, Water and Other Media
13002	Gross Alpha/Beta
13003	Total Alpha Emitting Isotopes of Radium
13004	Preparation of Strontium 89 and 90
13005	Tritium in Water or other Fluids
13006	Preparation of Soil, Sludge and Filter Paper Samples for Radiochemical Analysis
13007	Sequential Determination of Isotopic Plutonium, Thorium and Uranium
13010	Radium 228 in Water
13012	Evaluation of the Sample Transmission Factor
13013	Operation and Calibration of the Alpha Spectrometer
13014	Calibration of Princeton Gamma Tech Intrinsic Germanium Gamma Spectrometer
13015	Screening Samples for the Presence of Radioactive Material
13016	Classifying Radioactive Samples
13017	Daily Calibration Verification and Maintenance of the Germanium Spectroscopy System
13018	Operation of the Germanium Spectroscopy System

TABLE SL-3-1
ITAS-ST. LOUIS LABORATORY
Standard Operating Procedure (SOP) List

SOP NO.	SOP TITLE
13019	Calibration of the Low Background Gas Flow Proportional Counting System
13020	Daily Calibration Verification and Maintenance of the Low Background Gas Flow Proportional Counting System
13021	Operation of the Low Background Gas Flow Proportional Counting System
13022	Analysis of Total Uranium by Laser Induced Phosphorimetry
13023	Operation and Calibration of a Liquid Scintillation Counter
13026	Radiochemical Determination of Tritium in Soil, Vegetation and Other Biological Samples - Azeotropic Method
13027	Gross Alpha Radiation in Water Using Coprecipitation
13028	Preparation and Dissolution of Sediment and Soil by Microwave Digestion
13029	Drying and Grinding of Soil and Solid Samples
13030	Preparation of Samples for Gamma Spectroscopy
13031	Preparation of Vegetation and Tissue Samples
13032	Radium 226 and Radon 222 by Radon Emanation
13033	Determination of Plutonium and/or Americium in Small Soil and Fresh Water Sediment Samples

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APPENDIX

ST. LOUIS-4

ANALYTICAL METHODS

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Acidity	Water	Method 305.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Alkalinity	Water	Method 310.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Ammonia	Water	Method 350.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Bromide	Water	Method 300.0	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cation Exchange Capacity	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9081	Not Applicable	Not Applicable
Chloride	Water	Method 300.0[1] Method 325.3[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Conductivity	Water	Method 120.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Amenable)	Water	Method 335.1	Method 9010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 9010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Cyanide (Free)	Water	Not Applicable	Not Applicable	Not Applicable	Standard Methods 412 H
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Standard Methods 412 H

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Cyanide	Water	Method 335.2[2]	Method 9010	Method is CLP	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 1311 to obtain leachate Method 9010 for Leachate	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9010	Method is CLP	Not Applicable
Dissolved Organic Carbon (DOC)	Water	Method 415.1[3]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Flashpoint	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 1010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Fluoride	Water	Method 300.0[1] Method 340.2[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Hardness	Water	Method 130.2	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Nitrite (NO_2)	Water	Method 300.0[1] (non-preserved) Method 353.1[2] (preserved)	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nitrate (NO_3)	Water	Method 300.0[1] (non-preserved) Method 353.1[2] (preserved)	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Nitrate plus Nitrite	Water	Method 353.1[3]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Oil and Grease	Water	Method 413.1	Method 9070	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Method 9071	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9071	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Ortho-phosphate	Water	Method 300.0[1] Method 365.1[1]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
pH	Water	Method 150.1	Method 9040	Method CLP	Not Applicable
	Liquid	Not Applicable	Method 9040	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 9040	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Method 9045	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 9045	Not Applicable	Not Applicable
Phenol	Water	Method 420.2[2]	Method 9066[2]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Phosphate (Total)	Water	Method 365.1[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phosphorus (Total)	Water	Method 365.1[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Reactivity	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Section 7.3 Only Applicable to solid waste	Not Applicable	Not Applicable
	Soil	NA	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Residual Chlorine	Water	Method 330.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not applicable
Sulfate (SO_4)	Water	Method 300.0[1]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Sulfide (SO_3)	Water	Method 376.1[2]	Method 9030[4]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Sulfite (SO_3)	Water	Method 377.1[5]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Organic Carbon (TOC)	Water	Method 415.1[2]	Method 9060[2]	Not Applicable	Not Applicable
	Liquid	Not Applicable.	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Organic Halides (TOX)	Water	Method 450.1[2]	Method 9020[6]	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Total Petroleum Hydrocarbons by IR	Water	Method 418.1	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Method 418.1-M
Total Solids	Water	Method 160.3[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Total Suspended Solids	Water	Method 160.2[2]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TABLE SL-4-1
ITAS-ST. LOUIS LABORATORY
Wet Chemistry Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Total Kjeldahl Nitrogen (TKN)	Water	Method 351.2	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Turbidity	Water	Method 180.1[4]	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Not Applicable	Not Applicable

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters.

[5]Includes drinking and surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters.

TABLE SL-4-2
ITAS-ST. LOUIS LABORATORY
Metals Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Toxicity Characteristic Leaching Procedure (TCLP)	Water	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Not Applicable	Not Applicable	40 CFR Part 268
	Soil	Not Applicable	Not Applicable	Not Applicable	40 CFR Part 268
ICAP Metals	Water	Method 200.7	Method 3005 Method 3010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 3040	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Proper pretreatment is described in Section 9 of Method 200.7	Method 3050	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3050	Method CLP ILMO3.0	Not Applicable
CVAA Mercury	Water	Method 245.1	Method 7470	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Method 7470	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Method 7471	Not Applicable	Not Applicable
	Soil	Method 245.5	Method 7471	Method CLP ILMO3.0	Not Applicable

TABLE SL-4-2
ITAS-ST. LOUIS LABORATORY
Metals Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Flame AA Metals	Water	Element Method Potassium 258.1	Element Method Potassium 3005 3010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Element Method Potassium 3040	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment	Not Applicable	Element Method Potassium 3050	Not Applicable	Not Applicable
	Soil	Not Applicable	Element Method Potassium 3050	Not Applicable	Not Applicable
GFAA Metals	Water	Element Method Arsenic 206.2 Antimony 204.2 Lead 239.2 Selenium 270.2 Silver 272.2 Thallium 279.2	Element Method Arsenic 3050 & 7060 Antimony 7041 Lead 3020 Selenium 3050 & 7740 Silver 7761 Thallium 3050 & 7841	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 3020	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3020	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solid, Sediment		Element Method Arsenic 3050 & 7060 Antimony 7041 Lead 3050 Selenium 3050 & 7740 Silver 7761 Thallium 3050 & 7841	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3050	Method CLP ILMO3.0	Not Applicable

TABLE SL-4-2
ITAS-ST. LOUIS LABORATORY
Metals Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters.

[5]Includes drinking and surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters.

[7]Includes ground waters, drinking, surface and saline waters.

TABLE SL-4-3
ITAS-ST. LOUIS LABORATORY
Organic Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Volatiles by GC/MS	Water	Method 624	Method 5030 Method 8240	Method CLP OLM01.8	Not Applicable
	Liquid	Not Applicable	Method 5030 Method 8240	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 5030 Method 8240	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 5030 Method 8240	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 5030 Method 8240	Method CLP OLM01.8	Not Applicable
Aromatic Volatiles by GC	Water	Method 602	Method 5030	Method CLP	Not Applicable
	Liquid	Not Applicable	Method 5030	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 5030	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 5030	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 5030	Method CLP	Not Applicable
Semivolatiles by GC/MS	Water	Method 625	Method 3510 Method 3520	Method CLP OLM01.8	Not Applicable
	Liquid	Not Applicable	Method 3580	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3510 Method 3520	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 3550 Method 3640	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3550 Method 3640	Method CLP OLM01.8	Not Applicable

TABLE SL-4-3
ITAS-ST. LOUIS LABORATORY
Organic Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Pesticides/ PCBs by GC	Water	Method 608	Method 3510 Method 3620	Method CLP OLM01.8	Not Applicable
	Liquid	*Not Applicable*	*Method 3580*	*Not Applicable*	*Not Applicable*
	TCLP Leachate	Not Applicable	Method 3510 Method 3620	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 3550 Method 3640 Method 3620	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3550 Method 3640 Method 3620	Method CLP OLM01.8	Not Applicable
Dioxins/ Dibenzofurans by HRGC/LRMS[2]	Water	Method 613	Method 8280	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8280	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8280	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8280	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8280	Not Applicable	Not Applicable

TABLE SL-4-3
ITAS-ST. LOUIS LABORATORY
Organic Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nitroaromatics by HPLC	Water	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	Liquid	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	Soil	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038

TABLE SL-4-3
ITAS-ST. LOUIS LABORATORY
Organic Sample Preparation Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Total Petroleum Hydrocarbons by GC	Water	Not Applicable	Method 3510 Method 3520	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 3580	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 3510 Method 3520	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 3540 Method 3550	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 3540 Method 3550	Not Applicable	Not Applicable
Herbicides by GC	Water	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8150	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8150	Not Applicable	Not Applicable

[1]Includes drinking, surface and saline water

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Aluminum	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Antimony	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Barium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Beryllium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Bismuth	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not applicable	Not Applicable
Boron	Water	Method 200.7	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Calcium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Cadmium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Cobalt	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable

This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Chromium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Copper	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Iron	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Magnesium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Manganese	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Molybdenum	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nickel	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Silicon	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Silver	Water	Method 200.7	Method 6010	CLP Method ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **4 Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable

This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Sodium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Tin	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable
Titanium	Water	Method 200.7[1]	Method 6010	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Not Applicable	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE SL-4-4
ITAS-ST. LOUIS LABORATORY
Inductively Coupled Plasma Emission Spectroscopy Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Vanadium	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable
Zinc	Water	Method 200.7[1]	Method 6010	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 6010	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 6010	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 200.7 **Requires proper pretreatment**	Method 6010	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 6010	Method CLP ILMO3.0	Not Applicable

[1]Includes drinking, surface and saline water, domestic and industrial waste effluents.

The St. Louis Laboratory can recommend appropriate methodologies and can provide analysis for additional metals upon request.

This method is not recommend for this matrix.

TABLE SL-4-5
ITAS-ST. LOUIS LABORATORY
Flame Atomic Absorption Inorganic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Flame AA Metals	Water	Element Method Potassium 258.1	Element Method Potassium 7610	Not Applicable	Not Applicable
Potassium	Liquid	Not Applicable	Element Method Potassium 7610	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Element Method Potassium 7610	Not Applicable	Not Applicable
	Soil	Not Applicable	Element Method Potassium 7610	Not Applicable	Not Applicable

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters

[5]Includes drinking nd surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters

[7]Includes ground waters, drinking, surface and saline waters.

TABLE SL-4-6
ITAS-ST. LOUIS LABORATORY
Graphite Furnace Atomic Absorption Methods

Parameter	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Antimony	Water	Method 204.2[1]	Method 7041	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 7041	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 7041	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 204.2 **Requires proper pretreatment.**	Method 7041	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7041	Method CLP ILMO3.0	Not Applicable
Arsenic	Water	Method 206.2[1]	Method 7060	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 7060	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 7060	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 206.2 **Requires proper pretreatment**	Method 7060	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7060	Method CLP ILMO3.0	Not Applicable

[ ] This method is not recommend for this matrix.

TABLE SL-4-6
ITAS-ST. LOUIS LABORATORY
Graphite Furnace Atomic Absorption Methods

Parameter	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Lead	Water	Method 239.2[1]	Method 7421	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 74214	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 7421	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 239.2 **Requires proper pretreatment**	Method 7421	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7421	Method CLP ILMO3.0	Not Applicable
Selenium	Water	Method 270.2[1]	Method 7740	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 77404	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 7740	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 270.2 **Requires proper pretreatment**	Method 7740	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7740	Method CLP ILMO3.0	Not Applicable

This method is not recommend for this matrix.

TABLE SL-4-6
ITAS-ST. LOUIS LABORATORY
Graphite Furnace Atomic Absorption Methods

Parameter	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Silver	Water	Method 272.2	Not Applicable	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 270.2 **Requires proper pretreatment**	Not Applicable	Not Applicable	Not Applicable
	Soil	Not Applicable	Not Applicable	Method CLP ILMO3.0	Not Applicable
Thallium	Water	Method 279.2[1]	Method 7841	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Method 7841	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 7841	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Method 279.2 **Requires proper pretreatment**	Method 7841	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 7841	Method CLP ILMO3.0	Not Applicable

[1]Includes drinking, surface and saline waters

This method is not recommend for this matrix.

TABLE SL-4-7
ITAS-ST. LOUIS LABORATORY
Cold Vapor Atomic Absorption Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
CVAA Mercury	Water	Method 245.1	Method 7470	Method CLP ILMO3.0	Not Applicable
	Liquid	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	TCLP Extract	Not Applicable	Method 7470	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 7471	Not Applicable	Not Applicable
	Soil	Method 245.5	Method 7471	Method CLP ILMO3.0	Not Applicable

[1]Includes drinking water, surface water and mixed (aqueous) industrial waste effluents.

[2]Includes drinking, surface and saline waters, aqueous domestic and industrial waste.

[3]Includes drinking and other waters wherein the carbonaceous matter is either soluble or has a particle size of 0.2 mm or less. Homogenizing a sample to reduce the particle size may cause loss of purgeable organic carbon, thus yielding erroneously low results.

[4]Includes drinking, surface and saline waters

[5]Includes drinking nd surface waters, sewage and aqueous industrial waste.

[6]Includes drinking and ground waters

[7]Includes ground waters, drinking, surface and saline waters.

TABLE SL-4-8
ITAS-ST. LOUIS LABORATORY
Organic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Volatiles by GC/MS	Water	Method 624	Method 8240	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 8240	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8240	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8240	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8240	Method CLP OLMO1.8	Not Applicable
Aromatic Volatiles by GC	Water	Method 602	Method 8020	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8020	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8020	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8020	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8020	Not Applicable	Not Applicable
Semivolatiles by GC/MS	Water	Method 625	Method 8270	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 8270	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8270	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8270	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8270	Method CLP OLMO1.8	Not Applicable

TABLE SL-4-8
ITAS-ST. LOUIS LABORATORY
Organic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Pesticides/ PCBs by GC	Water	Method 608	Method 8080	Method CLP OLMO1.8	Not Applicable
	Liquid	Not Applicable	Method 8080	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8080	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8080	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8080	Method CLP OLMO1.8	Not Applicable
Dioxins/ Dibenzofurans by HRGC/LRMS[2]	Water	Method 613	Method 8280	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8280	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8280	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8280	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8280	Not Applicable	Not Applicable

TABLE SL-4-8
ITAS-ST. LOUIS LABORATORY
Organic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Nitroaromatics by HPLC	Water	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	Liquid	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	TCLP Leachate	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
	Soil	Not Applicable	Not Applicable	Not Applicable	ITAS St. Louis Developed Method SOP SL4038
Total Petroleum Hydrocarbons by GC	Water	Not Applicable	Method 8015-M	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8015-M	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8015-M	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8015-M	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8015-M	Not Applicable	Not Applicable

TABLE SL-4-8
ITAS-ST. LOUIS LABORATORY
Organic Methods

Analytical Parameters	Matrix	Methods			
		NPDES	RCRA (SW846)	CLP	Other
Herbicides by GC	Water	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Liquid	Not Applicable	Method 8150	Not Applicable	Not Applicable
	TCLP Leachate	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Domestic Waste, Industrial Waste, Sludge, Solids, Sediment	Not Applicable	Method 8150	Not Applicable	Not Applicable
	Soil	Not Applicable	Method 8150	Not Applicable	Not Applicable

[1]Includes drinking, surface and saline water

TABLE SL-4-9
ITAS-ST. LOUIS LABORATORY
Radiological Methods

Analytical Parameters	Matrix	Method
Gross Alpha/Beta	Water	EPA[1] 900.0
	Soil, Vegetation, Filter	Standard Methods[2], Method 7110
Radium-228	Water	EPA 904.0
Tritium	Water, Filters	EPA 906.0
	Soil, Vegetation	EPA EERF[3] H-01
Total Uranium	Water	ASTM[4], Method D5174-91 (KPA)
	Soil	HASL-300[5], 4.5.2.3 (Gamma)
Isotopic Uranium U-238, U-234, U-235	Water, Soil, Vegetation, Filters	NAS-NS-3050[6]
Isotopic Plutonium Pu-239/240, Pu-238	Water, Soil, Vegetation, Filters	NAS-NS-3058
Isotopic Thorium Th-228, Th-230, Th-232	Water, Soil, Vegetation, Filters	NAS-NS-3004
Technetium	Water, Soil, Vegetation, Filters	HASL-300, Tc-01
Gross Alpha by Coprecipitation	Water	EERF, 00-02
Americium-241	Water, Soil, Vegetation, Filters	NAS-NS-3006
Total Alpha Emitting Isoptopes of Radium	Water, Filters	EPA 903.0
Lead Pb-210	Water, Soil, Filters	EERF Pb-01
Polonium-210	Water	HASL-300, Po-02
Strontium-89,90 and Total Strontium	Water, Filters	NAS-NS-3010
Radium-226/228	Soil	HASL-300, 4.5.2.3 (Gamma)
Radium-226 Radon-222 (Emanation)	Water	EPA 903.1
Gamma Emitters Actinides, as applicable, Co-60, Cs-137, K-40, Mn-54, and other fission/activation products	Water, Soil, Vegetation, Filters	HASL-300, 4.5.2.3

TABLE SL-4-9
ITAS-ST. LOUIS LABORATORY
Radiological Methods

Analytical Parameters	Matrix	Method
[1]USEPA, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, No. EPA-600/4-80-032, Cincinnati, Ohio, 1980.		
[2]Standard Methods, 18th Edition, 1992.		
[3]USEPA, Eastern Environmental Radiation Facility Radiochemistry Procedures Manual, No. 520/5-84-006, 1984.		
[4]Annual Book of American Society for Testing Materials (ASTM) Standards.		
[5]HASL, Environmental Measurements Laboratory Procedures Manual, No. HASL-300.		
[6]National Academy of Sciences, Nuclear Science Series		

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APPENDIX

ST. LOUIS-5

METHOD DETECTION LIMITS AND PRACTICAL QUANTITATION LIMITS

TABLE SL-5-1
ITAS-ST. LOUIS LABORATORY
Practical Quantitation Limits for
Wet Chemistry

Parameter	Method	PQL (ppm except as noted))
Alkalinity	310.1	5.0
Ammonia	350.1	0.050
BOD	405.1	1
CBOD	SM-5210	1
Bromide	300.0	0.25
Chloride	300.0	0.25
Chlorine, Total Residual	330.3	0.1
COD	410.4	5
Conductivity	120.1	1 umhos/cm
Cyanide	335.2/9010	0.005
Cyanide, amenable	335.1/9010	0.005
Flashpoint	1010	amb temp
Fluoride	340.2 300.0	0.1 0.1
Hardness	130.2	1
Nitrate	300.0	0.03
Nitrate/Nitrite	353.1	0.050
Nitrite	300.0	0.08
TKN	351.2	0.05
Oil & Grease	413.1/9070/9071	1
Orthophosphate	300.0 365.1	1 0.05
Paint Filter Test	9095	N/A
TPH	418.1	2.5
pH	150.1/9040/9045	0.01 units
Phenols	420.2	0.05
Sulfate	300.0	1.0
Sulfide	376.1/9030	1

TABLE SL-5-1
ITAS-ST. LOUIS LABORATORY
Practical Quantitation Limits for
Wet Chemistry

Parameter	Method	PQL (ppm except as noted))
TDS	160.1	5
Total Solids	160.3	0.1
TSS	160.2	1
TOC	415.1/9060	1.0
TOX	450.1/9020	0.005
Turbidity	180.1	0.9 NTU

TABLE SL-5-2
ST. LOUIS LABORATORY
ICAP Metals
Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2], and Practical Quantitation Limits (PQL)[3]

Element	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (mg/Kg)	Water MDL (ug/L)	Soil MDL[4] (mg/Kg)	Water PQL (ug/L)	Soil PQL[4] (mg/Kg)
Aluminum	7429-90-5	200	40	23.7	3.03	75	7.5
Antimony	7440-36-0	60	12	56.1	7.82	200	20
Arsenic	7440-38-2	10	2	222	44.9	500	50
Barium	7440-39-3	200	40	3.14	0.78	10	1
Beryllium	7440-41-7	5	1	4.42	0.57	10	1
Boron	7440-42-8			84.3	5.19	100	10
Bismuth	7440-69-9			48.7		500	50
Cadmium	7440-43-9	5	1	7.44	1.16	10	1
Calcium	7440-70-2	5000	1000	81.1	4.13	100	10
Chromium	7440-47-3	10	2	9.48	2.03	25	2.5
Cobalt	7440-48-4	50	10	7.23	0.91	20	2
Copper	7440-50-8	25	5	5.57	1.74	20	2
Iron	7439-89-6	100	20	41.6	6.16	50	5
Lead	7439-92-1	3	0.6	148	26.1	150	15
Lithium	7439-93-2			58.7	33.4	200	20
Magnesium	7439-95-4	5000	1000	17.2	2.43	100	10
Manganese	7439-96-5	15	3	4.01	1.22	10	1
Molybdenum	7439-98-7			22.7	9.16	50	5
Nickel	7440-02-0	40	8	72.4	16.9	75	7.5
Potassium	7440-09-7	5000	1000	1300	447	5000	500
Selenium	7782-49-2	5	1	315	43.5	500	50
Silicon	7440-21-3			448		450	45
Silver	7440-22-4	10	2	3.21	1.01	20	2
Sodium	7440-22-4	5000	1000	565	4.74	1000	100
Strontium	7440-24-6			1.61		50	5
Tellurium	13494-80-9			176	32.0	200	20
Thallium	7440-28-0	10	2	52.1	77.5	500	50
Thorium	7440-29-1			26.6	2.49	750	75
Tin	7440-31-5			224	12.9	2000	200

TABLE SL-5-2
ST. LOUIS LABORATORY
ICAP Metals
Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2], and Practical Quantitation Limits (PQL)[3]

Element	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (mg/Kg)	Water MDL (ug/L)	Soil MDL[4] (mg/Kg)	Water PQL (ug/L)	Soil PQL[4] (mg/Kg)
Titanium	7440-32-6			87.7		1000	100
Uranium	7440-62-2			88.4	27.0	500	50
Vanadium	7440-62-2	50	10	17.7	0.93	20	2
Zinc	7440-66-6	20	4	3.88	1.26	20	2

1 CRDLs apply to work performed according to the USEPA Scope of Work ILM03.0 and its revisions.

2 Method detection limits were performed using SW-846 Method 6010 on 9/2/92 and 3/24/93 for waters. Soil MDLs were run using Method 6010 on 9/2/92.

3 PQLs were estimated from the results of water MDL determinations.

4 Soil detection limits are based on wet weight of sample, and will be higher when converted to a dry weight basis.

TABLE SL-5-3
ST. LOUIS LABORATORY
AA Metals
Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2], and Practical Quantitation Limits (PQL)[3]

Element	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (mg/Kg)	Water MDL (ug/L)	Soil MDL[4] (mg/Kg)	Water PQL (ug/L)	Soil PQL[4] (mg/Kg)
Arsenic	7440-38-2	10	2	1.7	0.091	3	0.3
Lead	7439-92-1	3	0.6	1.9	0.098	3	0.3
Selenium	7782-49-2	5	1	0.50	0.023	3	0.3
Thallium	7440-28-0	10	2	2.38	0.204	3	0.3
Antimony	7440-36-0	60	12	4.5	0.36	6	0.6
Silver	7440-22-4	10	2	6.4	0.64	8	0.8
Mercury[5]	7439-97-6	0.2	0.1	0.175	0.013	0.2	0.1

[1] CRDLs apply to analyses performed under the Scope of Work of the USEPA Scope of work of Work ILM03.0 and its revisions.

