Y-12

OAK RIDGE Y-12 PLANT

MARTIN MARIETTA

Final Report from IT Corporation
for the Pilot-Scale Thermal Treatment of
Lower East Fork Poplar Creek
Floodplain Soils

Prepared by IT Corporation
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managing the
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Oak Ridge, Tennessee
under contract DE-AC05-84OR21400
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FOR THE UNITED STATES
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**REPORT
FOR THE
PILOT-SCALE THERMAL TREATMENT
OF
LOWER EAST FORK POPLAR CREEK FLOODPLAIN SOILS**

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U.S. Department of Energy

IT Project Number 483138

**Final
September 1994**

MASTER

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ACRONYMS

acfm	actual cubic feet per minute
APC	air pollution control
ASTM	American Society for Testing and Materials
BDAT	Best Demonstrated Available Technology
Btu	British thermal unit per hour
cc	cubic centimeters
CEM	continuous emissions monitoring
CLP	Contract Laboratory Program
cm	centimeter
CRZ	contaminant reduction zone
CVAA	cold vapor atomic adsorption
°C	degrees Celsius
DQO	data quality objective
Energy Systems	Martin Marietta Energy Systems
EPA	U.S. Environmental Protection Agency
ETDC	Environmental Technology Development Center
EZ	exclusion zone
HEPA	high-efficiency particulate air
HSP	Health and Safety Plan
IT	IT Corporation
ITAS	IT Analytical Services
J/s	joule per second
kg	kilogram
kJ/hr	kilojoule per hour
L/min	liters per minute
lb	pound
LEFPC	Lower East Fork Poplar Creek
m	meter
m ³	cubic meters
µg/kg	microgram per kilogram
mg	milligram
mg/L	milligram per liter
mL	milliliter
MS	matrix spike

ACRONYMS

(Continued)

MSD	matrix spike duplicate
MTCLP	Modified Toxicity Characteristics Leaching Procedure
N	normal
NA	not analyzed
NBS	National Bureau of Standards
ND	below method detection limit
NIOSH	National Institute of Occupational Safety and Health
O&M	operations and maintenance
PAH	polynuclear aromatic hydrocarbons
PARC	powered air-purifying respirator
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PEL	permissible exposure limits
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
RFP	request for proposal
RPD	relative percent difference
rpm	revolutions per minute
RSD	relative standard deviation
RTA	Rotary Thermal Apparatus
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SVOC	semivolatile organic compound
SVOST	Semivolatile Organic Sampling Train
TC	toxicity characteristic
TCLP	Toxicity Characteristic Leaching Procedure
TDL	Technology Development Laboratory
TIC	tentatively identified compound

ACRONYMS
(Continued)

TLD	thermoluminescent dosimeter
TOC	total organic carbon
tph	tons per hour
TSCA	Toxic Substances Control Act
USDA	U.S. Department of Agriculture
VOA	volatile organic analysis
VOC	volatile organic compound
VOST	Volatile Organic Sampling Train
WESP	wet electrostatic precipitator

1.0 SUMMARY

IT Corporation (IT) was contracted by Martin Marietta Energy Systems, Inc. (Energy Systems) to perform a pilot-scale demonstration of the effectiveness of thermal desorption as a remedial technology for removing mercury from the Lower East Fork Poplar Creek (LEFPC) floodplain soil. Previous laboratory studies by Energy Systems suggested that this technology could reduce mercury to very low levels. This pilot-scale demonstration study was initiated to verify on an engineering scale the performance of thermal desorption. This report includes the details of the demonstration study, including descriptions of experimental equipment and procedures, test conditions, sampling and analysis, quality assurance (QA), detailed test results, and an engineering assessment of a conceptual full-scale treatment facility.

The specific project tasks addressed in this report were performed between October 1993 and June 1994. These tasks include soil receipt, preparation, and characterization; prepilot (bench-scale) desorption tests; front-end materials handling tests; pilot tests; back-end materials handling tests; residuals treatment; and engineering scale-up assessment.

Prior to beginning the demonstration test activities, IT prepared the following project-specific plans which provide the details for performance of the work tasks:

- Work Plan (December 6, 1993)
- Health and Safety Plan (HSP) (December 6, 1993)
- Quality Assurance Project Plan (QAPjP) (December 6, 1993)
- Sampling and Analysis Plan (SAP) (December 6, 1993)
- Transportation and Waste Management Plan (December 6, 1993).

Program objectives, as established in the Energy Systems Statement of Work and as enumerated in the work plan, were as follows:

- Reduce the concentration of mercury in the soil to below 10 parts per million (ppm).
- Demonstrate accountability for mercury throughout the process.
- Generate treated soil that will pass the U.S. Environmental Protection Agency (EPA) Toxicity Characteristic Leaching Procedure (TCLP).
- Demonstrate effective off-gas treatment.

- Minimize the generation of wastes.
- Treat residuals to ensure they are nonhazardous.
- Evaluate material handling/preparation characteristics to determine applicable unit processes.
- Obtain high quality analytical data to confirm performance of the treatment process.
- Obtain appropriate and sufficient engineering data to enable full-scale conceptual design and budgetary costing sufficient for feasibility study alternative evaluation.
- Complete the test program within an acceptable time frame and cost, in compliance with all regulatory and health and safety requirements.

The materials handling tests provided qualitative data on using the "as is" material as feed to a full-scale thermal unit, and on the transport of the treated material after quenching to a stockpile for storage. The effect of moisture content on handling characteristics was evaluated and acceptable limits for moisture were identified. This information is critical in designing a materials handling system for a full-scale unit.

The demonstration study program required confirmation of the temperature, time at temperature, and purge gas that would provide the desired results. Screening tests were performed on the bench-scale to establish these conditions. The bench-scale studies identified that at 350 degrees Celsius ($^{\circ}\text{C}$) with a retention time of 10 minutes, a mercury concentration of approximately 15 ppm was achieved. Additional bench-scale tests were performed to evaluate the temperatures and times required to obtain 10 ppm. Tests at 600°C for 10 minutes were able to achieve less than the 10 ppm target mercury level. However, it was decided by Energy Systems to perform the initial pilot tests at 350°C to avoid significant alteration of the soil which might affect final disposition. Based on the results, 350°C at 10 minutes retention time was chosen for the pilot-scale study.

Once the conditions were identified, a pilot-scale "shakedown" test was performed to establish critical operating parameters of the desorber. Temporally related feed and treated soil samples were collected during this test to ensure treatment goals were met at the established conditions.

The operating conditions established by the preliminary test were used in a verification test at 350°C and 10 minutes to thermally treat approximately 243 kg (534 lbs) of soil. Samples of the feed and treated soil, off-gas treatment residuals, and the off-gas and vent gas streams were sampled for analyses. Off-gas samples and residuals were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), and metals to evaluate the effects of thermal treatment on their desorption, generation, or removal.

An additional test was performed at a higher temperature (600°C) with the same retention time. This treatment condition was selected from the bench-scale results to achieve less than 10 ppm mercury. Except for gas sampling (which was limited to analysis of carbon