[2] Method detection limits for furnace metals were determined between 2/12/93 and 4/2/93. Water MDLs for mercury were determined on 9/9/92. Soil MDLs for mercury were determined on 6-22-93.

[3] PQLs are estimated from the method detection limit studies for water samples.

[4] Soil detection limits are based on wet weight of sample; detection limits will be higher when corrected for percent solids.

[5] Mercury is performed by cold vapor atomic absorption. The other elements are performed by graphite furnace techniques.

TABLE SL-5-4
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Volatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/Kg)
Chloromethane	74-87-3	10	10	2.1	1.2	10	10
Bromomethane	74-83-9	10	10	1.6	1.7	10	10
Vinyl Chloride	75-01-4	10	10	2.1	1.2	10	10
Chloroethane	75-00-3	10	10	2.1	2.4	10	10
Methylene Chloride	75-09-2	10	10	0.50	0.44	5	5
Acetone	67-64-1	10	10	2.8	6.0	100	100
Carbon Disulfide	75-15-0	10	10	1.2	0.47	5	5
1,1-Dichloroethene	75-35-4	10	10	1.0	0.50	5	5
1,1-Dichloroethane	75-34-3	10	10	0.47	0.41	5	5
1,2-Dichloroethene (total)	540-59-0	10	10	0.82	0.82	5	5
Chloroform	67-66-3	10	10	0.44	0.28	5	5
1,2-Dichloroethane	107-06-2	10	10	0.19	0.19	5	5
2-Butanone	78-93-3	10	10	3.8	2.2	100	100
1,1,1-Trichloroethane	71-55-6	10	10	0.79	0.50	5	5
Carbon Tetrachloride	56-23-5	10	10	0.85	0.53	5	5
Vinyl Acetate		NA	NA	0.97	2.0	50	50
Bromodichloromethane	75-27-4	10	10	0.35	0.31	5	5
1,2-Dichloropropane	78-87-5	10	10	0.35	0.53	5	5
cis-1,3-Dichloropropene	10061-01-5	10	10	0.28	0.50	5	5
2-chloroethylvinylether	110-75-8	NA	NA	1.1	1.5	10	10
Trichloroethene	79-01-6	10	10	0.53	0.85	5	5
Dibromochloromethane	124-48-1	10	10	0.22	0.31	5	5
1,1,2-Trichloroethane	79-00-5	10	10	0.44	0.28	5	5
Benzene	71-43-2	10	10	0.31	0.22	5	5
trans-1,3-Dichloropropene	10061-02-6	10	10	0.44	0.38	5	5
Bromoform	75-25-2	10	10	0.31	0.44	5	5
4-Methyl-2-Pentanone	108-10-1	10	10	2.0	2.3	50	50
2-Hexanone	591-78-6	10	10	1.3	3.3	50	50
Tetrachloroethene	127-18-4	10	10	0.66	0.50	5	5

TABLE SL-5-4
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Volatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/Kg)
Toluene	108-88-3	10	10	0.50	0.57	5	5
1,1,2,2-Tetrachloroethane	79-34-5	10	10	0.53	1.2	5	5
Chlorobenzene	108-90-7	10	10	0.38	0.44	5	5
Ethylbenzene	100-41-4	10	10	0.47	0.47	5	5
Styrene	100-42-5	10	10	0.44	0.41	5	5
Xylene (total)	1330-20-7	10	10	0.72	0.38	5	5

[1] CRDLs apply to analyses performed under the USEPA CLP Scope of Work OLMO1.0 and its revisions only.

[2] The Method Detection Limit study for water was performed on 6-10-93 and 6-11-93. The MDL study for soil was performed on 6-10-93. Both studies were run by SW-846 Method 8240.

[3] Practical Quantitation Limits are taken from SW-846 Method 8240.

[4] Quantitation limits listed for soil are based on wet weight. The quantitation limits based on dry weight as required, will be higher.

TABLE SL-5-5
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/L)
Phenol	108-95-2	10	330	3.4	115	10	330
bis(2-Chloroethyl)ether	111-44-4	10	330	1.3	117	10	330
2-Chlorophenol	95-57-8	10	330	6.2	102	10	330
1,3-Dichlorobenzene	541-73-1	10	330	2.4	64	10	330
1,4-Dichlorobenzene	106-46-7	10	330	2.6	44	10	330
Benzyl Alcohol	100-51-6	NA	NA	3.7	83	20	670
1,2-Dichlorobenzene	95-50-1	10	330	2.3	83	10	330
2-Methylphenol	95-48-7	10	330	6.0	78	10	330
bis(2-chloroisopropyl)ether	108-60-1	10	330	2.1	163	10	330
4-Methylphenol	106-44-5	10	330	5.4	171	10	330
n-Nitroso-di-n-Propylamine	621-64-7	10	330	1.6	166	10	330
Hexachloroethane	67-72-1	10	330	3.0	104	10	330
Nitrobenzene	98-95-1	10	330	1.1	181	10	330
Isophorone	78-59-1	10	330	1.2	204	10	330
2-Nitrophenol	88-75-5	10	330	1.6	98	10	330
2,4-Dimethylphenol	105-67-9	10	330	5.3	84	10	330
Benzoic Acid	65-85-0	NA	NA		345	50	1600
bis(2-Chloroethoxy) Methane	111-91-1	10	330	1.5	67	10	330
2,4-Dichlorophenol	120-83-2	10	330	6.1	34	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330	2.3	51	10	330
Naphthalene	91-20-3	10	330	2.3	49	10	330
4-Chloroaniline	106-47-8	10	330	1.6	232	20	670
Hexachlorobutadiene	87-68-3	10	330	2.8	106	10	330
4-Chloro-3-Methylphenol	59-50-7	10	330	5.6	151	20	670
2-Methylnaphthalene	91-57-6	10	330	3.7	122	10	330

TABLE SL-5-5
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/L)
Hexachlorocyclopentadiene	77-47-4	10	330	1.9	82	10	330
2,4,6-Trichlorophenol	88-06-2	10	330	7.2	87	10	330
2,4,5-Trichlorophenol	95-95-4	25	800	6.0	100	10	330
2-Chloronaphthalene	91-58-7	10	330	2.5	109	10	330
2-Nitroaniline	88-74-4	25	800	1.3	94	50	1600
Dimethyl Phthalate	131-11-3	10	330	3.6	74	10	330
Acenaphthylene	208-96-8	10	330	1.9	55	10	330
2,6-Dinitrotoluene	606-20-2	10	330	1.4	82	10	330
3-Nitroaniline	99-09-2	25	800	1.8	271	50	1600
Acenaphthene	83-32-9	10	330	2.4	32	10	330
2,4-Dinitrophenol	51-28-5	25	800	50	67	50	1600
4-Nitrophenol	100-02-7	25	800	31	158	50	1600
Dibenzofuran	132-64-9	10	330	1.9	89	10	330
2,4-Dinitrotoluene	121-14-2	10	330	0.92	133	10	330
Diethylphthalate	84-66-2	10	330	2.1	207	10	330
4-Chlorophenyl-phenylether	7005-72-36	10	330	2.2	176	10	330
Fluorene	86-73-7	10	330	2.0	188	10	330
4-Nitroaniline	100-01-6	25	800	2.2	94	50	1600
4,6-Dinitro-2-Methylphenol	534-52-1	25	800	23	86	50	1600
n-Nitrosodiphenylamine	86-30-6	10	330	1.4	74	10	330
4-Bromophenyl-phenylether	101-55-3	10	330	2.1	114	10	330
Hexachlorobenzene	118-74-1	10	330	2.0	208	10	330
Pentachlorophenol	87-86-5	25	800	11	77	50	1600
Phenanthrene	85-01-8	10	330	1.2	34	10	330
Anthracene	120-12-7	10	330	1.2	37	10	330

TABLE SL-5-5
ST. LOUIS LABORATORY
CLP or Hazardous Substance List for Semivolatile Organics with Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2] and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/L)
Carbazole	86-74-8	10	330	NA	60	10	330
Di-n-Butylphthalate	84-74-2	10	330	1.4	263	10	330
Fluoranthene	206-44-0	10	330	1.4	181	10	330
Pyrene	129-00-0	10	330	1.2	160	10	330
Butylbenzylphthalate	85-68-7	10	330	1.7	192	10	330
3,3'-Dichlorobenzidine	91-94-1	10	330	1.6	175	20	670
Benzo(a)anthracene	56-55-3	10	330	2.8	19	10	330
Chrysene	218-01-9	10	330	2.1	31	10	330
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	3.3	92	10	330
Di-n-Octylphthalate	117-84-0	10	330	1.4	106	10	330
Benzo(b)fluoranthene	205-99-2	10	330	1.9	93	10	330
Benzo(k)fluoranthene	207-08-9	10	330	1.3	100	10	330
Benzo(a)pyrene	50-32-8	10	330	1.2	44	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	1.4	184	10	330
Dibenzo(a,h)anthracene	53-70-3	10	330	0.85	203	10	330
Benzo(g,h,i)perylene	191-24-2	10	330	1.8	167	10	330

1 CRDLs apply to analyses performed under the USEPA CLP Scope of Work OLM01.0 and its revisions only.

2 The Method Detection Limit for water was performed by SW-846 Method 8270 on 7-16-93. The MDL study for soil was performed by SW-846 Method 8270 on 1-20-93 and 2-3-93.

3 Practical Quantitation Limits are taken from SW-846 Method 8270; soil detection limits are based on wet weight, and are the same with and without GPC cleanup.

4 Quantitation limits listed are for low soil procedure, and are based on wet weight. The quantitation limits based on dry weight as required, will be higher. The quantitation limits for medium level soil procedures will be higher by a factor of 30 than the low soil limits.

TABLE SL-5-6
ST. LOUIS LABORATORY
Pesticides and PCBs
Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2], and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/Kg)
α-BHC	319-84-6	0.05	1.7	0.017	1.36	0.03	0.99
β-BHC	319-85-7	0.05	1.7	0.035	0.32	0.06	2.0
δ-BHC	319-86-8	0.05	1.7	0.032	0.37	0.09	3.0
γ-BHC (Lindane)	58-89-9	0.05	1.7	0.023	1.5	0.04	1.3
Heptachlor	76-44-8	0.05	1.7	0.013	1.4	0.03	0.99
Aldrin	309-00-2	0.05	1.7	0.029	0.33	0.04	1.3
Heptachlor Epoxide	1024-57-3	0.05	1.7	0.030	0.36	0.83	27
Endosulfan I	959-98-8	0.05	1.7	0.014	1.5	0.14	4.6
Dieldrin	60-57-1	0.10	3.3	0.029	2.8	0.02	0.66
4,4'-DDE	72-55-9	0.10	3.3	0.056	0.67	0.04	1.3
Endrin	72-20-8	0.10	3.3	0.033	2.8	0.06	2.0
Endosulfan II	33213-65-9	0.10	3.3	0.061	2.1	0.04	1.3
4,4'-DDD	72-54-8	0.10	3.3	0.030	3.3	0.11	3.6
Endosulfan sulfate	1031-07-8	0.10	3.3	0.050	3.2	0.66	22
4,4'-DDT	50-29-3	0.10	3.3	0.029	3.0	0.12	4.0
Methoxychlor	72-43-5	0.50	17.0	0.17	15	1.8	59
Endrin Aldehyde	7421-93-4	0.10	3.3	0.045	0.66	0.23	7.6
Endrin Ketone	53494-70-5	0.10	3.3	0.052	0.72	NA	NA
α-Chlordane	5103-71-9	0.05	1.7	0.029	0.33	NA	NA
γ-Chlordane	5103-74-2	0.05	1.7	0.028	0.34	NA	NA
Chlordane (Tech)	57-74-9	NA	NA	0.05	2.6	0.14	4.6
Toxaphene	8001-35-2	5.0	170.0	2.2	ND0	2.4	79
Aroclor 1016	12674-11-2	1.0	33.0	0.30	16.7	1.0	33
Aroclor 1221	11104-28-2	2.0	67.0	0.59	37.2	1.0	33
Aroclor 1232	11141-16-5	1.0	33.0	0.50	15.6	1.0	33
Aroclor 1242	53469-21-9	1.0	33.0	0.79	10.2	1.0	33
Aroclor 1248	12672-29-6	0.50	33.0	0.83	7.4	1.0	33
Aroclor 1254	11097-69-1	1.0	33.0	0.45	3.7	1.0	33

TABLE SL-5-6
ST. LOUIS LABORATORY
Pesticides and PCBs
Contract Required Detection Limits (CRDL)[1], Method Detection Limits (MDL)[2], and Practical Quantitation Limits (PQL)[3]

Analyte	CAS Number	Water CRDL (ug/L)	Soil CRDL[4] (ug/Kg)	Water MDL (ug/L)	Soil MDL[4] (ug/Kg)	Water PQL (ug/L)	Soil PQL[4] (ug/Kg)
Aroclor 1260	11096-82-5	1.0	33.0	0.32	18	1.0	33

[1] CRDLs apply to analyses performed under the USEPA Scope of Work OLM01.0 and its revisions.

[2] The Method Detection Limit studies for pesticides/PCBs were performed on 1/18/93 and on 2/4/93 using Method 8080.

[3] Practical Quantitation Limits are taken from SW-846 method 8080.

[4] Quantitation limits listed for soil are based on wet weight. The quantitation limits based on dry weight as required. will be higher.

NA = Not Applicable
ND = Not Determined

TABLE SL-5-7
ST. LOUIS LABORATORY
Chlorinated Herbicides
Method Detection Limits (MDL)[1], and
Practical Quantitation Limits (PQL)[2]

Analyte	CAS Number	Water MDL (ug/L)	Soil MDL[3] (ug/Kg)	Water PQL (ug/L)	Soil PQL[3] (ug/Kg)
Dalapon	75-99-0	9.48	320	58	1160
Dicamba	1918-00-9	0.28	31.3	2.7	54
MCPA	94-74-6	97.2	8120	2490	49800
MCPP	93-65-2	122	5960	1920	38400
Dichlorprop	120-36-5	1.05	87.0	6.5	130
2,4-D	94-75-7	2.15	158	12	240
2,4,5-TP (Silvex)	93-72-1	0.19	14.9	1.7	35
2,4,5-T	93-76-5	0.21	15.1	2.0	40
Dinoseb	88-85-7	0.14	1.98	0.7	14
2,4-DB	94-82-6	1.20	84.2	9.1	182

1 MDLs were determined on 1/14/93, using SW-846 Method 8150.

2 PQLs are taken from SW-846 Method 8150. The soil detection limits reflect the dilution factor obtained from a 50 gram sample taken to a volume of 10 mls.

3 Soil detection limits are based on 50 g. wet weight. Detection limits corrected for percent solids will be higher.

TABLE SL-5-8
ST. LOUIS LABORATORY
Organophosphorous Pesticides
Method Detection Limits (MDL)[1], and
Practical Quantitation Limits (PQL)[2]

Analyte	CAS Number	Water MDL (ug/L)	Soil MDL[3] (ug/Kg)	Water PQL (ug/L)	Soil PQL[3] (ug/Kg)
Demeton	8065-48-3	0.55	5.21	1.2	40
Diazinon	333-41-5	0.13	7.63	2.0	67
Disulfoton	298-04-4	0.12	7.02	0.70	23
Methyl Parathion	298-00-0	0.11	8.19	1.2	40
Malathion	121-75-5	0.12	11.0	1.1	37
Ethyl Parathion	56-38-2	0.10	6.77	0.60	20
Ethion	563-12-2	0.09	7.26	(0.60)	(20)
Azinphos Methyl	86-50-0	0.43	22.6	1.0	33
EPN	2104-64-5	0.56	9.69	0.40	13

1 MDLs for water analyses were determined on 2/3/93, and for soils on 12/23/92, both using SW-846 Method 8140.

2 PQLs are taken from SW-846 Method 8141A, except for Ethion, for which PQLs are assigned according to the similarity of the MDL values to Ethyl Parathion.

3 Soil detection limits are based on 30 g. wet weight. Detection limits corrected for percent solids will be higher.

TABLE SL-5-9
ST. LOUIS LABORATORY
Aromatic Volatiles by GC
Method Detection Limits (MDL)[1], and
Practical Quantitation Limits (PQL)[2]

Analyte	CAS Number	Water MDL (ug/L)	Soil MDL[3] (ug/Kg)	Water PQL (ug/L)	Soil PQL[3] (ug/Kg)
Benzene	71-43-2	0.09	0.06	2.0	2.0
Chlorobenzene	108-90-7	0.16	0.22	2.0	2.0
1,4-Dichlorobenzene	106-46-7	0.38	0.75	3.0	3.0
1,3-Dichlorobenzene	541-73-1	0.25	0.38	4.0	4.0
1,2-Dichlorobenzene	95-50-1	0.35	0.69	4.0	4.0
Ethylbenzene	100-41-4	0.16	0.19	2.0	2.0
Toluene	108-88-3	0.16	0.38	2.0	2.0
m,p-Xylene		0.19	0.44	2.0	2.0
o-Xylene	95-47-6	0.19	0.94	2.0	2.0

1 MDLs were determined on 8/27/93 for water and on 8/19/93 for soil samples using SW-846 Method 8020.

2 PQLs are taken from SW-846 Method 8020, with the exception of the PQLs for xylenes, which are determined by comparison to the other PQLs.

3 Soil detection limits are based on 5 g. wet weight. Detection limits corrected for percent solids will be higher.

TABLE SL-5-10
ST. LOUIS LABORATORY
Polynuclear Aromatic Hydrocarbons by HPLC
Method Detection Limits (MDL)[1], and
Practical Quantitation Limits (PQL)[2]

Analyte	CAS Number	Water MDL (µg/L)	Water PQL (µg/L)
Naphthalene	91-20-3	1.2	18
Acenaphthylene	208-96-8	1.5	23
Acenaphthene	83-32-9	1.6	18
Fluorene	86-73-7	0.24	2.1
Phenanthrene	85-01-8	0.29	6.4
Anthracene	120-12-7	1.2	6.6
Fluoranthene	206-44-0	0.22	2.1
Pyrene	129-00-0	0.33	2.7
Benzo(a)anthracene	56-55-3	0.063	0.13
Chrysene	218-01-9	0.062	1.5
Benzo(b)fluoranthene	205-99-2	0.057	0.18
Benzo(k)fluoranthene	207-08-9	0.11	0.17
Benzo(a)pyrene	50-32-8	0.048	0.23
Dibenzo(ah)anthracene	53-70-3	0.16	0.30
Benzo(ghi)perylene	191-24-2	0.099	0.76
Indeno(123-cd)pyrene	193-39-5	0.10	0.43

[1] MDLs for water analyses were determined on 8/10/93, using SW-846 Method 8310.

[2] PQLs are taken from SW-846 Method 8310.

TABLE SL-5-11
ST. LOUIS LABORATORY
Polychlorinated Dioxins and Furans
Method Detection Limits (MDL)[1], and
Practical Quantitation Limits (PQL)[2]

Analyte	CAS Number	Water MDL (ng/L)	Soil MDL[3] (ug/Kg)	Water PQL (ng/L)	Soil PQL[3] (ug/Kg)
2378-TCDD	1746-01-6	6.05	0.27	10	1.0
12378-PeCDD	40321-76-4	1.77	0.42	25	2.5
123478-HxCDD	39227-28-6	3.57	0.54	25	2.5
123678-HxCDD	57653-85-7	2.62	0.64	25	2.5
123789-HxCDD	19408-74-3	2.36	0.70	25	2.5
2378-TCDF	51207-31-9	0.78	0.13	10	1.0
12378-PeCDF	57117-41-6	3.07	0.49	25	2.5
23478-PeCDF	57117-31-4	2.42	0.38	25	2.5
123478-HxCDF	70648-26-9	6.96	0.44	25	2.5
123678-HxCDF	57117-44-9	6.90	0.38	25	2.5
234678-HxCDF	60851-34-5	2.15	0.38	25	2.5
123789-HxCDF	72918-21-9	1.85	0.38	25	2.5
1234678-HpCDD	35822-46-9	7.22	0.19	25	2.5
OCDD	3268-87-9	29.0	0.19	50	5.0
1234678-HpCDF	67562-39-4	8.75	0.42	25	2.5
1234789-HpCDF	55673-89-7	2.56	0.14	25	2.5
OCDF	39001-02-0	16.2	0.84	50	5.0

[1] MDLs for water analyses were determined on 7/26/93, and for soils on 3/22/93, both using SW-846 Method 8280.

[2] PQLs are taken from the USEPA CLP Statement of Work for Analysis of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans, Document Number DFLM01.1.

[3] Soil detection limits are based on 10 g. wet weight. Detection limits corrected for percent solids will be higher.

FIGURE SL-5-12
ITAS-ST. LOUIS LABORATORY
Radiochemical Target Detection Limits

Analytical Parameters	Matrix	Detection Limit[1]
Total Uranium	Water	1 µg/L (KPA)
	Soil	20 µg/g (gamma)
Radium-228	Water	3 pCi/L
Tritium	Water	500 pCi/L
	Soil	500 pCi/L
Gross Alpha	Water	5 pCi/L[2]
	Soil, Vegetation	25 pCi/g
	Filter	1 pCi/filter
Gross Beta	Water	4 pCi/L
	Soil, Vegetation	25 pCi/g
	Filter	2 pCi/filter
Total Alpha Emitting Isotopes for Radium	Water, Vegetation	1 pCi/unit volume
Radium-226/228 by Gamma	Soil	1 pCi/g (Ra-226)
		3 pCi/g (Ra-228)
Isotopic Americium, Uranium, Plutonium, Thorium	Water	1 pCi/L
	Soil	1 pCi/g
	Vegetation	1 pCi/g
	Filter	1 pCi/filter
Technetium-99	Water, Filter	3 pCi/L
	Soil, Vegetation	2 pCi/g
Strontium-89/90	Water, Filter	1 pCi/L
	Soil, Vegetation	1 pCi/g
Polonium-210	Water	1 pCi/L
Lead-210	Water	1 pCi/L
Gamma	Water, Filter	20 pCi/L (based on Cs-137)
	Soil, Vegetation	2 pCi/g (based on Cs-137)
Ra-226/Rn-222 by Emanation	Water	0.2 pCi/L

FIGURE SL-5-12
ITAS-ST. LOUIS LABORATORY
Radiochemical Target Detection Limits

Analytical Parameters	Matrix	Detection Limit[1]

[1]Count durations for all samples will be optimized so that client required detection limits can be achieved. Interferences, contaminants, and other matrix problems may cause the sample detection limit to exceed the desired detection limit.

[2]Achievable only when dissolved solids <500 ppm.

APPENDIX

ST. LOUIS-6

PERFORMANCE EVALUATION STUDIES

TABLE SL-6-1
ITAS-ST. LOUIS Laboratory
Performance Evaluation Studies

PE Sample Program Description	Analysis Performed	Frequency of Participation
USEPA Water Supply Performance Evaluation Study- Environmental Monitoring Systems Laboratory- Cincinnati	Trace Metals, Minerals, Nutrients, Demands, PCBs, Pesticides, Volatile Halocarbons, Volatile Aromatics and Miscellaneous Parameters, in Water	Bi-Annually
USEPA Water Pollution Performance Evaluation Study - Environmental Monitoring Systems Laboratory - Cincinnati	Trace Metals, Nitrate/Nitrite/Fluoride, Trihalomethanes, Volatile Organics and Miscellaneous Parameters, in Water	Bi-Annually
USEPA Inorganic Performance Evaluation Study - Environmental Monitoring Systems Laboratory - Las Vegas	Metals in Water and Soil. TAL[1]	Quarterly
USEPA Environmental Radioactivity Laboratory Intercomparison Studies Program - Environmental Monitoring Systems Laboratory - Las Vegas	U-Total, $^{226/228}$Ra, Gross α/β, $^{89/90}$Sr, ^{239}Pu, and ^{3}H in Water. Gamma Emitters in Water. Blind Samples A & B in Water. Gross α/β, ^{90}Sr, ^{137}Cs in Filters.	Monthly
Department of Energy Environmental Measurements Laboratory (DOE-EML) Office of Environmental Restoration and Waste Management, Quality Assessment Program - New York	Gamma Emitters, ^{90}Sr, $^{238/239}$Pu, ^{241}Am, $^{234/238}$U, and U-Total in Filters. Gamma Emitters, ^{90}Sr, ^{239}Pu, ^{241}Am, and $^{234/238}$U in Soil. Gamma Emitters, ^{90}Sr, $^{238/239}$Pu and ^{241}Am in Vegetation. Gamma Emitters, ^{90}Sr, $^{238/239}$Pu, ^{241}Am, $^{234/238}$U and U-Total in Water.	Bi-Annually

[1] Target Analyte List USEPA CLP ILM03.0

APPENDIX

ST. LOUIS-7

PREVENTIVE MAINTENANCE SCHEDULES

TABLE SL-7-1
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Gas Chromatography[1]

As Needed	Semi-annually
Replace front portion of column packing or break off front portion of capillary columns. Replace column if this action fails to restore performance of the column or when column performance (*e.g.* peak tailing, poor resolution, high backgrounds, etc.) indicates it is required.	Perform ECD wipe test.
Change glass wool plug in injection port and/or replace injection port liner with cleaned liner when front portion of column packing is changed or front portion of capillary column is removed.	Replace carbon filters at instrument effluent sites.
Replace septum (usually approximately every 100 injections).	
Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).	
Replace or repair flow controller if constant gas flow cannot be maintained.	
Change fuse when performance indicates fuse has blown.	
Reactivate external carrier gas dryers when blue indicator changes to pink.	
Clean detectors when baseline indicates contamination or when response is low.	
Reactivate flow controller filter dryers when presence of moisture is suspected.	
Tekmar purge and trap devices: replace traps and columns when poor response or disappearance of reactive or poorly trapped compounds.	

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-2
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Gel Permeation Chromatograph (GPC)[1]

As Needed	Daily	Monthly	Semi-annually	Annually
Replace column packing material and filter membranes when column performance does not meet method specifications	None	None	Oil the electric motor on the pump every 1500-2000 hours of use.	None
Backflush loops if pressure exceeds 15-psi (due to a small particle clogging the valve)				

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-3
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Mass Spectrometers[1]

Instrument	As Needed	Monthly	Annually
Mass Spectrometer	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between service contract maintenance.	Not Applicable	Not Applicable
	Electron multiplier: replace when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.		
	Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.		
Neslab Chiller	Check coolant level. Add coolant as required to maintain cooling.	Vacuum outside chiller to prevent dust from clogging filters	Clean on-line filter in Neslab

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations

TABLE SL-7-4
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Graphite Furnace Atomic Absorption[1]

Daily	Monthly	Semi-Annually	Annually
Clean Optical Windows	Check coolant level in cooling unit. Add coolant if error message appears	Replace contact cylinders	Notify service representative to perform cleaning of optics
Clean Contact Cylinders			
Check tubes and platform, replace if corroded, flaking or if low absorbance results			

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations

TABLE SL-7-5
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Ion Chromatography[1]

As Needed	Daily	Weekly	Monthly	Semi-annually
Clean micromembrane suppressor when decreases in sensitivity are observed	Check plumbing	Check pump heads for leaks	Clean conductivity cell	Replace gradient pump piston seal
Change fuses when power problems occur	Check UV/VIS detector for leaks	Check filter (inlet)	Check conductivity cell for calibration	Clean high pressure valve
Change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated.			Check all air and liquid lines for discoloration and crimping, if indicated.	
Degas pump head when flow is erratic				

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-6
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
ICP[1]

Daily	Monthly	Semi-annually
Check the pump winding, replace if needed.	Clean intelligence controller filters	Change vacuum pump oil
	Check and clean nebulizer, mixing chamber and torch	
	Check the pump capillary tubing, clean or replace if needed	
	Clean optical path windows	
	Clean RF generator filters	

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-7
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Total Organic Carbon Analyzer[1]

Daily	Weekly	Bi-monthly	Monthly
Check oxygen supply	Check liquid flow rate pump tubing conditions	Change pump tubing	Change Sn and Cu
Check persulfate supply	Check for moisture in LiOH tube		
Check acid supply	Check injection port septum		
Check printer paper			
Check Sn and Cu scrubber			
Add a few drops of H_3PO_4 to GLS			
Check carrier gas flow rate (≈200 cc/min.)			

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-8
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Total Organic Halide Analyzer[1]

Daily	Weekly	Monthly
Check exit tube and quartz wool	Change quartz wool in inlet liner and exit tube	Examine and clean pyrolysis tube
Check for gas bubbles in titration sidearm	Measure gas flow	Clean titration cell
Check inlet area for GAC spills	Perform cell performance check	Perform electronic test
Check electrolyte level, add if needed		Check O-rings, replace if worn
Clean quartz boat		

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-9
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
TRAACS 800 Auto Analyzer[1]

As Needed	Daily	Monthly	Semi-annually	Annually
Replace air filter when progressive loss of air pressure is observed	Check air pressure gauge (22 ± 2 psi)	Change all pump tubes (or after 200 hours of pumping time)	(or after 1000 hours of pumping time) Replace pump platens	Lightly lubricate the Linear Sample Rails (use semi-fluid lubricant)
Replace air valve tubing when occlusion in tubing is observed	Use recommended washout procedure (at end of analysis operations)	Clean sample probe shaft		Replace colorimeter lamp (or after 2500 hours of use)

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-10
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Video 12E Cold Vapor Atomic Analyzer[1]

Daily	Weekly	Monthly	Annually
Clean sample aspirator by flushing with DI water	Clean windows with methanol	Clean cell in aqua regia	Notify service representative to perform cleaning of optics
Check flow rate of stannous chloride			
Check tubing and replace if needed			

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-11
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
High Pressure Liquid Chromatography[1]

As Needed
Column change: Columns are replaced when peak shape and resolution indicate that the chromatographic performance of the column is below method requirements
Filters are cleaned every time a column change takes place
The slides on the auto sampler are oiled when the sample does not advance as required
[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

TABLE SL-7-12
ITAS-ST. LOUIS LABORATORY
Maintenance Schedule
Radiological Analysis Equipment[1]

Instrument	As Needed	Weekly	Monthly	Annually
Gas Flow Proportional Counters	As carrier gas is consumed, change P-10	Not Applicable	Not Applicable	Not Applicable
Germanium Gamma Detector	Not Applicable	Fill liquid nitrogen Dewars	Not Applicable	Not Applicable
Alpha Spectrometers	Not Applicable	Not Applicable	Check vacuum pump oil level, fill if necessary	Change vacuum pump oil
Liquid Scintillation Counter	Not Applicable	Not Applicable	Normalize PM tubes	Not Applicable

[1]Refer to manufacturer's instructions for each instrument to perform maintenance operations.

APPENDIX

ST. LOUIS-8

ADDITIONAL OPERATION-SPECIFIC INFORMATION

TABLE SL-8-1
ITAS-ST. LOUIS LABORATORY
Summary of Radiological Instrument Calibrations

Detector	Type	Minimum Frequency	Criteria
Gas Proportional Counter	Initial Calibration	Every 3 years	±10% of NIST traceable standard
	Self-Absorption	Every 3 years	Alpha mass thickness < 10 mg/cm² Beta mass thickness < 10 mg/cm²
	Check Source	Daily	±3 Standard Deviations from Control Chart
	Background	Daily	±3 Standard Deviations from Control Chart
Alpha Spectrometry	Initial Calibration	Annually	10,000 counts
	Pulser Check	Daily	±100 KeV of true value
	Energy Calibration Check	Weekly	Peak Resolution at FWHM (Full Width at Half Maximum Height) ≤100 KeV
	Efficiency Check	Weekly	Minimum 10,000 counts; uncertainty ≤2%
	Background	Monthly	4,000 minutes
KPA	Initial Calibration	Per Batch	5 low and 5 high standards; $r^2 \geq 0.96$; lifetime between 100-340 μs
	Calibration Check	Per Batch	1 low and 1 high; must be within 2σ error
	Background	Per Batch	1 low and 1 high standard, $r^2 \geq 0.96$; lifetime between 100-340 μs
Radon Emanation Counter	Check Source	Per Batch	±3 Standard Deviations from Control Chart
	Cell Efficiency	Annually	> 1000 counts
	Background	Per Batch	≥ sample count time

TABLE SL-8-1
ITAS-ST. LOUIS LABORATORY
Summary of Radiological Instrument Calibrations

Detector	Type	Minimum Frequency	Criteria
Gamma Spectrometer	Inital Calibration	Annually	± 10% of NIST source
	Check Source	Daily	±3 Standard Deviations from Control Chart
	Background	Monthly	≥ 24 hours
Liquid Scintillation	Initial Calibration	Monthly	Per manufacturer Quench curves ≥ 100,000 counts
	Check Source	Per Batch	≥ 100,000 counts
	Background	Per Batch	±3 Standard Deviations from Control Chart
	Efficiency	Per Batch	±3 Standard Deviations from Control Chart
	Quench Curve Check	Per Batch	Per manufacturer

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Gross Alpha/Beta	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
Radium-228	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria
Tritium	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
Total Uranium	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Isotopic Uranium U-238, U-234, U-235	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria
Isotopic Plutonium Pu-239/240, Pu-238	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Isotopic Thorium Th-228, Th-230, Th-232	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria
Technetium	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
Gross Alpha by Coprecipitation	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Americium-241	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria
Total Alpha Emitting Isoptopes of Radium	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Lead Pb-210	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria
Polonium-210	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Strontium-89,90 and Total Strontium	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria
Radium-226/228	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
	Carrier	Frequency: Tracer added to each sample, blank and QC sample Criteria: Tracer recovery shall be 20-110% Corrective Action: Reanalyze analytical batch if yield for blank or LCS is outside acceptance criteria. Reanalyze samples with yield outside acceptance criteria

TABLE SL-8-2
ITAS-ST. LOUIS LABORATORY
Minimum Radiological Quality Control Samples

Analytical Parameters	QC Sample	Quality Control
Radium-226 Radon-222 (Emanation)	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation
Gamma Emitters Actinides, as applicable, Co-60, Cs-137, K-40, Mn-54, and other fission/activation products	Method Blank	Frequency: 1 per analytical batch of ≤ 20 samples of the same matrix Criteria: Activity is ≤ Contract Detection Limit Corrective Action: Evaluate data; reanalyze blank and associated sample batch
	Laboratory Control Sample	Frequency: 1 per analytical batch of ≤ 20 samples of the sample matrix Criteria: ± 3σ of the mean recovery as determined by control tables Corrective Action: Evaluate data; reanalyze LCS and associated sample batch
	Duplicate Sample	Frequency: 1 per batch of ≤ 20 samples of the same matrix within a 14-day period Criteria: 1.5 x 2σ error of the sample Corrective Action: Flag data for client evaluation

STS

E

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix E

Supplemental Information: Other Sampling

316 EAST ILLINOIS PROJECT
CHICAGO, ILLINOIS

STS Consultants, Ltd.
111 Pfingsten Road, Northbrook, Illinois

APPENDIX E

This appendix provides supplemental information related to the 316 East Illinois property.

Pages E-2 to E-16 are taken from the STS 1992 investigation report (STS92). Pages E-2 - E-8 provide a summary of the sample results from the subject investigation. Pages E-10 and E-11 are two of the boring logs and pages E-12 to E-15 are the logs for the monitoring wells. Page E-9 is a map based on the U.S.G.S. quadrangle map.

September 29, 1992

Mr. Pat Newman
POWER/CRSS
8700 W. Bryn Mawr
Chicago, IL 60631

RE: Report of Environmental Investigation of the Proposed Northwestern Memorial Hospital Facility Redevelopment Site, Located between Grand, Columbus, Illinois and McClurg Court, Chicago, IL -- STS Project No. 27313-XH

Dear Mr. Newman:

STS Consultants, Ltd. has completed the environmental investigation of the above referenced site. The investigation consisted of a series of tasks including a historical and site background review, subsurface explorations and chemical testing of selected soil samples. A discussion of the exploration methods, results, analysis and recommendations are presented in this report. The results of the concurrent geotechnical exploration program are described in a separate report.

STS has appreciated the opportunity to work with POWER/CRSS on this project. If you have any questions regarding the information contained in this draft report please do not hesitate to call.

Respectfully,

STS CONSULTANTS, LTD.

David L. Grumman, Jr.
Project Geologist

Steven A. Bucher, P.E.
Associate

Richard G. Berggreen
Principal Geologist

DLG/nt/AC1

STS Consultants Ltd.
Consulting Engineers

111 Pfingsten Road
Northbrook, Illinois 60062
708.272.8520/Fax 708.498.2721

4.0 ANALYSIS AND CONCLUSIONS

General Summary of Environmental Findings

The site investigation of the proposed Northwestern Memorial Hospital Facility Development project has been completed. The site consists of three Cityfront Center parcels bounded by Grand, Columbus and Illinois Streets and a Chicago Police building. The site investigation consisted of a review of available historical information, subsurface explorations, chemical testing, and a preliminary analysis of site remediation options. The results of the historical research reveal that the site was occupied by a variety of commercial and industrial occupants in the decades preceding and following the turn of the century. Among these occupants were a lubricating oil plant, carbonic acid manufacturer, and metal polish plant, none of which appear to have remained on site past the early 1900s. During the past 50 years, the site has reverted to mostly paved vacant land used for parking.

The subsurface exploration program discovered an area of subsurface petroleum concentrations in the vicinity of the former carbonic acid and lubricating oil plants.

Based on the chemical analyses, the source of these petroleum concentrations is a petroleum product, probably a diesel, heating or lubricating oil. The location at which these petroleum concentrations were identified corresponds to the approximate position of a former lubricating oil warehouse (1905) and three underground storage tanks used by a previous carbonic acid manufacturer (1886). The highest concentrations appear to be found near the estimated former UST area. It is not known whether the USTs remain on site.

The analytical testing results suggest that, whatever the source, the petroleum concentrations are the result of historical operations, perhaps dating back to the early 1900s. The analytical results show that many of the more volatile petroleum

indicator compounds (e.g. benzene, xylene, toluene, and ethylbenzene) are mostly gone. This has left the heavier, less volatile petroleum indicators, including many PNAs. The groundwater testing results showed trace to low level PNA and heavy metal detections. PNA detections can be expected from urban fill materials, as well as from petroleum product sources.

Over 20 borings, including four groundwater monitoring wells, and three test pits were performed to estimate the lateral and vertical dimensions of petroleum concentrations on site. The confines of these petroleum concentrations cover an area of approximately 24,000 square feet over a 6 to 8 foot thick area. Based on the existing testing results , the northern and southern confines of the petroleum concentrations may not be fully identified. The shallow groundwater flow direction appears to be to the south, toward the Chicago River and former Ogden Slip.

No indication of environmental impacts were observed during the subsurface exploration program from the other previously occupied areas on site or adjacent parcels. Although no indications of environmental problems in other areas on site were discovered, given the nature of the site's historical usage it is considered possible that small localized areas of contamination or sources of potential contamination such as underground storage tanks may be discovered on site during site development. It is also considered possible that the long term use of the site as a parking lot could have resulted in small and isolated areas of petroleum product contamination, none of which are likely to require remediation.

Table 2
Selected Chemical Testing Results
Results in mg/kg (parts per million)

	Sample Identification								
	TP1	TP2	TP3	TP4	TP6	B-108	B-109	B-115	B-118
Volatile Organic Compounds (VOC)									
Benzene	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	0.006	--	--	--
Ethylbenzene	--	--	--	--	--	0.086	--	0.014	--
Total Xylenes	--	--	--	--	--	0.240	0.089	0.180	0.010
Tetrachloroethene	0.044	0.036	--	--	--	--	--	--	--
Trichloroethene	0.023	--	--	--	--	--	--	--	--
Tetrachloromethane	--	--	--	0.014	--	--	--	--	--
Carbon Disulfide	--	--	--	0.014	--	--	--	--	--
Total Petroleum Hydrcarbons	NT	NT	NT	NT	NT	38	15000	37	22
Oil & Grease	NT	NT	NT	NT	NT	38	16000	43	34
Polynuclear Aromatic Hydrocarbons (PNA)									
Acenapthylene	NT	NT	NT	NT	NT	5.800	--	--	--
Acenapthene	NT	NT	NT	NT	NT	--	54.000	--	--
Fluorene	NT	NT	NT	NT	NT	18.000	--	--	--
Phenanthrene	NT	NT	NT	NT	NT	6.000	--	0.011	0.025
Anthracene	NT	NT	NT	NT	NT	21.000	7.500	0.004	0.0081
Fluoranthene	NT	NT	NT	NT	NT	38.000	25.000	--	--
Pyrene	NT	NT	NT	NT	NT	12.000	--	--	0.022
Benzo(a)anthracene	NT	NT	NT	NT	NT	1.300	0.950	--	0.0087
Chrysene	NT	NT	NT	NT	NT	1.500	0.770	--	0.021
Benzo(b)fluoranthene	NT	NT	NT	NT	NT	--	--	--	0.0066
Benzo(k)fluoranthene	NT	NT	NT	NT	NT	0.130	0.120	0.001	0.0058
Benzo(a)fluoranthene	NT	NT	NT	NT	NT	0.300	0.230	0.001	0.013
Benzo(g.h.i)perylene	NT	NT	NT	NT	NT	0.300	--	--	--

Legend:

NT: Not Tested
--: Result below laboratory practical quantitation level (PQL)

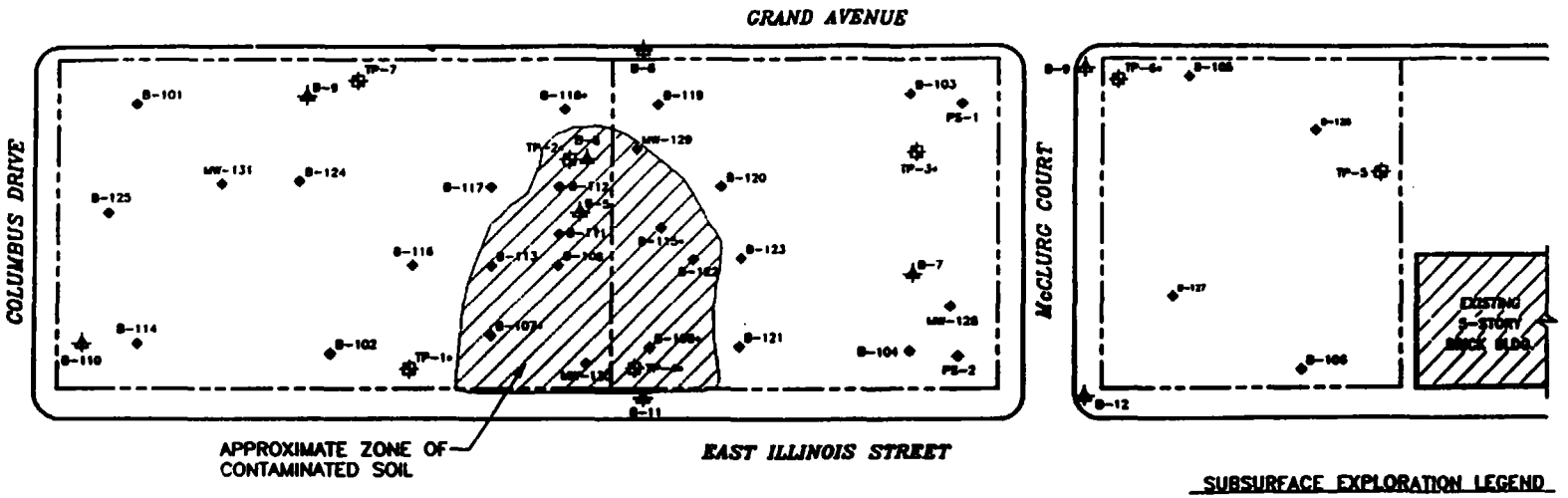
DLG/nt/AB1

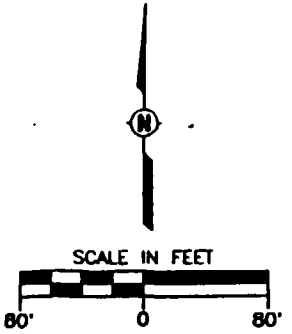
Table 3
Selected Chemical Testing Results
Results in mg/kg or mg/L [water samples]

	Soil Samples					Groundwater Samples			
	B-126	B-128	B-129	B-130	B-131	MW-128	MW-129	MW-130	MW-13
Volatile Organic Compounds (VOC)*									
Benzene	NT	NT	--	NT	--	--	--	--	--
Toluene	NT	NT	--	NT	--	--	--	0.13	--
Ethylbenzene	NT	NT	--	NT	--	--	--	--	--
Total Xylenes	NT	NT	--	NT	--	--	--	0.13	--
Tetrachloroethene	NT	NT	--	NT	--	--	--	--	--
Trichloroethene	NT	NT	--	NT	--	--	--	--	--
Tetrachloromethane	--	--	--	0.014	--	--	--	--	--
Carbon Disulfide	--	--	--	0.014	--	--	--	--	--
RCRA Heavy Metals*									
Barium	1.0	12.1	0.2	1.1	0.1	0.33	0.21	0.29	0.14
Lead	--	--	--	--	--	0.50	--	1.80	2.90
Chromium	--	--	--	--	--	--	--	0.06	--
Polynuclear Aromatic Hydrocarbons (PNA)									
Acenapthylene	NT	NT	NT	NT	NT	--	--	--	--
Acenapthene	NT	NT	NT	NT	NT	--	--	--	--
Fluorene	NT	NT	NT	NT	NT	--	--	--	--
Phenanthrene	NT	NT	NT	NT	NT	--	--	--	--
Anthracene	NT	NT	NT	NT	NT	--	--	0.087	--
Fluoranthene	NT	NT	NT	NT	NT	0.0021	--	--	--
Pyrene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(a)anthracene	NT	NT	NT	NT	NT	0.00095	--	--	0.0001
Benzo(a)pyrene	NT	NT	NT	NT	NT	0.00097	--	--	0.0002
Chrysene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(b)fluoranthene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(k)fluoranthene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(a)fluoranthene	NT	NT	NT	NT	NT	--	--	--	--
Benzo(g,h,i)perylene	NT	NT	NT	NT	NT	--	--	--	--
Napthalene	NT	NT	NT	NT	NT	--	--	0.37	--

Legend:
NT: Not Tested
--: Result below laboratory practical quantitation level (PQL)
* : Only compounds detected are listed

DLG/nt/AB1





SUBSURFACE EXPLORATION LEGEND

- BORINGS STS JOB #27313 (1992)
- BORINGS STS JOB #27313XH (1992) (MW PREFIX INDICATES MONITORING WELL INSTALLATION)
- TEST PITS STS JOB #27313XH (1992)
- BORINGS STS JOB #25400XF (1988)
- BORINGS STS JOB #24418-N (1987)
- BORINGS STS JOB #24418-C (1986)
- SAMPLE RETAINED FOR CHEMICAL TESTING

DRAWN BY PCK	DATE 8/6/92	
CHECKED BY DLG	DATE 8/6/92	
APPROVED BY SAB	DATE 8/6/92	

EXTENT OF CONTAMINATION DIAGRAM
PROPOSED NORTHWESTERN MEMORIAL HOSPITAL
GRAND/COLUMBUS/ILLINOIS/McCLURG COURT
CHICAGO, ILLINOIS

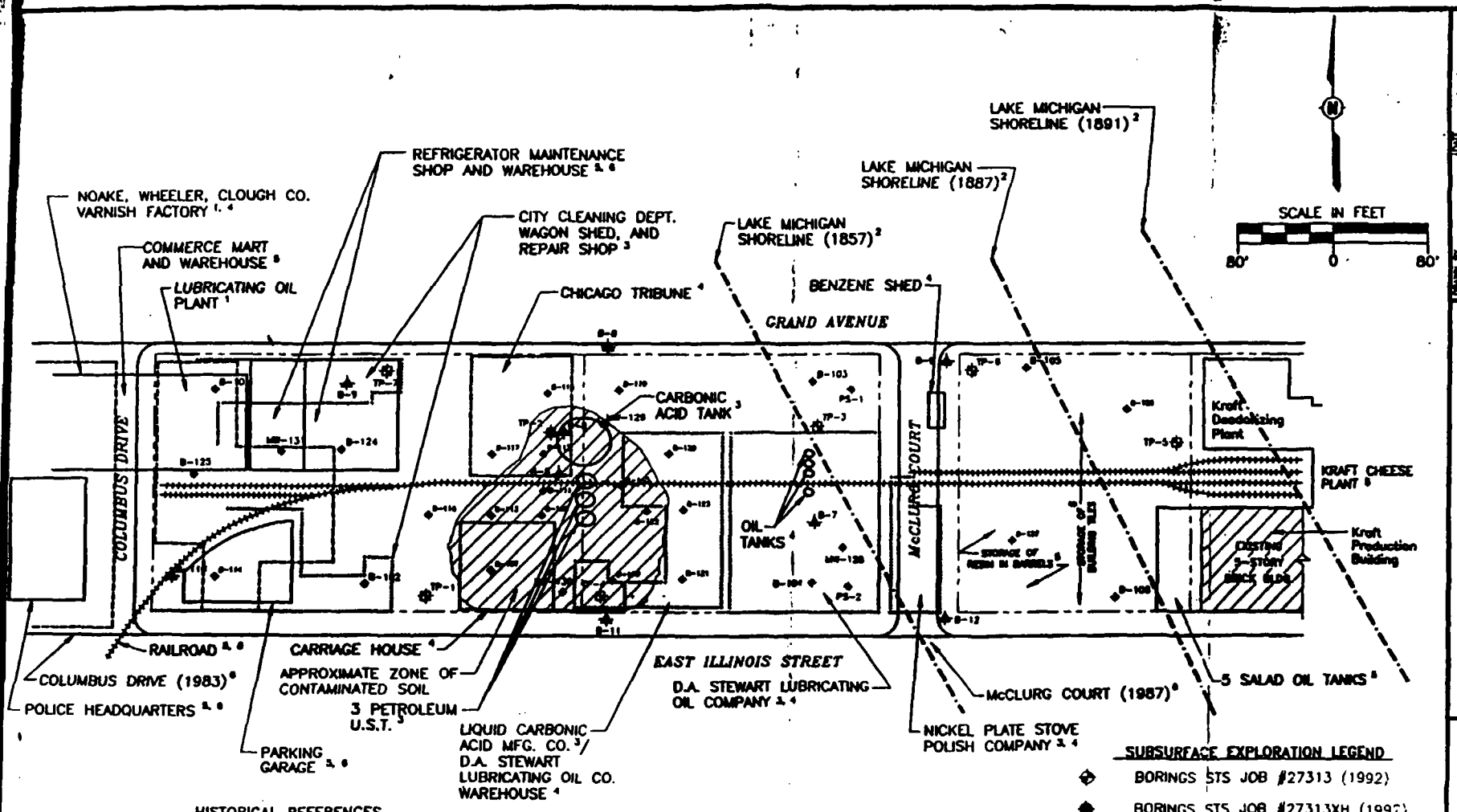
STS CONSULTANTS LTD.
CONSULTING ENGINEERS

STS PROJECT NO. 27313-XH

STS PROJECT FILE

SCALE: 1" = 80'±

SHEET NO. FIGURE 3



HISTORICAL REFERENCES

1. ROBINSONS ATLAS OF CHICAGO, FIRE INSURANCE MAP (1886) [----------]
2. GREELY CARLSON FIRE INSURANCE MAP (1891) [— · — · — · —]
3. RASCHER FIRE INSURANCE MAP (1891) [————————]
4. SANBORN FIRE INSURANCE MAP (1905) [————————]
5. SANBORN FIRE INSURANCE MAP (1949) [————————]
6. AERIAL PHOTOGRAPHY OF SITE, MISC. YEARS 1938–1988

THE LOCATIONS OF THE HISTORICAL STRUCTURES AS ILLUSTRATED ABOVE ARE CONSIDERED APPROXIMATE AND ARE BASED ON THE REFERENCES LISTED.

SUBSURFACE EXPLORATION LEGEND

- BORINGS STS JOB #27313 (1992)
- BORINGS STS JOB #27313XH (1992) (MW PREFIX INDICATES MONITORING WELL INSTALLATION)
- TEST PITS STS JOB #27313XH (1992)
- BORINGS STS JOB #25400XF (1988)
- BORINGS STS JOB #24418-N (1987)
- BORINGS STS JOB #24418-C (1986)

DRAWN BY PCK	DATE 8/6/92	
CHECKED BY DLG	DATE 8/6/92	
APPROVED BY SAB	DATE 8/6/92	
DISPLAY D:\PEOPLE\KRESSON\DWG\DISPTCH\27313.dwg		

HISTORICAL SITE USAGE DIAGRAM
PROPOSED NORTHWESTERN MEMORIAL HOSPITAL
GRAND/COLUMBUS/ILLINOIS/McCLURG COURT
CHICAGO, ILLINOIS

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STS PROJECT NO. 27313-XH
STS PROJECT FILE
SCALE: 1" = 80'±
SHEET NO. FIGURE 5

REF. BASE MAP: USGS QUADRANGLE MAP
7.5 MINUTE SERIES (TOPOGRAPHIC)
CHICAGO LOOP
PHOTOREVISED 1972

N

LEGEND

SITE

● CERCLIS SITES

▲ RCRA GENERATORS AND [1] TSDS FACILITIES

■ UST SITES[2]

♦ LUST SITES[3]

▰ SOLID WASTE DISPOSAL SITES[4]

LEGEND

1. USEPA COMPUTER DATA BASE SEARCH DATED 5-21-91.
2. ILLINOIS STATE FIRE MARSHALL UNDERGROUND STORAGE TANKS (UST) DATA BASE 6-9-90.
3. ILLINOIS STATE FIRE MARSHALL LIST OF LEAKING UNDERGROUND STORAGE TANKS (LUST) INCIDENTS REPORT 5-1-91
4. NORTHEASTERN ILLINOIS PLANNING COMMISSION HISTORICAL INVENTORY OF SOLID WASTE DISPOSAL SITES 1987.

STS Consultants Ltd.
Consulting Engineers

HAZARDOUS WASTE FACILITIES
LOCATED IN U.S. POSTAL ZIP CODE AREA
60601, 60602, 60603, 60604, 60606
60611 AND PORTIONS OF 60610

DRAWN BY	DATE	SCALE	STS PROJECT NO
KKB	7-15-92	SHOWN	27313-XH
CHECKED BY	DATE	SHEET NO.	STS FILE NO.
DLG	7-15-92		27313-XH

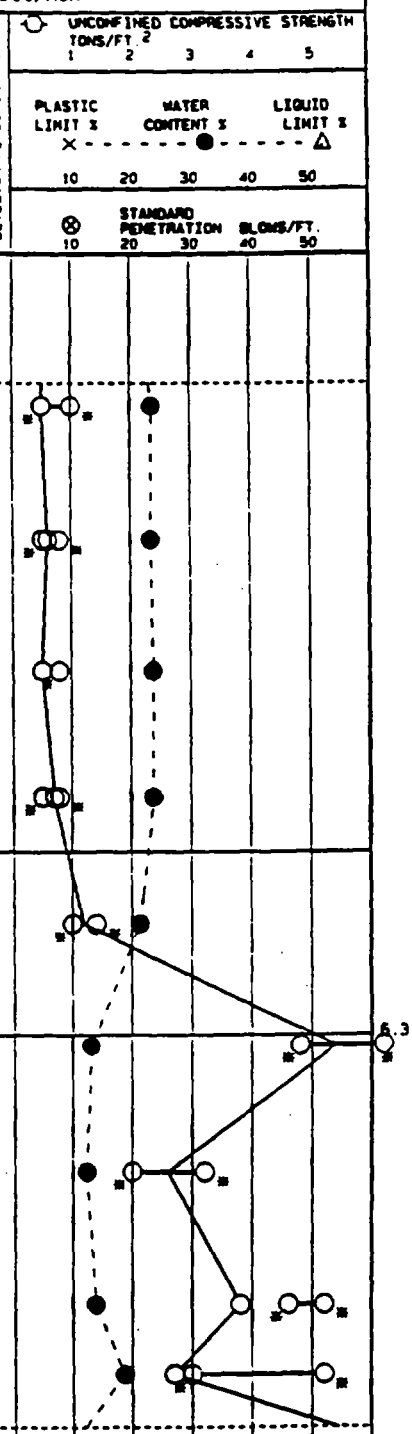
FIGURE 6

ALL LOCATIONS ARE APPROXIMATE

STS Consultants Ltd	CLIENT: Power/CRSS	LOG OF BORING NUMBER B-106
	PROJECT NAME: Northwestern Memorial Hospital	ARCHITECT-ENGINEER: Ellerbe Beckett/HOK

SITE LOCATION: Grand/Columbus/Illinois/McClurg Ct.; Chicago, Illinois

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL / SURFACE ELEVATION	UNIT DRY WT. LBS./FT.^{3}	PHOTO-IONIZATION DETECTOR READING (PPM)
				Continued from previous page		
40.0						
	10	ST		Silty clay, trace gravel, sand and shale - gray - medium (CL)	106	
		RB				
		VS		Field vane at 42.5 ft. s_u = 1319 psf		
		RB				
45.0						
	11	ST			108	
		RB				
		VS		Field vane at 47.5 ft. s_u = 1066 psf		
		RB				
50.0						
	12	ST			107	
		RB				
	13	ST			106	
		RB		Silty clay, trace gravel, sand and shale - gray - stiff (CL)		
60.0						
	14	ST				
		RB				
65.0						
	15	ST		Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)		
		RB				
70.0						
	16	ST				
		RB				
75.0						
	17	ST			123	
		RB				
	18	ST			112	
80.0		RB				
				* Calibrated Penetrometer		
				.. continued		



(The stratification lines represent the approximate boundary lines between soil types in-situ, the transition may be gradual.)

STS JOB NO. 27313 | SHEET NO. 2 OF 3

STS Consultants Ltd.

CLIENT Power/CRSS	LOG OF BORING NUMBER B-106
PROJECT NAME Northwestern Memorial Hospital	ARCHITECT-ENGINEER Ellerbe Beckett/HOK

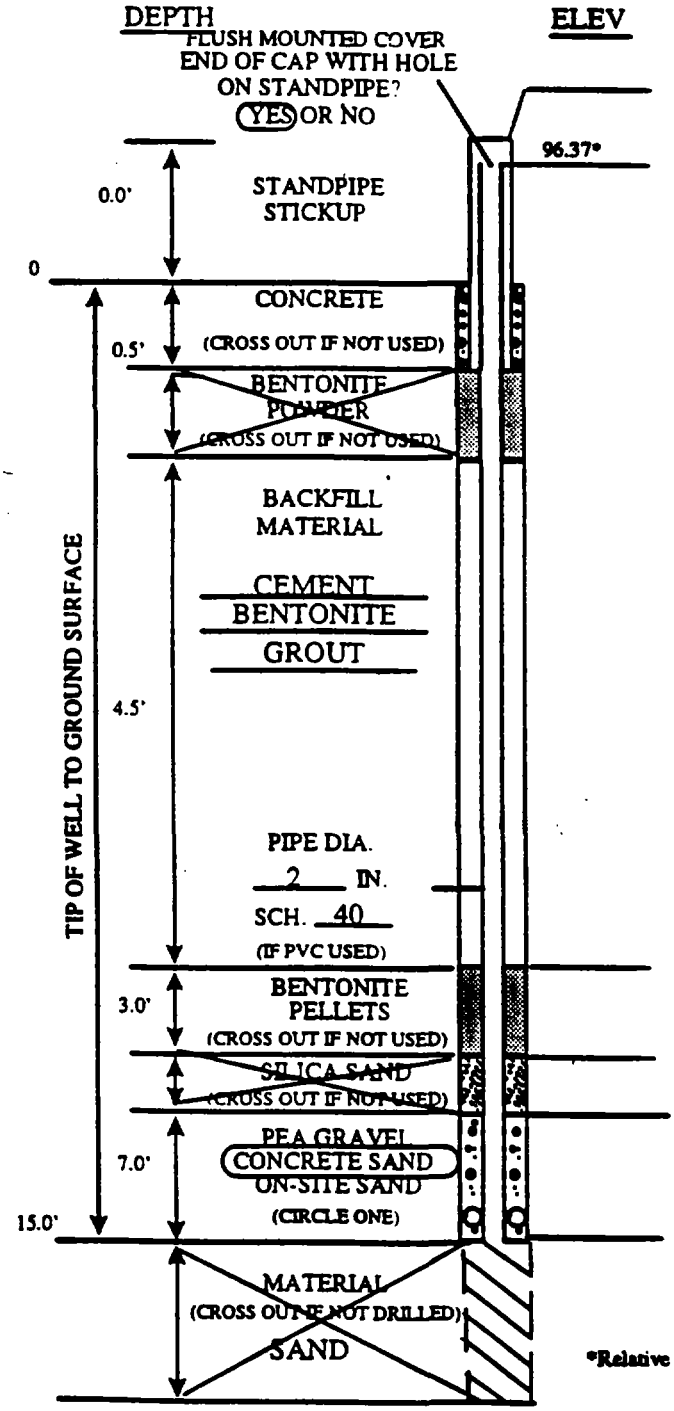
SITE LOCATION
Grand/Columbus/Illinois/McClurg Ct.: Chicago, Illinois

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.3	PHOTO-IONIZATION DETECTOR READING (PPM)	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.2 (1 2 3 4 5) / PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50) / STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)	
						SURFACE ELEVATION				
						Continued from previous page				
80.0										
		19	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)				6.8
		20	ST			Clayey silt, little sand, trace gravel - gray - moist (ML)				
			RB							
85.0						Silty clay, little sand, trace gravel and shale - gray - hard (CL)				
		21	ST				131			4 #7+
			RB							
		22	ST				132			#7+
			RB							
90.0		23	ST							1.6 #7+
			RB							
		24	ST							
			RB							
95.0										
		25	SS							4.4 #7+
			RB							
		26	SS							10.0 #7+
100.0										
						End of Boring Borehole grouted upon completion. Casing used 35 ft of 4 in.		* Calibrated Penetrometer		

The stratification lines represent the approximate boundary lines between soil types: in-situ, the transition may be gradual.

WL WS OR WD	BORING STARTED 07/17/92	STS OFFICE Northbrook-01	
WL BCR ACR	BORING COMPLETED 07/22/92	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN B-61/DT	APP'D BY MAK	STS JOB NO 27313

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER _____

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER _____

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER _____

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID Water
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY

1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
13 feet FT OR DRY

2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY

DATE 9/11/92, 11.09 FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

WELL NO. MW-128 DATE INSTALLED 9/5/92 DRILL RIG DR-9

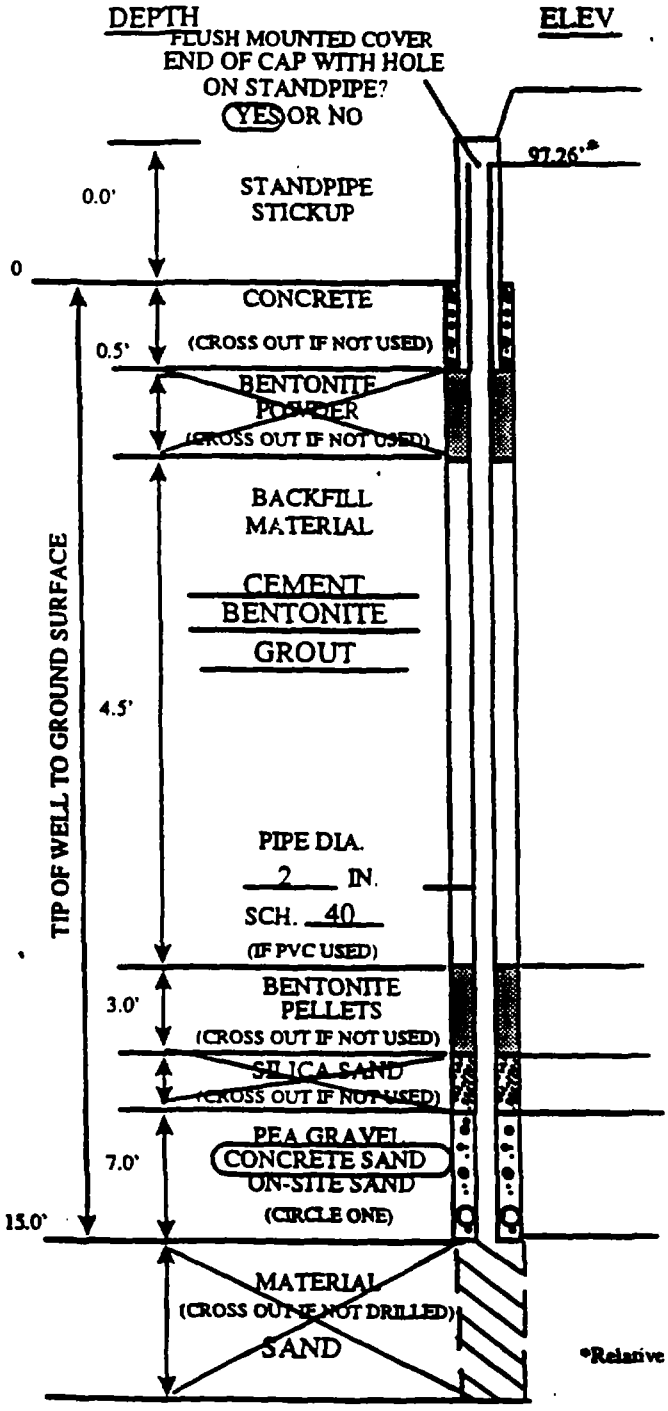
DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(Power/CRSS_mw-128/m11draw/nt)

(VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER _____

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER _____

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER _____

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID Water
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY

1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
13 feet FT OR DRY

2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY

DATE 9/11/92, 12.85 FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

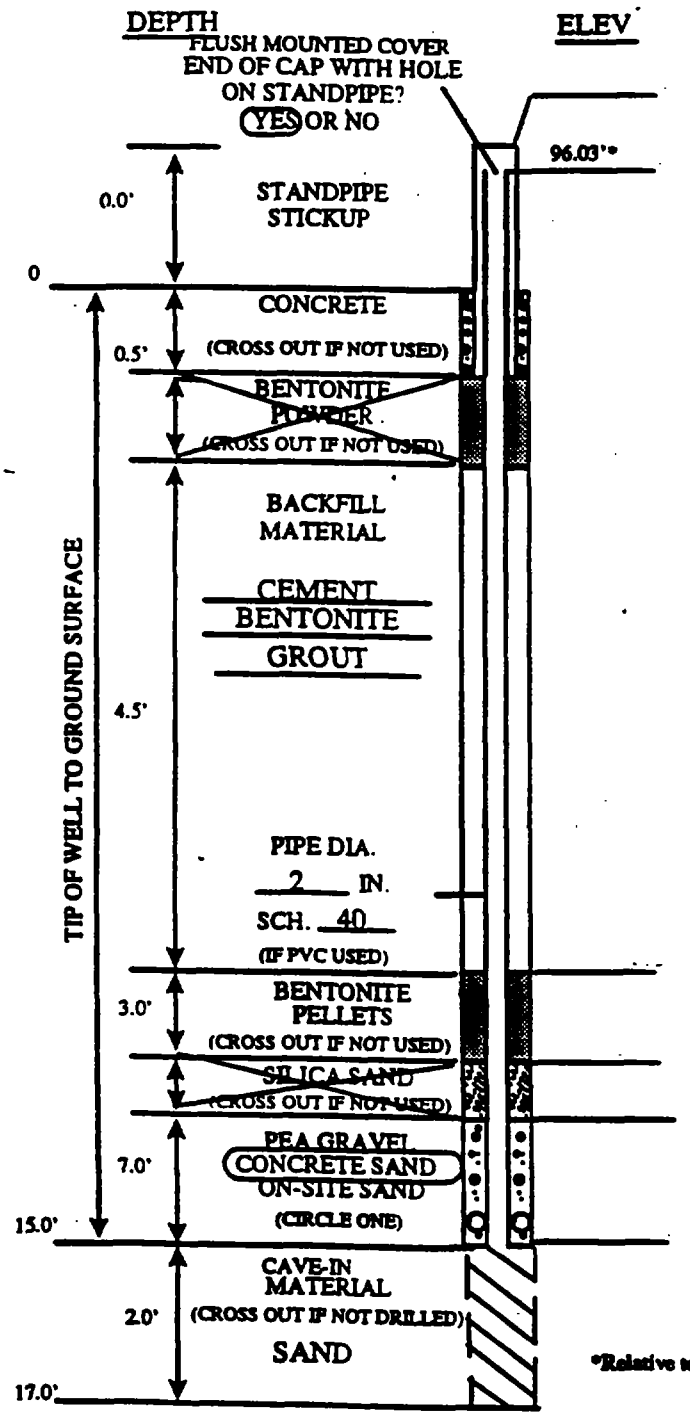
WELL NO. MW-129 DATE INSTALLED 9/5/92 DRILL RIG DR-9

DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(Power/CRSS_mw-129/m11draw/nt) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER _____

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER _____

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER _____

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID None
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM SURFACE TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY

1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
12.0 FT OR DRY

2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY

DATE 9/11/92, 11.87 FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

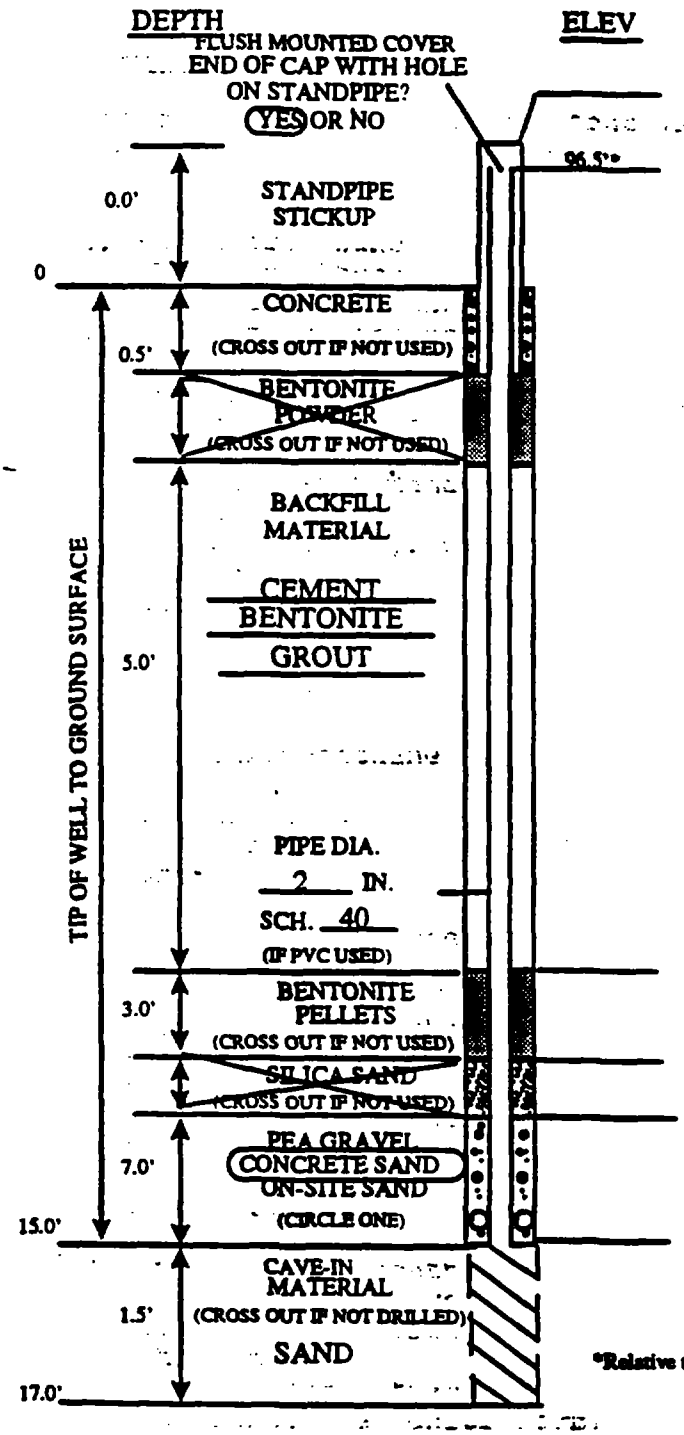
WELL NO. MW-130 DATE INSTALLED 9/5/92 DRILL RIG DR-9

DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(POWER/CRSS_MW-130/M11DRAW/NT) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

STS Field Well Installation Diagram



1) TYPE OF PIPE
PVC, GALVANIZED, STAINLESS, OTHER _____

2) TYPE OF PIPE JOINTS
BELLED, COUPLINGS, THREADED, OTHER _____

3) TYPE OF WELL SCREEN
PVC, GALVANIZED, STAINLESS, OTHER _____

4) SCREEN SLOT SIZE 0.01 inches

5) SCREEN LENGTH 5 feet

6) INSTALLED PROCTECTOR PIPE W/LOCK? YES OR NO

7) DRILLING METHOD Solid Stem Augers
DRILLING FLUID None
BOREHOLE DIAMETER 4 inches

8) BACKFILL MATERIAL INSTALATION FROM
SURFACE, TREMIE

9) HOW WAS WELL DEVELOPED?
BAILING, PUMPING, SURGING, COMPRESSED AIR

10) APPROXIMATE WATER VOLUME REMOVED OR ADDED?
5 GAL, 10 GAL, 15 GAL, OTHER 4 gals

11) WATER CLARITY BEFORE DEVELOPMENT
CLEAR, TURBID, OPAQUE

12) WATER CLARITY AFTER DEVELOPMENT
CLEAR, TURBID, OPAQUE

13) DID THE WATER SMELL? YES OR NO

14) WATER LEVEL SUMMARY
1) DEPTH FROM T. STANDPIPE AFTER DEVELOPMENT?
13 FT OR DRY
2) OTHER MEASUREMENTS: SEE OBSERVATION WELL SUMMARY
DATE 9/11/92, 12.22 FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE
DATE _____, _____ FT FROM T. ST. PIPE

*Relative to benchmark elevation = 100.00 feet

WELL NO. MW_131 DATE INSTALLED 9/5/92 DRILL RIG DR-9

DRILLER Dumas DRILL CREW Deon

JOB/CLIENT Proposed NWMH Facility Redevelopment Site/Power/CRSS STS PROJECT NO. 27313-XH

(POWER/CRSS_MW-131/M11DRAW/NT) (VERSION 3: 08/91 - M11DRAW "FIELD_WELL_KAS")

REF. BASE MAP: USGS QUADRANGLE MAP
7.5 MINUTE SERIES (TOPOGRAPHIC)
CHICAGO LOOP
PHOTOREVISED 1972

N

LEGEND

SITE

● CERCLIS SITES

▲ RCRA GENERATORS AND[1] TSDS FACILITIES

■ UST SITES[2]

♦ LUST SITES[3]

▰ SOLID WASTE DISPOSAL SITES[4]

LEGEND

1. USEPA COMPUTER DATA BASE SEARCH DATED 5-21-91.
2. ILLINOIS STATE FIRE MARSHALL UNDERGROUND STORAGE TANKS (UST) DATA BASE 6-3-90.
3. ILLINOIS STATE FIRE MARSHALL LIST OF LEAKING UNDERGROUND STORAGE TANKS (LUST) INCIDENTS REPORT 5-1-91.
4. NORTHEASTERN ILLINOIS PLANNING COMMISSION HISTORICAL INVENTORY OF SOLID WASTE DISPOSAL SITES 1987.

STS Consultants Ltd.
Consulting Engineers

HAZARDOUS WASTE FACILITIES
LOCATED IN U.S. POSTAL ZIP CODE AREA
60601, 60602, 60603, 60604, 60606
60611 AND PORTIONS OF 60610

DRAWN BY	DATE	SCALE	STS PROJECT NO
KKB	7-15-92	SHOWN	27313-XH
CHECKED BY	DATE	SHEET NO	STS FILE NO
DLG	7-15-92		27313-XH

FIGURE 6

ALL LOCATIONS ARE APPROXIMATE

APPENDIX G

M.J.W. CORPORATION INC.

RADIOLOGICAL CONTROL PROCEDURES NO. ~~20~~ 10 ,14,20,27

OPERATING AND CALIBRATION INSTRUCTIONS FOR

~~LUDLUM MODELS 2200 AND~~

~~1000 PORTABLE SCALER RATEMETERS~~ RADIATION DETECTING INSTRUMENTS

MJW Corporation, Inc.

RADIOLOGICAL CONTROL PROCEDURE 10

Controlled Copy Number _____

OPERATION OF THE EBERLINE ESP-1

1.0 PURPOSE

To establish standardized operating techniques for the Eberline ESP-1.

2.0 SCOPE

The Eberline Smart Portable (ESP-1) is a microcomputer-based portable radiation survey instrument designed to operate with most Eberline radiation detectors. The ESP-1 can display the data from these detectors in radiation units as selected and calibrated. The following procedure provides qualified personnel with the basic guide for using the ESP-1. The procedure ensures operability of the instrument and standardizes operating techniques.

3.0 RESPONSIBILITIES

3.1 It is the responsibility of personnel using the instrument to understand and follow all operating procedures. Variance from these procedures could result in nullification of results.

4.0 PROCEDURE

4.1 Operability check for the ESP-1 must be completed prior to use.

(1) Check instrument calibration data - The calibra-tion date is located on the main housing of the instrument.

(2) Check for physical damage.

(3) Scan the daily instrument check sheet (see RCP-9, Attachment 1) - Information on the sheet may point to possible problems. Efficiencies for the ESP-1 may vary ±5%.

(4) Check detector ensuring:

(a) detector has been calibrated and a plateau has been performed with the instrument for which it is being used;

(b) settings on detector (HV, WINDOW, THRESH, etc.) match instrument settings.

(5) Turn the instrument on - A bar graph will briefly appear on the screen prior to displaying a count rate.

(6) Select a mode of operation - Rate meter, scaler, inquiry/calibration.

(7) Verify operating parameters - Alarm settings, high voltage, calibration constant, etc.

(8) Check instrument operability - Use a check source to determine if instrument will respond to radioactivity.

(9) If respons is satisfactory, the instrument may then be used.

(10) See Attachment 1 for detailed operating instructions of ESP-1.

5.0 DETECTORS WHICH ARE COMPATIBLE WITH THE ESP-1 AND THEIR OPERATING PROCEDURES

5.1 Eberline PG-2

The PG-2 is a large area, rugged scintillation detector with a thin window for application in the detection of low energy gamma or x-ray radiation. Typical applications include monitoring for Pu-239 (17 keV), monitoring for Am-241 (60 keV, checking color TV sets for x-ray emission, checking for leakage from x-ray machines.

5.1.1 Operating Procedure

(1) Check operability of detector and probe using the procedure in Section 4.1.

(2) Obtain a background reading.

(3) Place probe near surface of area to survey (approximately 2"). Note: Do not touch the probe to the survey surface.

(4) At a slow but steady rate, survey the area. Keep probe at an equal distance from the surface.

(5) If the ESP-1 displays radiation levels above background, keep the probe in that area until a peak reading can be obtained and record the results.

5.2 Eberline AC-3-7, AC-3-8

The AC-3 is a rugged scintillation-type alpha probe designed to work with several of Eberline's portable survey instruments including the ESP-1. The -7 and -8 probes are essentially identical differing only in window assembly. The -7 designates a maximum open area window for alpha surveys while the -8 designates a rugged window with fine mesh protection over the film window for personnel monitoring. Probe area is 59 cm^2.

5.2.1 Operating Procedure

(1) Check operability of instrument and probe using procedure in Section 4.1.

(2) Monitoring techniques will depend greatly on the situation at hand. Operator should hold detector within 1/4 inch of surface being checked. Holding it on contact with surface being monitored is the most effective method, but this runs the risk of puncturing or contaminating the probe face.

CAUTION:

The face of the AC-3 is extremely thin and easily punctured. Never set the detector on a sharp object. Always keep protective cover over detector face when not in use.

(3) Obtain a background reading. If the background is not close to zero (i.e., <5 cpm), check for a light leak in mylar by pointing at the sun or a bright light. If a light leak exists, repair using black lacquer and reperform daily efficiency check.

(4) At a slow and steady rate, survey the area keeping detector at an equal (but close) distance from the surface being monitored. If the ESP-1 displays contamination levels above background, keep detector in that area until a peak reading is obtained and record results. Document survey results per RCP-4.

6.0 REFERENCES

6.1 Eberline Smart Portable (ESP-1) Technical Manual - July 1984.
6.2 Eberline Technical Manual for Low Energy Gamma Detector, PG-2.
6.3 Eberline Technical Manual for Alpha Scintillation Detector, AC-3-7 & AC-3-8.
6.4 M.J.W. Procedure RCP-9, Calibration and Operability Checks of Radiological Instruments.
6.5 M.J.W. Procedure RCP-4, Routine Radiation and Contamination Surveys.

7.0 ATTACHMENTS

7.1 ESP-1 Simplified Operating Instructions

ESP-1

SECTION II
SIMPLIFIED OPERATING INSTRUCTIONS

A. INTRODUCTION

1. General

This section is intended to provide the first time user with a quick guide to what the ESP-1 does and how to operate it. Much of the information included here occurs in later sections of this manual in more detail.

The ESP-1 is simple and straightforward in its operation. The basic principle of operation is that the signal from an attached detector is input into the computer in the ESP-1 instrument, and this signal is converted to count rate. The ESP-1 can be used either as a ratemeter or as a scaler, and a variety of units can be selected for display of the data.

The ESP-1 has three modes of operation:

a. The Ratemeter Mode:

- updates and displays selected units per time, such as counts per minute or mR/hr;
- provides the operator with a dual respresentation of count rate; that is, it provides a moving analog bar graph representing count rate and also a digital value for count rate;
- alarms when a preset value is exceeded.

The Ratemeter Mode is generally used for routine surveys of surfaces, personnel, and clothing for either contamination or exposure rate measurements from a radioactive source.

b. The Scaler Mode:

- allows setting the time interval over which counts or events are to be measured;
- counting is started and ends after the selected time interval;
- registers the number of events for integrated exposure in the selected time interval;
- sounds audible alarm if the integrated counts in the selected time period exceeds the value set on the alarm.

The Scaler Mode is used for quantitive data accumulation over a longer period of time. Using the Scaler Mode, comparisons can be made of radioactivity in various samples or situtations with the result that increased accuracy in the data may be obtained by counting over longer periods of time. An example would be the determination of thyroid gland burden of radioiodine by counting the thyroid for a period of time, perhaps five minutes. This mode can be disabled by an internal switch; refer to Section II.D.

c. Inquiry/Calibration Mode:

- enables the user to select the units which will be used in the Ratemeter Mode;
- enables the user to set the alarm point;
- enables the user to set two constants, the calibration constant (CC) and the dead time (DT) for the particular detector being used;
- enables the user to monitor the high voltage which is applied to the detector.

This mode can be disabled by an internal switch, refer to Section II. E.

2. User Calibration

a. User Calibration of the ESP-1 with a Detector Purchased with the Instrument:

The ESP-1 is calibrated at the manufacturing facility. If the instrument was purchased with a detector, the correct calibration factors for that detector are already entered at the factory and the instrument is ready for immediate use. You should verify that these parameters are the same as those supplied on the Calibration Certificate supplied with the detector. Refer to Section II.E. for directions on viewing the parameters.

b. User calibration of ESP-1 with Various Detectors:

If a radiation detector was not purchased with the ESP-1 from the factory, the ESP-1 was calibrated generically at the factory rather than for a specific detector. In that case, calibration factors for the detector of choice will have to be entered into the ESP-1 before it is ready for use.

CAUTION: Failure to enter the correct parameters for the detector being used may result in erroneous values being presented on the display of the ESP-1.

The parameters which require being set for a particular detector are:

		SECTION
1)	Alarm Point	II.E.1.
2)	Units	II.E.2.
3)	Calibration Constant	II.E.3.
4)	Detector Dead Time	II.E.4.
5)	High Voltage	II.E.5.

The last four are preset at the factory for the detector which was purchased with the ESP-1. The alarm point is set at a high value at the factory and, thus, should be reset to a user determined value if it is desired to use this feature of the instrument.

Section II.E. provides simple instructions on how to reset (re-calibrate) the items when changing detectors or re-calibrating the instrument.

The high voltage should be checked or re-adjusted for a new detector, PRIOR to connecting the detector. Failure to do so may result in damage to the detector.

3. Calibrations Required by Regulatory Agencies

Regulatory agencies generally require routine laboratory calibration of radiation survey instruments by an approved facility at least once per year. To have your instrument recalibrated return the ESP-1 and detector to the factory in Santa Fe, to the Eberline repair facility in Columbia, South Carolina, or to another approved calibration facility. If your facility has been approved for such calibrations, this may be accomplished by using the procedures given in Section V. CALIBRATION.

B. PRELIMINARY INSTRUCTIONS

Upon receiving the ESP-1 perform the following before proceeding.

1. Set up the ESP-1 and Detector

The ESP-1 has an MHV connector on its front surface for connection to a radiation detector. This connector supplies high voltage to the detector and also transmits the detector signal to the ESP-1 for processing and display. If the ESP-1 is already connected to a detector then it is reasonable to assume that the high voltage has been previously set. If you are not sure that the high voltage has been properly adjusted, disconnect the detector from the instrument by rotating the cable connector counterclockwise. You can proceed through these instructions without the detector being connected.

CAUTION: Failure to disconnect the detector from the instrument before turning it on can damage the detector if the high voltage is not set properly for the particular detector. Instructions for checking and setting the high voltage can be found in Section II.E.5.

When you are ready to connect the detector, verify that you have the proper cable. It should have a MHV connector on one end which mates to the ESP-1 and a connector on the other end to mate with the detector. Refer to your detector catalog sheet for the appropriate connector type. An MHV cable connector typically has white insulation in the center which extends slightly beyond the end of the metal portion of the connector. In contrast, a BNC cable connector typically has the insulation flush with the connector end. To connect the cable, rotate the connector clockwise.

2. Turn the Instrument "On" and Off"

Press the "On/Off" switch to turn the instrument "on". The same switch will have to be pressed to turn the instrument "off".

When the instrument is turned on, the display should indicate a numerical value on the lower line and a bar graph on the upper line. The bar graph may be off-scale, so press the RESET button to get it back on scale. The ESP-1 is in its Ratemeter Mode. Refer to Section II.C. for more information on the displayed information.

If the instrument has been properly calibrated and is connected to a detector, it is ready to use. Refer to Section II.E. for instructions on how to view and change the calibration parameters.

A quick check to determine that the instrument is functioning is to compare the numerical value being displayed to the background radiation level. If they are close then the instrument is operating and ready to use. Remember that normal statistical fluctuations can cause relatively large changes in the displayed reading at low levels. Press the SPKR button and you should hear a click corresponding to each detector event. If this is not the case, the speaker rate switch could be in wrong position. Refer to Section III.A.2.

3. Determine Low Battery Condition and Battery Replacement

Examine the first character space in the display (upper left hand corner). If it is blinking, the batteries are low and need replacing. The ESP-1 uses 6 C-cell batteries.

The instrument automatically turns itself off two hours after the low battery condition signal is given. The ESP-1 can be turned back on after it turns off, but will turn itself off again after two hours.

To change batteries, remove the large screw in the bottom of the case, and carefully remove the case bottom while being careful not to disconnect the grounding wire which is connected to the bottom of the case. Replace the batteries while being careful to orient the batteries according to the diagram printed on the bottom surface of the compartment which holds the batteries. (See Figure 5.2)

C. OPERATION IN THE RATEMETER MODE

The ESP-1 is automatically placed in the Ratemeter Mode when the instrument is turned on. Examine the display. It will show:

1. Analog Bar Graph (at the top of the display)

   The length of the moving analog bar graph is proportional to the detector count rate. One purpose of the moving bar graph is to permit more rapid recognition of a sudden increase or decrease in the radiation field being measured as compared to visual recognition from the changing numbers.

   If the bar graph is off scale in either direction, it may be brought back on scale by pressing the RESET button. The full scale value of the bar depends on the level of radiaion being measured. Pressing the RESET button always resets the value of the full scale of the bar graph to a point that is 33 percent of full scale. If the bar graph is displayed and is varying, the ESP-1 is working.

2. Numerical Value of Count Rate (at the bottom of the display)

   The second line of the display is the numerical value of the count rate. The value is expressed as a number followed by a second positive or negative number. The second number corresponds to a power of 10. Example: 1.00 + 02 mR/hr is $1 \times 10^2 = 100$ mR/hr.

3. Alarm

   The alarm point is a selected value which results in an audible alarm when the counting rate reaches that value. To silence the alarm, press SPKR key. The alarm will sound even if the speaker is off at the time the alarm is activated.

The alarm point can be viewed and set by pressing the MODE key. The display will contain either the ALM AT (Alarm Setting) display or will contain the "SCALER MODE?" prompt. If the latter is displayed, press the "-" key and you will see:

ALM AT(ALARM SETTING) RATEMETER READING

The value of the alarm setting (ALM AT) can be increased or decreased as desired by simultaneously pressing "RESET" and "+" or "RESET" and "-".

Note that the longer the RESET and "+" or "-" are held down, the faster the value changes. In this manner large changes in value can be made in a relatively short period of time. When the changing value approaches the desired value, release the keys and then press them down again to permit slow changes in the displayed numbers until the desired value is reached.

When the desired value of ALARM AT is displayed, press the MODE key to return to the bar graph display.

CAUTION: While ALM AT is being displayed, the instrument will not provide an audible alarm even if the counting rate exceeds the alarm point. The audible alarm is only active in the Ratemeter Mode when the bar graph is displayed (regardless of whether the bar graph is on scale or not).

4. Over Range Indication

When the detector pulse rate exceeds the capability of the ESP-1 to maintain a linear relationship between radiation level and displayed reading, the words "OVER RANGE" will appear on the display in place of the analog bar graph. Numerical value will still be displayed but SHOULD NOT BE RELIED UPON as the useful range of the ESP-1 and detector has been exceeded. This is a latching condition and once it occurs the words "OVER RANGE" will be displayed in all three modes of operation. To clear the condition, the ESP-1 must be turned off and then back on. The over range determination is based upon the detector pulse rate and the dead time (see Section II.E.4.). This feature REQUIRES that the ESP-1 and detector be properly calibrated for it to function correctly.

D. OPERATION IN SCALER MODE

Start with the instrument in the RATEMETER MODE. Press the MODE switch. The display should read:

Scaler Mode + = USE/- = NO

If the display does not indicate the above, the Scaler Mode has been disabled by an internal switch. To enable access to this mode, first open the door in the side of the instrument and locate the switch in the lower left corner marked "scaler". Refer to Figure 3.1. Move this switch to the enable position by sliding it to the left.

If the "+" key is pressed, the scaler function will be selected. If the "-" switch is pressed, the instrument will again be placed in the Inquiry/Calibration mode provided it has not been disabled by the internal switch. Press the "+" key. The display will read:

UNITS = EVENTS + = USE/- = NO

or

UNITS = (UNITS SELECTED) + = USE/- = NO

Units are either events or the selected ratemeter units (e.g., mR, REM, CNT). To select units, press "-" until the desired unit is displayed. Then press "+" to accept the unit displayed. The units selected will utilize the same calibration constant as was used in the Ratemeter Mode. The display will change to:

UNITS = (AS SELECTED) ALM AT (ALARM SETTING)

The alarm indicated here is not the ratemeter alarm, but is one that sounds if the set value of total (integrated) events or selected units is exceeded. Pressing RESET and "+" or "-" simultaneously will increase or decrease the total at which the alarm sounds. Press "+". The display will read:

```
UNITS = (AS SELECTED)
CNT FOR (COUNT PERIOD)
```

The count period can be set by the operator for any interval from 1 second to 4 hours. Pressing RESET and "+" or "-" simultaneously will increase or decrease the length of the counting period.

To obtain a total count over a set count period, press "+". The display will read:

```
CNT FOR (X:XX:XX)(h:m:s)
   "RESET" TO START
```

Press RESET. After one second, the display will read:

```
(X:XX:XX) LEFT (h:m:s)
(TOTAL COUNT SO FAR)
```

When the count period has expired, the display will read:

```
CNT FOR (X:XX:XX)
  (TOTAL COUNT)
```

For another total count, pressing RESET erases the previous count and starts a new counting interval. During the count period, the audio alarm will sound if the alarm limit is exceeded.

When operations or settings in the Scaler Mode have been completed, pressing MODE twice will shift the ESP-1 to the Ratemeter Mode. The display will read:

```
1111 (BAR GRAPH)
RATEMETER READING
```

E. OPERATION IN INQUIRY/CALIBRATION MODE:

1. Selecting of Inquiry/Calibration Mode and Setting the Alarm

After turning on the instrument it will be in the Ratemeter Mode. Press the Mode key and the display will read:

SCALER MODE + = USE/- = NO

or

ALM AT (ALARM SETTING RATEMETER READING

If the SCALER MODE prompt is displayed (the first possibility shown above) then press the "-" key to enter the Inquiry/Calibration Mode and obtain the ALM AT display (the second possible display shown above). Pressing the "+" key will place the instrument in the Scaler Mode; refer to Section II.D.

The first entry in this mode is the alarm point viewing and setting. Refer to Section II.C.3. where directions for this procedure have already been given in the discussion on the Ratemeter Mode. When the desired value of ALM AT is displayed, press the "+" key.

2. Changing Units

a. When the "+" key is pressed above (Step 1), the display should show:

UNITS = (UNITS SELECTED) RATEMETER READING

If the display does not indicate the above, the Inquiry/Calibration Mode has been disabled by an internal switch. To enable access to this mode, first open the door in the side of the instrument and locate the switch in the lower left corner marked "Inquiry/Calibration". Refer to Figure 3.1. Move this switch to the enable position by sliding it to the left. This will permit adjusting of all the parameters that can be changed from the keypad on the top of the instrument. Likewise, after all the parameters have been adjusted, placing the switch in the disable position will prevent changing of the parameters from the top of the instrument.

b. If the units currently displayed are acceptable, the next step (c.) may be bypassed by pressing "+".

c. If units other than those displayed are desired, press "RESET". The options for selection are the "BASE" unit, the "SUFFIX" on the unit, and the "PREFIX" on the unit. The first display will be the selection of "BASE" unit as follows:

BASE (UNIT) + = USE/- = NO

The choices available for base radiation units are: the selection of the BASE units is now possible.

R	Roentgen
cnt	counts
Gy	Gray
Sv	Sieverts
REM	roentgen equivalent man
dis	disintegrations
rad	rad

Notice that the base unit is what is displayed; thus, if mR/hr is desired on the display, select "R" as the base unit. The prefix (milli) and the suffix (hr) will be added in the next steps.

In each case, press "-" to reject the displayed parameter, and another selection will be offered. When the display shows the desired base unit, press "+" to accept it.

CAUTION: Selection of a new base unit requires an appropriate change in the calibration constant (CC). Refer to Section II.E.3. Changing the prefix or suffix DOES NOT affect calibration and so requires no change in the calibration constant.

Selection of Suffix:

After the "+" is pressed above to accept the base unit, the display will then present the selection of "SUFFIX" as follows:

SUFFIX (UNIT TIME) + = USE/- = NO

The suffix is the unit of time used to calculate the displayed ratemeter reading. Three are available:

s	second
min	minute
h	hour

Again, press the "-" switch to reject the suffix displayed and call the next choice to be displayed. When the desired suffix is displayed, press "+" to accept it.

Selection of "PREFIX":

After the "+" is pressed above to accept the suffix, the display will then present the selection of "PREFIX" as follows:

PREFIX (VALUE) + = USE/- = NO

The prefix is the value by which the base unit is multiplied to provide a more convenient unit of actual measurement. Four are available:

(NONE)	no prefix
u	micro (x 10^{-6})
m	milli (x 10^{-3})
k	kilo (x 10^{+3})

If the prefix displayed is not the desired value, then press "-" to reject it and call the next choice to be displayed. When the desired prefix is displayed, press "+" to select it. The setting of radiation units to be measured would now be complete. An example of this would be:

PREFIX	BASE		SUFFIX
m	R	/	h
(milli)	(Roentgen)	/	(hour)

The units may be selected in any combination of prefix/base/suffix. Press the "+" switch to select the prefix.

3. Setting the Calibration Constant (CC)

a. Definition of Calibration Constant:

The calibration constant (CC) is the number used to convert the counts from the detector to the previously displayed base unit. Specifically, the displayed ratemeter reading is derived by dividing the counts per seconds (from the detector) by CC and then scaling the result based on the selected prefix and suffix.

b. Display of Calibration Constant (CC) Setting:

If the current value for the units was accepted by pressing "+" (step 2 above), the display will read:

CC = (NUMERICAL VALUE) RATEMETER READING

c. Selection of Calibration Constant (CC) for Detectors Which Were Purchased with the ESP-1 From the Factory:

If a detector was purchased with the ESP-1 from the factory, the calibration constant will already be set at the factory for this detector, and the following section may be bypassed until a different type of detector is to be used with the instrument or until time for routine re-calibration of the instrument.

The calibration constant will have to be changed when switching detectors. When changing back from another detector to the detector which was purchased with the ESP-1, use the calibration constant which is given on the calibration sheet supplied with the combined ESP-1 and detector. Change values by pressing simultaneously either "RESET" and "+" or "RESET" and "-".

d. Selection of Calibration Constant for Various Detectors:

1) If the detector was not purchased with the ESP-1 and, thus, a calibration sheet is not available, use the nominal value for the particular Eberline detector which is given in Section V, MAINTENANCE, Table 1.

2) To increase the value of CC, press "RESET" and "+" simultaneously. To decrease the value of CC, press "RESET" and "-" simultaneously.

3) To calculate a calibration constant for detectors other than those listed in the table, the sensitivity of the detector must be known and is usually found in the list of specifications given on the catalog sheet. Calculation using a HP-270 detector as an example are given as follows:

EXAMPLE: HP-270 detector, sensitivity = 1200 c/min/mR/hr.

$$\text{Calibration Constant} = \frac{1200\ \text{c/min}}{\text{mR/hr}} \times 1000\ \text{mR/R} \times 60\ \text{m/hr} = 7.2\times10^{7}\ \text{c/R}$$

4. Setting the Dead Time (DT)

a. Definition:

The dead time correction constant is a derived number used to correct for counting losses due to inability of the detector to recover at high counting rates. This correction results in a more linear response to the radiation field being measured and extends the useful range of some detectors used with the ESP-1 by a factor of as much as ten times (which provides the equivalent of an extra range on a standard ratemeter).

b. Selection of DT for Detectors Which Were Purchased from the Factory with the Instrument:

If the ESP-1 was purchased with a detector from the factory, the DT value will be correctly set at the factory and the next section may be bypassed until it is necessary to use a different detector or until time for routine calibration.

When changing back from another detector to the detector purchased with the ESP-1, use the DT given on the calibration sheet supplied with the combined ESP-1 and detector.

c. Selection of DT for Various Detectors:

1) If the detector was not purchased with the ESP-1 and, thus, a combined calibration data sheet is not available, use the nominal value for the particular detector which is given in Section V, MAINTENANCE, Table 1.

2) To increase the value of DT, simultaneously press "RESET" and "+". To decrease the value of DT, simultaneously press "RESET" and "-".

3) For a detailed discussion of DT consult Section V, MAINTENANCE, A. Calibration,

CAUTION: If you do change detectors, the calibration constant (CC) and the dead time (DT) must be changed. Use the procedures just described in Section II. E. Steps 3 and 4.

5. Setting the High Voltage for the Detector of Choice

CAUTION: Do not press any of the keys! The high voltage is not changed from the top of the instrument. Proceed as follows:

a. Selection of High Voltage for Detectors which were Purchased from the Factory with the Instrument:

If a detector was purchased from the factory with the instrument, the operating high voltage will already be set at the factory for this detector, and the following section may be bypassed until a different type of detector is to be used with the instrument.

b. Selection of High Voltage for Various Detectors:

1) If the calibration data sheet supplied with the detector is available, use the recommended operating high voltage which is given there.

2) If the calibration sheet supplied with the detector is not available, use the following general recommendations:

a) Geiger-type detectors (HP-190, HP-260, HP-270): use 900 volts (exception: HP-290 requires 500 volts).

b) Scintillation detectors: determine the plateau response of the detector according to the procedure described Section V.3c and Figure 5-1, and select as the operating voltage a value which is 75 volts above the beginning of the plateau.

c. Procedure for Determining the Present Setting for the High Voltage as Viewed on the Display:

After the desired value for DT was selected above, press "+". The display will then show the present value for the high voltage setting and will look like this:

HV = (NUMERICAL VALUE) RATEMETER READING

If this value is not the recommended high voltage for the detector which you plan to use with the instrument, change the value using the directions given in the next step (d).

CAUTION: Do not attempt to adjust the high voltage using the keys on top of the instrument. See CAUTION in Step d. (following).

d. Changing the High Voltage:

1) Disconnect the detector from the instrument by rotating the MHV connector counterclockwise and then open the door on the side of the instrument.

2) Refer to Figure 3-1. Using a small screwdriver, adjust the potentiometer marked "HV" (the third potentiometer from the right) until the value seen on the display is the value desired for the operating high voltage.

CAUTION: Caution Regarding Changing High Voltage when Changing Types of Detectors.

The operating high voltage must be changed when switching to a different type of detector, such as switching from a Geiger-Mueller (G.M. or ionization) type of detector (HP-210, HP-260, HP-190, HP-270, HP-290) to a scintillation type detector (LEG-1, SPA-3, SPA-6, etc.) or to the neutron detector (NRD-1). To accomplish this, remember that HIGH VOLTAGE CAN ONLY BE CHANGED WITH A SCREWDRIVER AT THE SIDE OF THE INSTRUMENT (inside the compartment at the right side) by adjusting the correct potentiometer (Figure 2.3) and viewing the values on the display until the decided voltage is reached. DO NOT ATTEMPT TO CHANGE THE VALUES SHOWN ON THE DISPLAY FOR "HV" BY PRESSING "RESET" AND "+" OR "-". This latter maneuver changes the calibration of the display itself, it does NOT change the high voltage. If this occurs, the meter will have to be recalibrated by returning the instrument to the factory or recalibrated by a competent electronic technician. If it is not recalibrated, then it is possible to operate the detector at the wrong high voltage and not realize it. This may result in damage to the detector or may result in erroneous values being presented on the display of the ESP-1.

Make sure that you have lowered the high voltage when changing from a scintillation detector to a Geiger type detector, which requires lower high voltage, BEFORE you attach the detector to the ESP-1. This will protect your Geiger detectors from accidental exposure to voltage which is too high for the tube.

3) The detector of choice may now be attached to the ESP-1 since there is now assurance that the correct high voltage will be applied by the instrument to the detector.

The next sequence on the display (after the "HV" display) goes back to the beginning of the sequence, which is the "ALM AT" parameter. Return to the Ratemeter Mode by pressing the MODE key.

F. SIMPLE TROUBLESHOOTING

Although detailed troubleshooting will be given in Section V, two simple suggestions for troubleshooting will be given here.

1. Condition: Blinking character or letter on the display.

If the character in the upper left hand corner of the display is blinking, the batteries are low and need replacing.

Remove the large screw in the bottom of the case, and carefully remove the case bottom while being careful not to disconnect the grounding wire which is connected to the bottom of the case. Replace the batteries while being careful to orient the batteries according to the diagram printed on the bottom surface of the compartment which holds the batteries; see Figure 5.2.

2. Condition: Display prints erratic numbers or figures ("garbage").

If the display shows characters or letters which are not a part of the usual display mode (displays "garbage"), the program in the microprocessor has lost its initialization (has become "scrambled"). To correct this condition and reinitialize the microprocessor, perform <u>one</u> of the following procedures:

a. Take the batteries out of the instrument and wait about 20 minutes. This will give adequate time for a capacitor (C1) to discharge, and allow the microprocessor to reinitialize itself when the batteries are replaced and the instrument turned on.

b. <u>Or</u>, if you cannot wait 20 minutes after removing the batteries, perform the following steps:

1) Remove the side door to the instrument.

2) Refer to Figure 3-1. While examining inside the instrument, locate capacitor C1. This capacitor is located on the top electronic board (in the top half of the area which is visible after the side door is removed), it is round in shape and is 5/8" in height and 5/8" in diameter, and it is usually green or gray in color.

3) Discharge this capacitor by touching the end of a small screwdriver across the two leads (wires at the bottom) of the capicator. A small discharge noise may be heard.

c. Replace the batteries in the instrument while being careful to orient them according to the diagram printed on the bottom surface of the compartment which holds the batteries.

d. Turn on the instrument and determine if the condition is corrected; that is, that the display presents letters and numbers which are a part of the usual display modes and are "reasonable".

e. If the display is still not functioning correctly, you may wish to consult detailed troubleshooting in Section V or return your instrument to the factory for repair.

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RADIOLOGICAL CONTROL PROCEDURE 14

Controlled Copy Number _____

MEASURING SURFACE CONTAMINATION WITH ALPHA & BETA/GAMMA SURVEY INSTRUMENTS

1.0 PURPOSE

To provide a set of guidelines to personnel for measuring surface contamination using alpha and beta gamma survey instruments.

2.0 SCOPE

Proper use of survey equipment ensures the quality of the survey and the data acquired.

3.0 RESPONSIBILITIES

3.1 It shall be the responsibility of Health Physics personnel to ensure that all surveys are conducted to the standards of this procedure.

4.0 PROCEDURES

4.1 Instrumentation

4.1.1 Pancake G-M Detectors

1) Slowly scan a surface with the probe held within one-half inch of the surface. The detector should be moved at a rate no greater than 1-2 inches per second.

2) If the survey meter reads above background levels, hold the probe stationary at that position until the meter levels off. Record results.

Approved: David A. Cooley Effective: 6/26/91
Health Physics Director

3) For background radiation levels above 300cpm, relocate the object being surveyed to an area of lower background radiation levels, if possible.

4.1.2 Gamma Scintallation Detectors

1) Areas to be surveyed shall be gridded into sections. Grid sizes shall be determined by the Health Physicist.

2) Place the probe at the midpoint of the grid, 3 inches from survey surface.

3) Move the probe slowly to either side of the grid midpoint, covering a distance of half the grid with each side movement. Note: Speed of probe for surveys depends on the response rate of the monitoring instrument.

4) Upon completion of pass (one full width), move forward eight inches and repeat step 3.

5) Repeat steps 3 and 4 until full grid has been scanned.

6) Record results.

4.1.3 Alpha Scintillation Detectors

1) Place probe 1/4" from survey surface.

2) Hold in position for several seconds.

3) Listen for audible clicks and observe meter indication above background.

4) Continue survey.

5) Record results.

4.2 Monitoring Fixed Contamination

4.2.1 Alpha and Beta-Gamma Detection

1) Monitor fixed contamination with end window gamma probes for beta-gamma contamination or scintillation probes for alpha contamination.

2) Survey areas according to Sections 4.1.1, 4.1.2 and 4.1.3 of this procedure.

3) Use earphones or speaker to facilitate locating contamination.

4) Establish the location and extent of the fixed contamination, the type of radiation involved, radionuclides involved, and amount of contamination deposited.

4.3 Monitoring Loose Contamination

4.3.1 Alpha and Beta-Gamma Contamination

1) Wipe 100cm^2 (approx. 4"x4") of the surface being monitored with a dry piece of swipe material.

2) If item is less than 100cm^2, wipe its entire surface.

3) Dry swipes shall be used to measure loose surface contamination.

4) Wet wipes are permitted when surface contamination is suspected which is not detectable using dry wipes.

5) Dry the wet wipes prior to counting for alpha activity.

4.3.2 Beta-Gamma Swipe Counting

1) Count swipes for beta-gamma activity using a pancake G-M probe or instrument of equivalent sensitivity.

2) Hold swipe approximately 1/2" from probe and count until a stabilized meter reading is obtained. Alternatively, use a scaler with a combination GM detector/sample drawer to give reproducible geometry.

3) A reading above background indicates possible loose contamination. Background count rate should be $\leq$ 300 cpm.

4.3.3 Alpha Swipe Counting

1) Count for alpha activity on alpha scintillation detectors or other equivalent counting equipment.

2) Place swipe 1/4" from probe.

3) Count until a stabilized meter reading is obtained.

4) A swipe which produces a meter indication above background indicates loose surface contamination.

5.0 DEFINITIONS

None

6.0 REFERENCES

Knolls Atomic Power Lab Spec. S-15

7.0 ATTACHMENTS

None

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RADIOLOGICAL CONTROL PROCEDURE 27

Controlled Copy Number ____

OPERATION OF THE LUDLUM 2220

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1.0 PURPOSE

To establish standardized operating techniques for the Ludlum 2220

2.0 SCOPE

The Ludlum 2220 is a portable scaler/ratemeter designed for operation with scintillation, proportional or G-M detectors. It is powered by four "D" cell batteries which have a life span of approximately 20 hours. A single channel analyzer is featured for use in gamma spectrum analysis and potentiometers are supplied for threshold, window and high voltage controls. The following procedure provides qualified personnel with the basic guide for using the Ludlum 2220, insures operability of the instrument and standardizes operating techniques.

3.0 RESPONSIBILITIES

It is the responsibility of personnel using the instrument to understand and follow all operating procedures. Variance from these procedures could result in nullification of results.

4.0 PROCEDURE

4.1 Operability check for the Ludlum 2220 must be completed prior to use.

(1) Check instrument calibration date which shall be located on the main housing of the instrument.

(2) Check for physical damage.

(3) Scan the daily instrument check sheet (RCP-9 Attachment 1) - Information on the sheet may point to possible problems. Efficiencies should not vary more than ± 5%.

(4) Turn range switch to "LOG" position - meter should peg high and then return to < 50 on log scale. LCD readout should turn on.

(5) Press BAT button to display battery voltage in 1/100 volts (0595 = 5.95 volts). Four "D" cell 1.5 volt batteries should be near 6.00 volts when new. Readings slightly higher than 0600 are not uncommon for newer batteries. Minimum battery test voltage is 4.2 volts (0420) and batteries should be changed prior to reading < 4.2 volts.

(6) Press HV button, THRESH button and WINDOW button one at a time and ensure readings agree with those specified on probe attached to 2220. NOTE: WINDOW IN/OUT toggle switch must be in the IN position for proper WINDOW reading.

(7) Press COUNT button. LCD display should zero and two colons should appear on screen indicating instrument is being used in scaler mode. Meter reading will still provide readout in total counts/minute. When colons disappear, count is complete. Pressing HOLD button automatically terminates count and colons should disappear. To set count time, a 4-position COUNT TIME MINUTES switch has four settings of 0.1, 0.5, 1.0 (minutes) and CONT (continuous) for manual timing.

4.2. Source Check

The Ludlum 2220 shall be source checked daily when in use.

(1) Expose probe to appropriate source.

(2) Perform two 1.0 minute counts and take average. Subtract background and determine efficiency via
the formula cpm/dpm x 100 = % eff. Record on INSTRUMENT SOURCE CHECK form (RCP 9, Attachment 1).

5.0 DETECTORS THAT ARE COMPATIBLE WITH LUDLUM 2220 AND THEIR OPERATION

5.1 Ludlum 43-5

The Ludlum 43-5 is a rugged scintillation-type alpha detector designed to work with several of Ludlum's portable survey instruments including the 2220.

5.2 Ludlum 44-9

The Ludlum 44-9 G-M (Pancake) Detector is capable of detecting Alpha, Beta or Gamma radiation. The detector is energy dependent, over responding by a factor of six in the 60 keV to 100 keV range when normalized to Cs-137. The 44-9 will operate with any of the Ludlum instruments or equivalent instruments that provide 900 volts and an input sensitivity of approximately 30 mV and above.

5.3 Ludlum 44-40

The Ludlum 44-40 is a lead shielded G-M detector capable of detecting Alpha, Beta or Gamma radiation. The lead shield attenuates the background and unwanted radiations, which allow for greater sensitivity in counting wipes, filters or slides. The 44-40 will operate with any of the Ludlum instruments or equivalent instruments that provide 900 V and an input sensitivity of approximately 30 mV or higher.

5.4 Operating Procedure

(1) Check operability/integrity of detector and probe using procedure in Section 4.1.

(2) Obtain a background reading. If background is not close to zero (i.e., < 5 cpm), check for a light leak in mylar by pointing at the sun or a bright light. If a light leak exists, repair using black lacquer and reperform daily efficiency check.

(3) At a slow and steady rate, survey the area keeping detector at an equal (but close) distance to surface being monitored. If the 2220 displays contamination levels above background, keep detector in that area until a peak reading is obtained and record results on the appropriate survey form.

(4) Monitoring techniques will depend greatly on the situation at hand. The operator should hold the detector within 1/4 inch of the surface being checked. Holding it on contact with surface being monitored is the most effective method, but this runs the risk of puncturing or contaminating the probe face.

CAUTION:

The face of the 43-5, 44-9 and the 44-40 is extremely thin and easily punctured. Never set the detector on a sharp object and always keep protective cover on when not in use.

5.5 Eberline PG-2

The PG-2 is a large area, rugged scintillation detector with a thin window for application in the detection of low energy gamma or x-ray radiation. Typical applications include monitoring for Pu-239 (17 keV), monitoring for Am-241 (60 keV), checking color TV sets for x-ray emission, checking for leakage from x-ray machines.

5.5.1 Operating Procedure

(1) Check operability of detector and probe using the procedure in Section 4.1.

(2) Obtain a background reading.

(3) Place probe near surface of area to survey (within approximately 2"). Note: Do not touch the probe to the survey surface.

(4) At a slow but steady rate, survey the area. Keep probe at an equal distance from the surface.

(5) If the 2220 displays radiation levels above background, keep the probe in that area until a peak reading can be obtained and record the results.

6.0 DEFINITIONS

None

7.0 REFERENCES

7.1 Ludlum 2220 Technical Manual
7.2 Ludlum 43-5 Technical Manual
7.3 Ludlum 44-9 Technical Manual
7.4 Ludlum 44-40 Technical Manual
7.5 Eberline PG 2 Technical Manual
7.6 M.J.W. Procedure RCP-9, Calibration and Operability Checks of Radiological Instuments

8.0 ATTACHMENTS

None

APPENDIX I

ILLINOIS ADMINISTRATIVE CODE
TITLE 32, PART 341
TRANSPORTATION OF RADIOACTIVE MATERIAL

TITLE 32: ENERGY
CHAPTER II: DEPARTMENT OF NUCLEAR SAFETY
SUBCHAPTER b: RADIATION PROTECTION

PART 341
TRANSPORTATION OF RADIOACTIVE MATERIAL

Section
341.10 Purpose and Scope
341.20 Definitions
341.30 Requirement for License
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341.50 Transportation of Licensed Material
341.60 General Licenses for Carriers
341.70 General License: Approved Packages
341.80 Previously Approved Type B Packages
341.90 General License: DOT Specification Container
341.100 General License: Use of Foreign Approved Package
341.110 General License: Type A, Fissile Class II Packages
341.120 General License: Restricted, Fissile Class II Package
341.130 Fissile Material: Assumptions as to Unknown Properties
341.140 Preliminary Determinations
341.150 Routine Determinations
341.160 Air Transport of Plutonium
341.170 Records
341.180 Reports
341.190 Advance Notification of Transport of Nuclear Waste
341.200 Quality Assurance Requirements

APPENDIX A DETERMINATION OF A_1 AND A_2
TABLE A A_1 and A_2 VALUES FOR RADIONUCLIDES
TABLE B RELATIONSHIP BETWEEN A_1 AND E_{max} FOR BETA EMITTERS
TABLE C RELATIONSHIP BETWEEN A_3 AND THE ATOMIC NUMBER OF THE RADIONUCLIDE
TABLE D ACTIVITY-MASS RELATIONSHIPS FOR URANIUM/THORIUM

AUTHORITY: Implementing and authorized by the Radiation Protection Act (Ill. Rev. Stat. 1986 Supp., ch. 111½, pars. 211 et seq.), and Section 9 of the Illinois Low-Level Radioactive Waste Management Act (Ill. Rev. Stat. 1986 Supp., ch. 111½, par. 241-9), and by Section 71 of The Civil Administrative Code of Illinois (Ill. Rev. Stat. 1986 Supp., ch. 127, par. 63b17G).

SOURCE: Adopted at 10 Ill. Reg. 17616, effective September 25, 1986; amended at 11 Ill. Reg. 5219, effective March 13, 1987; amended at 12 Ill. Reg. 2434, effective January 15, 1988.

Section 341.10 Purpose and Scope

The regulations in this Part establish requirements for packaging, preparation for shipment, and transportation of radioactive material and apply to any person who transports radioactive material or delivers radioactive material to a carrier for transport.

Section 341.20 Definitions

As used in this Part, the following definitions apply:

"$A_{(1)}$" means the maximum activity of special form radioactive material permitted in a Type A package.

"$A_{(2)}$" means the maximum activity of radioactive material, other than special form radioactive material, permitted in a Type A package.

AGENCY NOTE: These values are either listed in Appendix A, Table A, or may be derived in accordance with the procedure prescribed in Appendix A of this Part.

"Carrier" means a person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

"Exclusive use" (also referred to in regulations of the U.S. Department of Transportation as "sole use" or "full load") means the sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee.

"Fissile material" means any special nuclear material* consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233, and uranium-235. Neither natural nor depleted uranium is fissile material.

*AGENCY NOTE: Department of Nuclear Safety (Department) jurisdiction extends to special nuclear material only if quantities are not sufficient to form a critical mass as defined in 32 Ill. Adm. Code 310.

Fissile Class I: A package which may be transported in unlimited numbers and in any arrangement, and which requires no nuclear criticality safety controls during transportation.

Fissile Class II: A package which may be transported together with other packages in any arrangement but, for criticality control, in numbers which do not exceed an aggregate transport index* of 50. These shipments require no other nuclear criticality safety control during transportation. Individual packages may have a transport index not less than 0.1 and not more than 10.

*AGENCY NOTE: A transport index is not assigned for purposes of nuclear criticality safety but may be required because of external radiation levels.

"Low specific activity material" means any of the following:

Uranium or thorium ores and physical or chemical concentrates of those ores;

Unirradiated natural or depleted uranium or unirradiated natural thorium;

Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries (185 MBq) per milliliter;

Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration per gram of contents does not exceed:

0.0001 millicurie (3.7 kBq) of radionuclides for which the A_2 quantity in Appendix A of this Part is not more than 0.05 curie (1.85 GBq);

0.005 millicurie (185 kBq) of radionuclides for which the A_2 quantity in Appendix A of this Part is more than 0.05 curie (1.85 GBq), but not more than 1 curie (37 GBq); or

0.3 millicurie (11.1 MBq) of radionuclides for which the A_2 quantity in Appendix A of this Part is more than 1 curie (37 GBq).

Objects of non-radioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 transformations per minute) (3.7 kBq) per square centimeter of radionuclides for which the A_2 quantity in Appendix A of this Part is not more than 0.05 curie (1.85 GBq), or 0.001 millicurie (2,200,000 disintegrations per minute) (37 kBq) per square centimeter for other radionuclides.

"Normal form radioactive material" means radioactive material which has not been demonstrated to qualify as "special form radioactive material."

"Package" means the packaging together with its radioactive contents as presented for transport.

"Packaging" means the assembly of components necessary to ensure compliance with the packaging requirements of this Part. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie down system, and auxiliary equipment may be designated as part of the packaging.

"Regulations of the U.S. Department of Transportation (U.S. DOT)" means the regulations in 49 CFR 100-189, revised as of October 1, 1986, exclusive of subsequent amendments or editions. A copy of 49 CFR 100-189 is available for public inspection at the Department of Nuclear Safety.

"Special form radioactive material" means radioactive material which satisfies the following conditions:

It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;

The piece or capsule has at least one dimension not less than 5 millimeters (0.197 inch); and

All special form radioactive material must meet the requirements of the U.S. Nuclear Regulatory Commission (NRC) regulations 10 CFR 71.75 and 71.77, revised as of January 1, 1987, exclusive of subsequent amendments or editions, except that special form radioactive material designed or constructed prior to July 1, 1985 need only meet the requirements of 10 CFR 71.75 and 71.77 in effect on June 30, 1983. A copy of 10 CFR 71 is available for public inspection at the Department of Nuclear Safety.

"Specific activity" of a radionuclide means the radioactivity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

"Transport index" means the dimensionless number (rounded up to the decimal place) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is the number expressing the maximum radiation level in millirem per hour at 1 meter from the external surface of the package.

"Type A quantity" means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for normal form radioactive material, where A_1 and A_2 are given in Appendix A of this Part or may be determined by procedures described in Appendix A of this Part.

"Type B package" means a Type B packaging together with its radioactive contents. A Type B package design is designated as B(U) or B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multilateral approval. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in 49 CFR 173. A Type B package approved prior to September 6, 1983, was designated only as Type B. Limitations on its use are specified in Section 341.80.

"Type B packaging" means a packaging designed to retain the integrity of containment and shielding required by U.S. NRC regulations when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR 71, revised as of January 1, 1987, exclusive of subsequent amendments or editions. A copy of 10 CFR 71 is available for public inspection at the Department of Nuclear Safety.

"Type B quantity" means a quantity of radioactive material greater than a Type A quantity.

(Source: Amended at 12 Ill. Reg. 2434, effective January 15, 1988)

Section 341.30 Requirement for License

No person shall transport radioactive material or deliver radioactive material to a carrier for transport except as authorized in a general or specific license issued by the Department or as exempted in Section 341.40.

Section 341.40 Exemptions

a) Common and contract carriers, freight forwarders, and warehousemen who are subject to the requirements of the U.S. DOT in 49 CFR 170 through 189 or the U.S. Postal Service in the Postal Service Manual (Domestic Mail Manual), Section 124.3 incorporated by reference, 39 CFR 111.1 (1984), are exempt from 32 Ill. Adm. Code 310, 320, 330, 340, 350, 400 and this Part to the extent that they transport or store radioactive material in the regular course of their carriage for another or storage incident thereto. Common and contract carriers who are not subject to the requirements of the U.S. DOT or U.S. Postal Service are subject to Section 341.30 and other applicable sections of this Part.

b) Any licensee is exempt from the requirements of this Part to the extent that the licensee delivers to a carrier for transport a package containing radioactive material having a specific activity not greater than 0.002 microcurie (74 Bq) per gram.

c) A licensee is exempt from all requirements of this Part, other than Sections 341.50 and 341.160 with respect to shipment or carriage of the following:

1) Packages containing no more than Type A quantities of radioactive material if the package contains no fissile material; or

2) Packages, transported between locations within the United States, which contain only americium or plutonium in special form with an aggregate radioactivity not to exceed 20 curies.

Section 341.50 Transportation of Licensed Material

a) No licensee may transport licensed material outside the confines of his plant or other place of use or deliver licensed material to a carrier for transport unless:

1) such transport and delivery is in compliance with the regulations of the U.S. DOT, 49 CFR revised as of October 1, 1986, exclusive of subsequent amendments or editions, and;

2) any special instructions needed to safely open the package have been made available to the consignee.

b) If, for any reason, the regulations of the U.S. DOT are not applicable to a shipment of licensed material, the licensee shall conform to the standards and requirements of those regulations to the same extent as if the shipment were subject to the regulations.

(Source: Amended at 12 Ill. Reg. 2434, effective January 15, 1988)

Section 341.60 General Licenses for Carriers

a) A general license is hereby issued to any common or contract carrier not exempt under Section 341.40 to receive, possess, transport, and store radioactive material in the regular course of its carriage for another or storage incident thereto, provided the transportation and storage is in accordance with U.S. DOT regulations (49 CFR 171 through 178, revised as of November 1, 1984, exclusive of subsequent amendments or editions), insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting.* Copies of 49 CFR 171 through 178 are available for inspection at the Department of Nuclear Safety.

b) A general license is hereby issued to any private carrier to transport radioactive material, provided the transportation is in accordance with U.S. DOT regulations (49 CFR 171 through 178, revised as of November 1, 1984, exclusive of subsequent amendments or editions), insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting.* Copies of 49 CFR 171 through 178 are available for inspection at the Department of Nuclear Safety,

*AGENCY NOTE: Any notification of incidents referred to in those U.S. DOT requirements shall be filed with, or made to, the Department.

c) Persons who transport radioactive material pursuant to the general licenses in Section 341.60(a) or 341.60(b) are exempt from the requirements of 32 Ill. Adm. Code 340 and 400 to the extent that they transport radioactive material.

Section 341.70 General License: Approved Packages

a) A general license is hereby issued to any licensee of the Department to transport, or to deliver to a carrier for transport, licensed material in a package for which a license, certificate of compliance, or other approval has been issued by the U.S. Nuclear Regulatory Commission.

b) This general license applies only to a licensee who:

1) Has a copy of the specific license, certificate of compliance, or other approval of the package, and has the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment;

2) Complies with the terms and conditions of the license, certificate, or other approval, as applicable, and the applicable requirements of Subsections 341.70(a), (b)(1), (b)(3), (b)(4), (c), (d) and Sections 341.50, 341.140, 341.150, 341.170, 341.180, 341.190 and 341.200;

3) Prior to the licensee's first use of the package, has registered with the U.S. Nuclear Regulatory Commission; and

4) Has a quality assurance program as required by Section 341.200 approved by the Department.

c) The general license in Subparagraph (a) applies only when the package approval authorizes use of the package under this general license.

d) For previously approved Type B packages which are not designated as either B(U) or B(M) in the NRC Certificate of Compliance, this general license is subject to additional restrictions of Section 341.80.

Section 341.80 Previously Approved Type B Packages

A Type B package previously approved by the NRC, but not designated as B(U) or B(M) in the NRC Certificate of Compliance, may be used under the general license of Section 341.70 with the following additional limitations:

a) Fabrication of the packaging was satisfactorily completed before August 31, 1986, as demonstrated by application of its model number in accordance with U.S. NRC regulations 10 CFR 71, Subparts E, F, G, and H, revised as of January 1, 1985, exclusive of subsequent amendments or editions. A copy of 10 CFR 71 is available for public inspection at the Department of Nuclear Safety; and

b) The package may not be used for a shipment to a location outside the United States after August 31, 1986, except under special arrangement approved by the U.S. DOT in accordance with 49 CFR 173.471, revised as of November 1, 1984, exclusive of subsequent amendments or editions. A copy of 49 CFR 173 is available for public inspection at the Department of Nuclear Safety.

Section 341.90 General License: DOT Specification Container

a) A general license is issued to any licensee of the Department to transport or to deliver to a carrier for transport licensed material in a specification container for a Type B quantity of radioactive material as specified in the regulations of the U.S. DOT in 49 CFR 173 and 178, revised as of November 1, 1984, exclusive of subsequent amendments or editions. Copies of 49 CFR 173 and 178 are available for public inspection at the Department of Nuclear Safety.

b) This general license applies only to a licensee who has a quality assurance program approved by the Department as satisfying the provisions of Section 341.200.

c) This general license applies only to a licensee who:

1) Has a copy of the specifications in accordance with 49 CFR 178; and

2) Complies with the terms and conditions of the specifications in accordance with 49 CFR 178 and the requirements of this Part.

d) The general license in subsection (a) is subject to the limitation that the specification container may not be used for a shipment to a location outside the United States after August 31, 1986, except under special arrangements approved by U.S. DOT in accordance with 49 CFR 173.472, revised as of November 1, 1984, exclusive of subsequent amendments or editions. A copy of 49 CFR 173 is available for public inspection at the Department of Nuclear Safety.

Section 341.100 General License: Use of Foreign Approved Package

a) A general license is issued to any licensee of the Department to transport or to deliver to a carrier for transport licensed material in a package the design of which has been approved in a foreign national competent authority certificate which has been revalidated by the U.S. DOT as meeting the applicable requirements of 49 CFR 171.12, revised as of November 1, 1984, exclusive of subsequent amendments or editions.

b) This general license applies only to shipments made to or from locations outside the United States.

c) This general license applies only to a licensee who:

1) Has a copy of the certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment; and

2) Complies with the terms and conditions of the certificate and revalidation and with the requirements of this Part.

Section 341.110 General License: Type A, Fissile Class II Packages

a) A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped as a Fissile Class II package.

b) This general license applies only when a package contains no more than a Type A quantity of radioactive material, including only one of the following:

1) Up to 40 grams of uranium-235; or

2) Up to 30 grams of uranium-233; or

3) Up to 25 grams of the fissile radionuclides of plutonium, except that for encapsulated plutonium-beryllium neutron sources in special form, an A_1 quantity of plutonium may be present; or

4) A combination of fissile radionuclides in which the sum of the ratios of the amount of each radionuclide to the corresponding maximum amounts in Section 341.110(b)(1), (2), and (3) does not exceed unity.

c) This general license applies only when:

1) A package containing more than 15 grams of fissile radionuclides is labeled with a transport index not less than the number given by the following equation, where the package contains x grams of uranium-235, y grams of uranium-233, and z grams of the fissile radionuclides of plutonium:

$$\text{minimum transport index} = (0.4x + 0.67y + z)\left(1 - \frac{15}{x+y+z}\right)$$

The transport index must be rounded up to one decimal place, and may not exceed 10.0; or

2) For a package in which the only fissile material is in the form of encapsulated plutonium-beryllium neutron sources in special form, the transport index based on criticality considerations shall be taken as 0.026 times the number of grams of the fissile radionuclides of plutonium in excess of 15 grams. The transport index must be rounded up to one decimal place, and shall not exceed 10.0.

Section 341.120 General License: Restricted, Fissile Class II Package

a) A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped as a Fissile Class II package.

b) This general license applies only when:

1) The package contains no more than a Type A quantity of radioactive material; and

2) Neither beryllium nor hydrogenous material enriched in deuterium is present; and

3) The total mass of graphite present does not exceed 150 times the total mass of uranium-235 plus plutonium; and

4) Substances having a higher hydrogen density than water, e.g. certain hydrocarbon oils, are not present, except that polyethylene may be used for packing or wrapping; and

5) Uranium-233 is not present, and the amount of plutonium does not exceed 1% of the amount of uranium-235; and

6) The amount of uranium-235 is limited as follows:

A) If the fissile radionuclides are not uniformly distributed, the maximum amount of uranium-235 per package may not exceed the value given as follows:

Uranium enrichment in weight percent of uranium-235 not exceeding	Permissible maximum grams of uranium-235 per package
24	40
20	42
15	45
11	48
10	51
9.5	52
9	54
8.5	55
8	57
7.5	59
7	60
6.5	62
6	65
5.5	68
5	72
4.5	76
4	80
3.5	88
3	100

2.5	120
2	164
1.5	272
1.35	320
1	680*
0.92	1200*

*AGENCY NOTE: Pursuant to its agreement with the U.S. Nuclear Regulatory Commission, Department jurisdiction extends only to 350 grams of uranium-235.

B) If the fissile radionuclides are distributed uniformly (i.e., cannot form a lattice arrangement within the packaging) the maximum amount of uranium-235 per package may not exceed the value given as follows:

Uranium enrichment in weight percent of uranium-235 not exceeding	Permissible maximum grams of uranium-235 per package
4	84
3.5	92
3	112
2.5	148
2	240
1.5	560*
1.35	800*

*AGENCY NOTE: Pursuant to its agreement with the U.S. Nuclear Regulatory Commission, Department jurisdiction extends only to 350 grams of uranium-235.

7) The transport index of each package based on criticality considerations is taken as ten (10) times the number of grams of uranium-235 in the package divided by the maximum allowable number of grams per package in accordance with Subsection (b)(6)(A) or (b)(6)(B) above as applicable.

Section 341.130 Fissile Material: Assumptions as to Unknown Properties

When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any package is not known, the licensee shall package the fissile material as if the unknown properties have credible values that will cause the maximum nuclear reactivity.

Section 341.140 Preliminary Determinations

Prior to the first use of any packaging for the shipment of radioactive material:

a) The licensee shall ascertain that there are no defects in the packaging

which could impact on compliance with the standards specified in 10 CFR 71, Subparts (E) and (F), revised as of January 1985, exclusive of subsequent amendments or editions;

b) Where the maximum normal operating pressure will exceed 34.3 kilopascal (5 psi) gauge, the licensee shall test the containment system at an internal pressure at least 50% higher than the maximum normal operating pressure to verify the capability of that system to maintain its structural integrity at that pressure.

c) The licensee shall conspicuously and durably mark the packaging with its model number, gross weight, and a package identification number assigned by the U.S. Nuclear Regulatory Commission. Prior to applying the model number, the licensee shall determine that the packaging has been fabricated in accordance with the design approved in the certificate of compliance issued by the U.S. Nuclear Regulatory Commission.

Section 341.150 Routine Determinations

Prior to each shipment of licensed material, the licensee shall ensure that the package with its contents satisfies the requirements of this Part and of the license. The licensee shall determine that:

a) The package is proper for the contents to be shipped in accordance with 49 CFR 173.401 through 173.435;

b) The package is in unimpaired physical condition except for superficial defects such as marks or dents;

c) Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;

d) Any system for containing liquid is sealed and has space or other specified provision for expansion of the liquid in accordance with 10 CFR 71, Subpart F, revised as of January 1985, exclusive of subsequent amendments or editions;

e) Any pressure relief device is operable and set in accordance with the certificate of compliance;

f) The package has been loaded and closed in accordance with written procedures;

g) Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for that purpose unless it satisfies design requirements specified in accordance with 10 CFR 71.45, revised as of January 1985, exclusive of subsequent amendments or editions;

h) The package meets the following requirements for removable contamination:

1) The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable. The level of non-fixed radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels.* Except as provided under Section 341.150(h)(2), the amount of radioactivity measured on any single wiping material when averaged over the surface wiped, must not exceed the limits given in Subsection (h)(1) of this Part at any time during transport. Other methods of assessment of equal or greater efficiency may be used. When other methods are used, the detection efficiency of the method used must be taken into account and in no case may the non-fixed contamination on the external surfaces of the package exceed ten (10) times the limits listed as follows:

REMOVABLE EXTERNAL RADIOACTIVE
CONTAMINATION WIPE LIMITS

Contaminant	Maximum Permissible Limits	
	uCi/cm^2	dpm/cm^2
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than ten (10) days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228; and thorium-230 when contained in ores or physical concentrates.....	10^{-5}	22
All other alpha emitting radionuclides.....	10^{-6}	2.2

2) In the case of packages transported as exclusive use shipments by rail or highway only, the non-fixed radioactive contamination at any time during transport must not exceed ten (10) times the levels prescribed in Section 341.150(h)(1). The levels at the beginning of transport must not exceed the levels prescribed in Section 341.150(h)(1);

*AGENCY NOTE: One generally acceptable technique is to perform one wipe test per square meter of surface area of the package. Appropriate locations for wipes include the areas where the package might leak through sealing gaskets or a location where water might stand on the container.

i) External radiation levels around the package and around the vehicle, if applicable, will not exceed 200 millirem per hour at any point on the external surface of the package at any time during transportation. The transport index shall not exceed ten (10).

j) For a package transported as exclusive use by rail, highway, or water, radiation levels external to the package may exceed the limits specified in Subparagraph (i) but must not exceed any of the following:

1) 200 millirem/hour on the accessible external surface of the package unless the following conditions are met, in which case the limit is 1000 millirem per hour.

A) The shipment is made in a closed transport vehicle;

B) Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation; and

C) There are no loading or unloading operations between the beginning and end of the transportation;

2) 200 millirem/hour at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of the vehicle;

3) 10 millirem/hour at any point two meters from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of an open vehicle, at any point two meters from the vertical planes projected from the outer edges of the vehicle; and

4) 2 millirem/hour in any normally occupied position of the vehicle, except that this provision does not apply to private motor carriers when persons occupying these positions are provided with special health supervision, personnel radiation exposure monitoring devices, and training in accordance with 32 Ill. Adm. Code 400.

k) A package must be prepared for transport so that in still air at 100°F (38°C) and in the shade, no accessible surface of a package would have a temperature exceeding 122°F (50°C) in a nonexclusive use shipment or 180°F (82°C) in an exclusive use shipment. Accessible package surface tempera tures shall not exceed these limits at any time during transportation.

Section 341.160 Air Transport of Plutonium

Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this part or included indirectly by citation of U.S. DOT regulations, as may be applicable, the licensee shall assure that plutonium in any form is not transported by air or delivered to a carrier for air transport unless:

a) The plutonium is contained in a medical device designed for individual human application; or

b) The plutonium is contained in a material in which the specific activity is not greater than 0.002 microcuries (74 Bq) per gram of material and in which the radioactivity is essentially uniformly distributed; or

c) The plutonium is shipped in a single package containing no more than an A_2 quantity of plutonium in any isotope or form and is shipped in accordance with Section 341.50; or

d) The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the U.S. Nuclear Regulatory Commission.

Section 341.170 Records

a) Each licensee shall maintain for a period of two (2) years after shipment a record of each shipment of licensed material not exempt under Section 341.40, showing, where applicable:

1) Identification of the packaging by model number;

2) Verification that there are no defects in the packaging, as shipped which would prevent the package from meeting the standards of 10 CFR 71, Subparts E and F, revised as of January 1985, exclusive of subsequent amendments or editions;

3) Volume and identification of coolant;

4) Type and quantity of licensed material in each package, and the total quantity of each shipment;

5) Date of the shipment;

6) Name and address of the transferee;

7) Address to which the shipment was made; and

8) Results of the determinations required by Section 341.130.

b) The licensee shall make available to the Department for inspection, at any time during shipment or upon three days notice after shipment, all records required by this Part.

Section 341.180 Reports

The licensee shall report to the Department within 30 days:

a) Any instance in which a reduction in the effectiveness of any authorized packaging impacts upon compliance with 10 CFR 71, Subparts E and F, revised as of January 1985, exclusive of subsequent amendments or editions; and

b) Details of any defects in the packaging after first use impacting upon compliance with 10 CFR 71, Subparts E and F, with the means employed to repair the defects and prevent their recurrence.

Section 341.190 Advance Notification of Transport of Nuclear Waste

a) Licensees who transport radioactive waste or deliver radioactive waste to a carrier for transport outside of the confines of the licensee's facility or other place of use or storage, must provide advance notification of such transport to the governor, or governor's designee* in accordance with subsection (b). Such notification shall include the governors or governors' designees of all states through which the radioactive waste is to be transported.

*AGENCY NOTE: A list of the mailing addresses of the governors and governors' designees is available upon request from the Director, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

b) Advance notification is required only when:

1) The nuclear waste is required to be in Type B packaging for transportation;

2) The nuclear waste is being transported to, through, or across state boundaries to a disposal site or to a collection point for transport to a disposal site;

3) The quantity of licensed material in a single package exceeds:

A) 5,000 curies (185 TBq) of special form radionuclides;

B) 5,000 curies (185 TBq) of uncompressed gases of argon-41, krypton-85m, krypton-87, xenon-131m, or xenon-135;

C) 50,000 curies (1.85 PBq) of argon-37, or of uncompressed gases of krypton-85 or xenon-133, or of hydrogen-3 as a gas, as luminous paint, or adsorbed on solid material;

D) 20 curies (740 GBq) of other non-special form radionuclides for which A_2 is less than or equal to four (4) curies (148 GBq); or

E) 200 curies (7.4 TBq) of other non-special form radionuclides for which A_2 is greater than four (4) curies (148 GBq).

c) Each advance notification required by Section 341.190(a) shall contain the following information:

1) The name, address, and telephone number of the shipper, carrier, and receiver of the shipment;

2) A description of the nuclear waste contained in the shipment as required by the regulations of the U.S. DOT, 49 CFR 172.202 and 172.203(d), revised as of November 1, 1984*;

*AGENCY NOTE: Requirements contained in subsequent amendments or editions of 49 CFR 172 are not incorporated into this rule. A copy of 49 CFR 172 is available for public inspection at the Department of Nuclear Safety.

3) The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

4) The seven-day period during which arrival of the shipment at state boundaries is estimated to occur;

5) The destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

6) A point of contact, with a telephone number, for current shipment information.

d) The notification required by Section 341.190(a) shall be made in writing to the office of the Governor or Governor's designee and to the Department. A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A notification delivered by messenger must reach the office of the governor, or governor's designee, at least four (4) days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A copy of the notification shall be retained by the licensee for one (1) year.

e) The licensee shall notify the Governor, or Governor's designee, and the Department of any changes to schedule information provided pursuant to Section 341.190(a). Such notification shall be by telephone to a responsible individual in the Office of the Governor, or Governor's designee, and in the Department. The licensee shall maintain for one (1) year a record of the name of the individual contacted.

f) Each licensee who cancels a nuclear waste shipment, for which advance notification has been sent, shall send a cancellation notice to the Governor, or Governor's designee, and to the Department. A copy of the notice shall be retained by the licensee for one (1) year.

Section 341.200 Quality Assurance Requirements

a) Each person licensed pursuant to this Part shall establish, maintain, and execute a quality assurance program to verify, by procedures such as checking, auditing, and inspection, that deficiencies, deviations, and defective material and equipment relating to the shipment of packages containing radioactive materials are promptly identified and corrected. Prior to the use of any package for the shipment of radioactive material, each licensee shall obtain Department approval of its quality assurance program. Such approval shall be in accordance with the U.S. Nuclear Regulatory Commission standards contained in their Regulatory Guide on Quality Assurance, Reg. Guide #7.10, Establishing Quality Assurance Programs for Packaging used in the Transport of Radioactive Material, published January, 1983, exclusive of subsequent amendments or editions. A copy of the Regulatory Guide is available for public inspection at the Department of Nuclear Safety.

b) Each person licensed pursuant to this Part shall document the quality assurance program by written procedures or instructions and shall carry out the program in accordance with those procedures throughout the period during which packaging is used. The licensee shall identify the material and components to be covered by the quality assurance program.

c) A person licensed pursuant to this Part shall maintain sufficient written records to demonstrate compliance with the quality assurance program. Records pertaining to the use of a package for shipment of radioactive material must be retained for a period of two (2) years after shipment.

(Source: Amended at 11 Ill. Reg. 5219, effective March 13, 1987)

SECTION 341. APPENDIX A DETERMINATION OF A_1 and A_2

a) Single radionuclides.

1) For a single radionuclide of known identity, the values of A_1 and A_2 are taken from Table A-1 if listed there. The values of A_1 and A_2 in Table A-1 are also applicable for radionuclides contained in alpha neutron or gamma neutron sources.

2) For any single radionuclide whose identity is known but which is not listed in Table A-1, the values of A_1 and A_2 are determined according to the following procedure:

A) If the radionuclide emits only one type of radiation, A_1 is determined according to the rules in paragraphs (i), (ii), (iii), and (iv) of this paragraph. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in both cases, A_1 is restricted to a maximum of 1000 Ci (37 TBq). If a parent nuclide decays into a shorter-lived daughter with a half-life not greater than ten (10) days, A_1 is calculated for both the parent and the daughter, and the more limiting of the two (2) values is assigned to the parent nuclide.

i) For gamma emitters, A_1 is determined by the expression:

$$A_1 = \frac{9}{K} \text{ curies}$$

where K is the gamma-ray constant, corresponding to the dose in R/h at 1 m per Ci; the number 9 results from the choice of 1 rem/h at a distance of 3 m as the reference dose-equivalent rate.

ii) For X-ray emitters, A_1 is determined by the atomic number of the nuclide;

for Z less than or equal to 55, A_1=1000 Ci (37 TBq)

for Z greater than 55, A_1=200 Ci (7.4 TBq)

where Z is the atomic number of the nuclide.

iii) For beta emitters, A_1 is determined by the maximum beta energy (E_{max}) according to Table A-2;

iv) For alpha emitters, A_1 is determined by the expression:

$$A_1 = 1000\ A_3$$

where A_3 is the value listed in Table A-3;

B) A_2 is the more restrictive of the following two (2) values:

i) The corresponding A_1; and

ii) The value A_3 obtained from Table A-3.

3) For any single radionuclide whose identity is unknown, the value of A_1 is taken to be 2 Ci (74 GBq) and the value of A_2 is taken to be 0.002 Ci (74 MBq). However, if the atomic number of the radionuclide is known to be less than 82, the value of A_1 is taken to be 10 Ci (370 GBq) and the value of A_2 is taken to be 0.4 Ci (14.8 GBq).

b) Mixtures of radionuclides, including radioactive decay chains.

1) For mixed fission products the following activity limits may be assumed if a detailed analysis of the mixture is not carried out:

A_1 = 10 Ci (370 GBq)

A_2 = 0.4 Ci (14.8 GBq)

2) A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring proportions and no daughter nuclide has a half-life either longer than ten (10) days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value from Table A-1 to be applied are those corresponding to the parent nuclide of that chain. When calculating A_1 or A_2 values, radiation emitted by daughters must be considered. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than ten (10) days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.

3) In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide are known, the permissible activity of each radionuclide R_1, $R_2 \ldots R_n$ is such that $F_1 + F_2 + \ldots F_n$ is greater than unity, where

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_1(R_2)}$$

$$F_n = \frac{\text{Total Activity of } R_n}{A_1(R_n)}$$

$A_1(R_1, R_2 \ldots R_n)$ is the value of A_1 or A_2 as appropriate for the nuclide $R_1, R_2 \ldots R_n$.

4) When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the formula given in subparagraph (3) is applied to establish the values of A_1 or A_2 as appropriate. All the radionuclides whose individual activities are not known (their total activity will, however, be known) are classed in a single group and the most restrictive value of A_1 or A_2 applicable to any one of them is used as the value of A_1 or A_2 in the denominator of the fraction.

5) Where the identity of each radionuclide is known but the individual activity of none of the radionuclides is known, the most restrictive value of A_1 or A_2 applicable to any one of the radionuclides present is adopted as the applicable value.

6) When the identity of none of the nuclides is known, the value of A_1 is taken to be 2 Ci (74 GBq) and the value of A_2 is taken to be 0.002 Ci (74 MBq). However, if alpha emitters are known to be absent, the value of A_2 is taken to be 0.4 Ci (14.8 GBq).

(Source: Amended at 12 Ill. Reg. 2434, effective January 15, 1988)

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SECTION 341. TABLE A

A_1 and A_2 VALUES FOR RADIONUCLIDES

(See Agency Notes At End Of Table)

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{227}Ac	Actinium (89)	1000	0.003	7.2 x 10
^{228}Ac		10	4	2.2×10^6
^{105}Ag	Silver (47)	40	40	3.1×10^4
^{110m}Ag		7	7	4.7×10^3
^{111}Ag		100	20	1.6×10^5
^{241}Am	Americium (95)	8	0.008	3.2
^{243}Am		8	0.008	1.9×10^{-1}
^{37}Ar (compressed or uncompressed)*	Argon (18)	1000	1000	1.0×10^5
^{41}Ar (uncompressed)*		20	20	4.3×10^7
^{41}Ar (compressed)*		1	1	4.3×10^7
^{73}As	Arsenic (33)	1000	400	2.4×10^4
^{74}As		20	20	1.0×10^5
^{76}As		10	10	1.6×10^6
^{77}As		300	20	1.1×10^6
^{211}At	Astatine (85)	200	7	2.1×10^6
^{193}Au	Gold (79)	200	200	9.3×10^5

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{196}Au		30	30	1.2×10^5
^{198}Au		40	20	2.5×10^5
^{199}Au		200	25	2.1×10^5
^{131}Ba	Barium (56)	40	40	8.7×10^4
^{133}Ba		40	10	4.0×10^2
^{140}Ba		20	20	7.3×10^4
^{7}Be	Beryllium (4)	300	300	3.5×10^5
^{206}Bi	Bismuth (83)	5	5	9.9×10^4
^{207}Bi		10	10	2.2×10^2
^{210}Bi (RaE)		100	4	1.2×10^5
^{212}Bi		6	6	1.5×10^7
^{249}Bk	Berkelium (97)	1000	1	1.8×10^3
^{77}Br	Bromine (35)	70	25	7.1×10^5
^{82}Br		6	6	1.1×10^6
^{11}C	Carbon (6)	20	20	8.4×10^8
^{14}C		1000	60	4.6
^{45}Ca	Calcium (20)	1000	25	1.9×10^4
^{47}Ca		20	20	5.9×10^5

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{109}Cd	Cadmium (48)	1000	70	2.6×10^3
^{115m}Cd		30	30	2.6×10^4
^{115}Cd		80	20	5.1×10^5
^{139}Ce	Cerium (58)	100	100	6.5×10^3
^{141}Ce		300	25	2.8×10^4
^{143}Ce		60	20	6.6×10^5
^{144}Ce		10	7	3.2×10^3
^{249}Cf	Californium (98)	2	0.002	3.1
^{250}Cf		7	0.007	1.3×10^2
^{252}Cf		2	0.009	6.5×10^2
^{36}Cl	Chlorine (17)	300	10	3.2×10^{-2}
^{38}Cl		10	10	1.3×10^8
^{242}Cm	Curium (96)	200	0.2	3.3×10^3
^{243}Cm		9	0.009	4.2×10
^{244}Cm		10	0.01	8.2×10
^{245}Cm		6	0.006	1.0×10^{-1}
^{246}Cm		6	0.006	3.6×10^{-1}
^{56}Co	Cobalt (27)	5	5	3.0×10^4
^{57}Co		90	90	8.5×10^3
^{58m}Co		1000	1000	5.9×10^6

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{58}Co		20	20	3.1×10^4
^{60}Co		7	7	1.1×10^3
^{51}Cr	Chromium (24)	600	600	9.2×10^4
^{129}Cs	Cesium (55)	40	40	7.6×10^5
^{131}Cs		1000	1000	1.0×10^5
^{134m}Cs		1000	10	7.4×10^6
^{134}Cs		10	10	1.2×10^3
^{135}Cs		1000	25	8.8×10^{-4}
^{136}Cs		7	7	7.4×10^4
^{137}Cs		30	10	9.8×10
^{64}Cu	Copper (29)	80	25	3.8×10^6
^{67}Cu		200	25	7.9×10^5
^{165}Dy	Dysprosium (66)	100	20	8.2×10^6
^{166}Dy		1000	200	2.3×10^5
^{169}Er	Erbium (68)	1000	25	8.2×10^4
^{171}Er		50	20	2.4×10^6
^{152m}Eu	Europium (63)	30	30	2.2×10^6
^{152}Eu		20	10	1.9×10^2
^{154}Eu		10	5	1.5×10^2

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{155}Eu		400	60	1.4×10^3
^{18}F	Fluorine (9)	20	20	9.3×10^7
^{52}Fe	Iron (26)	5	5	7.3×10^6
^{55}Fe		1000	1000	2.2×10^3
^{59}Fe		10	10	4.9×10^4
^{67}Ga	Gallium (31)	100	100	6.0×10^5
^{68}Ga		20	20	4.0×10^7
^{72}Ga		7	7	3.1×10^6
^{153}Gd	Gadolinium (64)	200	100	3.6×10^3
^{159}Gd		300	20	1.1×10^6
^{68}Ge	Germanium (32)	20	10	7.0×10^3
^{71}Ge		1000	1000	1.6×10^5
^{3}H	Hydrogen (1) see T-Tritium			
^{181}Hf	Hafnium (72)	30	25	1.6×10^4
^{197m}Hg	Mercury (80)	200	200	6.6×10^5
^{197}Hg		200	200	2.5×10^5
^{203}Hg		80	25	1.4×10^4
^{166}Ho	Holmium (67)	30	30	6.9×10^5

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{123}I	Iodine (53)	50	50	1.9×10^6
^{125}I		1000	70	1.7×10^4
^{126}I		40	10	7.8×10^4
^{129}I		1000	2	1.6×10^{-4}
^{131}I		40	10	1.2×10^5
^{132}I		7	7	1.1×10^7
^{133}I		30	30	1.1×10^6
^{134}I		8	8	2.7×10^7
^{135}I		10	10	3.5×10^6
^{111}In	Indium (49)	30	25	4.2×10^5
^{113m}In		60	60	1.6×10^7
^{114m}In		30	20	2.3×10^4
^{115m}In		100	20	6.1×10^6
^{190}Ir	Iridium (77)	10	10	6.2×10^4
^{192}Ir		20	10	9.1×10^3
^{194}Ir		10	10	8.5×10^5
^{42}K	Potassium (19)	10	10	6.0×10^6
^{43}K		20	10	3.3×10^6
^{85m}Kr (uncompressed)*	Krypton (36)	100	100	8.4×10^6
^{85m}Kr (compressed)*		3	3	8.4×10^6

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{85}Kr (uncompressed)*		1000	1000	4.0×10^2
^{85}Kr (compressed)*		5	5	4.0×10^2
^{87}Kr (uncompressed)*		20	20	2.8×10^7
^{87}Kr (compressed)*		0.6	0.6	2.8×10^7
^{140}La	Lanthanum (57)	30	30	5.6×10^5
^{177}Lu	Lutetium (71)	300	25	1.1×10^5
MFP	Mixed Fission Products	10	0.4	--
^{28}Mg	Magnesium (12)	6	6	5.2×10^6
^{52}Mn	Manganese (25)	5	5	4.4×10^5
^{54}Mn		20	20	8.3×10^3
^{56}Mn		5	5	2.2×10^7
^{99}Mo	Molybdenum (42)	100	20	4.7×10^5
^{13}N	Nitrogen (7)	20	10	1.5×10^9
^{22}Na	Sodium (11)	8	8	6.3×10^3
^{24}Na		5	5	8.7×10^6
^{93m}Nb	Niobium (41)	1000	200	1.1×10^3
^{95}Nb		20	20	3.9×10^4

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{97}Nb		20	20	2.6×10^{7}
^{147}Nd	Neodymium (60)	100	20	8.0×10^{4}
^{149}Nd		30	20	1.1×10^{7}
^{59}Ni	Nickel (28)	1000	900	8.1×10^{-2}
^{63}Ni		1000	100	4.6×10
^{65}Ni		10	10	1.9×10^{7}
^{237}Np	Neptunium (93)	5	0.005	6.9×10^{-4}
^{239}Np		200	25	2.3×10^{5}
^{185}Os	Osmium (76)	20	20	7.3×10^{3}
^{191}Os		600	200	4.6×10^{4}
^{191m}Os		200	200	1.2×10^{6}
^{193}Os		100	20	5.3×10^{5}
^{32}P	Phosphorus (15)	30	30	2.9×10^{5}
^{230}Pa	Protactinium (91)	20	0.8	3.2×10^{4}
^{231}Pa		2	0.002	4.5×10^{-2}
^{233}Pa		100	100	2.1×10^{4}
^{201}Pb	Lead (82)	20	20	1.7×10^{6}
^{210}Pb		100	0.2	8.8×10
^{212}Pb		6	5	1.4×10^{6}

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{103}Pd	Palladium (46)	1000	700	7.5×10^4
^{109}Pd		100	20	2.1×10^6
^{147}Pm	Promethium (61)	1000	25	9.4×10^2
^{149}Pm		100	20	4.2×10^5
^{210}Po	Polonium (84)	200	0.2	4.5×10^3
^{142}Pr	Praseodymium (59)	10	10	1.2×10^4
^{143}Pr		300	20	6.6×10^4
^{191}Pt	Platinum (78)	100	100	2.3×10^5
^{193m}Pt		200	200	2.0×10^5
^{197m}Pt		300	20	1.2×10^7
^{197}Pt		300	20	8.8×10^5
^{238}Pu	Plutonium (94)	3	0.003	1.7×10
^{239}Pu		2	0.002	6.2×10^{-2}
^{240}Pu		2	0.002	2.3×10^{-1}
^{241}Pu		1000	0.1	1.1×10^2
^{242}Pu		3	0.003	3.9×10^{-3}
^{223}Ra	Radium (88)	50	0.2	5.0×10^4
^{224}Ra		6	0.5	1.6×10^5
^{226}Ra		10	0.05	1.0

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{228}Ra		10	0.05	2.3×10^{2}
^{81}Rb	Rubidium (37)	30	25	8.2×10^{6}
^{86}Rb		30	30	8.1×10^{4}
^{87}Rb		Unlimited	Unlimited	6.6×10^{-8}
Rb (natural)		Unlimited	Unlimited	1.8×10^{-8}
^{186}Re	Rhenium (75)	100	20	1.9×10^{5}
^{187}Re		Unlimited	Unlimited	3.8×10^{-8}
^{188}Re		10	10	1.0×10^{6}
Re (natural)		Unlimited	Unlimited	2.4×10^{-8}
^{103m}Rh	Rhodium (45)	1000	1000	3.2×10^{7}
^{105}Rh		200	25	8.2×10^{5}
^{222}Rn	Radon (86)	10	2	1.5×10^{5}
^{97}Ru	Ruthenium (44)	80	80	5.5×10^{5}
^{103}Ru		30	25	3.2×10^{4}
^{105}Ru		20	20	6.6×10^{6}
^{106}Ru		10	7	3.4×10^{3}
^{35}S	Sulfur (16)	1000	60	4.3×10^{4}
^{122}Sb	Antimony (51)	30	30	3.9×10^{5}
^{124}Sb		5	5	1.8×10^{4}

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{125}Sb		40	25	1.4×10^3
^{46}Sc	Scandium (21)	8	8	3.4×10^4
^{47}Sc		200	20	8.2×10^5
^{48}Sc		5	5	1.5×10^6
^{75}Se	Selenium (34)	40	40	1.4×10^4
^{31}Si	Silicon (14)	100	20	3.9×10^7
^{147}Sm	Samarium (62)	Unlimited	Unlimited	2.0×10^{-8}
^{151}Sm		1000	90	2.6×10
^{153}Sm		300	20	4.4×10^5
^{113}Sn	Tin (50)	60	60	1.0×10^4
^{119m}Sn		100	100	4.4×10^3
^{125}Sn		10	10	1.1×10^5
^{85m}Sr	Strontium (38)	80	80	3.2×10^7
^{85}Sr		30	30	2.4×10^4
^{87m}Sr		50	50	1.2×10^7
^{89}Sr		100	10	2.9×10^4
^{90}Sr		10	0.4	1.5×10^2
^{91}Sr		10	10	3.6×10^6
^{92}Sr		10	10	1.3×10^7

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
T (uncompressed)*	Tritium (1)	1000	1000	9.7×10^3
T (compressed)*		1000	1000	9.7×10^3
T (activated luminous paint)		1000	1000	9.7×10^3
T (adsorbed on solid carrier)		1000	1000	9.7×10^3
T (tritiated water)		1000	1000	9.7×10^3
T (other forms)		20	20	9.7×10^3
^{182}Ta	Tantalum (73)	20	20	6.2×10^3
^{160}Tb	Terbium (65)	20	10	1.1×10^4
^{96m}Tc	Technetium (43)	1000	1000	3.8×10^7
^{96}Tc		6	6	3.2×10^5
^{97m}Tc		1000	200	1.5×10^4
^{97}Tc		1000	400	1.4×10^{-3}
^{99m}Tc		100	100	5.2×10^6
^{99}Tc		1000	25	1.7×10^{-2}
^{125m}Te	Tellurium (52)	1000	100	1.8×10^4
^{127m}Te		300	20	4.0×10^4
^{127}Te		300	20	2.6×10^6
^{129m}Te		30	10	2.5×10^4
^{129}Te		100	20	2.0×10^7

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{131m}Te		10	10	8.0×10^5
^{132}Te		7	7	3.1×10^5
^{227}Th	Thorium (90)	200	0.2	3.2×10^4
^{228}Th		6	0.008	8.3×10^2
^{230}Th		3	0.003	1.9×10^{-2}
^{231}Th		1000	25	5.3×10^5
^{232}Th		Unlimited	Unlimited	1.1×10^{-7}
^{234}Th		10	10	2.3×10^4
Th (natural)		Unlimited	Unlimited	2.2×10^{-7}
Th (irradiated)**		-----	------	------
^{200}Tl	Thallium (81)	20	20	5.8×10^5
^{201}Tl		200	200	2.2×10^5
^{202}Tl		40	40	5.4×10^4
^{204}Tl		300	10	4.3×10^2
^{170}Tm	Thulium (69)	300	10	6.0×10^3
^{171}Tm		1000	100	1.1×10^3
^{230}U	Uranium (92)	100	0.1	2.7×10^4
^{232}U		30	0.03	2.1×10
^{233}U		100	0.1	9.5×10^{-3}
^{234}U		100	0.1	6.2×10^{-3}

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{235}U		100	0.2	2.1×10^{-6}
^{236}U		200	0.2	6.3×10^{-5}
^{238}U		Unlimited	Unlimited	3.3×10^{-7}
U (natural)		Unlimited	Unlimited	(See Table A-4)
U (enriched) < 20%		Unlimited	Unlimited	(See Table A-4)
U (enriched) 20% or greater		100	0.1	(See Table A-4)
U (depleted)		Unlimited	Unlimited	(See Table A-4)
U (irradiated)***		-----	-----	-----
^{48}V	Vanadium (23)	6	6	1.7×10^{5}
^{181}W	Tungsten (74)	200	100	5.0×10^{3}
^{185}W		1000	25	9.7×10^{-3}
^{187}W		40	20	7.0×10^{5}
^{127}Xe (uncompressed)*	Xenon (54)	70	70	2.8×10^{4}
^{127}Xe (compressed)*		5	5	2.8×10^{4}
^{131m}Xe (compressed)*		10	10	1.0×10^{5}
^{131m}Xe (uncompressed)*		100	100	1.0×10^{5}
^{133}Xe (uncompressed)*		1000	1000	1.9×10^{5}
^{133}Xe (compressed)*		5	5	1.9×10^{5}
^{135}Xe (uncompressed)*		70	70	2.5×10^{5}

Symbol of Radionuclide	Element and Atomic Number	A_1(Ci)	A_2(Ci)	Specific Activity (Ci/g)
^{135}Xe (compressed)*		2	2	2.5×10^5
^{87}Y	Yttrium (39)	20	20	4.5×10
^{90}Y		10	10	2.5×10^5
^{91m}Y		30	30	4.1×10^7
^{91}Y		30	30	2.5×10^4
^{92}Y		10	10	9.5×10^6
^{93}Y		10	10	3.2×10^6
^{169}Yb	Ytterbium (70)	80	80	2.3×10^5
^{175}Yb		400	25	1.8×10^5
^{65}Zn	Zinc (30)	30	30	8.0×10^3
^{69m}Zn		40	20	3.3×10^6
^{69}Zn		300	20	5.3×10^7
^{93}Zr	Zirconium (40)	1000	200	3.5×10^{-3}
^{95}Zr		20	20	2.1×10^4
^{97}Zr		20	20	2.0×10^6

*AGENCY NOTE: For the purpose of Table A, compressed gas means a gas at a pressure which exceeds the ambient atmospheric pressure at the location where the containment system was closed.

**AGENCY NOTE: The values of A_1 and A_2 must be calculated in accordance with the procedure specified in Appendix A, paragraph b(3), taking into account the activity of the fission products and of the uranium-233 in addition to that of the thorium.

***AGENCY NOTE: The values of A_1 and A_2 must be calculated in accordance with the procedure specified in Appendix A, paragraph b(3), taking into account the activity of the fission products and plutonium isotopes in addition to that of the uranium.

SECTION 341. TABLE B

RELATIONSHIP BETWEEN A_1 AND E_{max} FOR BETA EMITTERS

	E_{max} (MeV)	A_1 (Ci)
less than	0.5	1000
	0.5 - less than 1.0	300
	1.0 - less than 1.5	100
	1.5 - less than 2.0	30
greater than or equal to	2.0	10

SECTION 341. TABLE C

RELATIONSHIP BETWEEN A_3 AND THE ATOMIC NUMBER OF THE RADIONUCLIDE

Atomic Number	A_3		
	Half-life less than 1000 days	Half-life 1000 days to 10^6 years	Half-life greater than 10^6 years
1 to 81	3 Ci	.05 Ci	3 Ci
82 and above	.002 Ci	.002 Ci	3 Ci

SECTION 341. TABLE D

ACTIVITY-MASS RELATIONSHIPS FOR URANIUM/THORIUM

Thorium and Uranium Enrichment* wt % ^{235}U present	Specific Activity	
	Ci/g	g/Ci
0.45	5.0×10^{-7}	2.0×10^{6}
0.72 (natural)	7.06×10^{-7}	1.42×10^{6}
1.0	7.6×10^{-7}	1.3×10^{6}
1.5	1.0×10^{-6}	1.0×10^{6}
5.0	2.7×10^{-6}	3.7×10^{5}
10.0	4.8×10^{-6}	2.1×10^{5}
20.0	1.0×10^{-5}	1.0×10^{5}
35.0	2.0×10^{-5}	5.0×10^{4}
50.0	2.5×10^{-5}	4.0×10^{4}
90.0	5.8×10^{-5}	1.7×10^{4}
93.0	7.0×10^{-5}	1.4×10^{4}
95.0	9.1×10^{-5}	1.1×10^{4}
Natural Thorium	2.2×10^{-7}	4.6×10^{6}

*The figures for uranium include representative values for the activity of the uranium-234 which is concentrated during the enrichment process. The activity for thorium includes the equilibrium concentration of thorium-228.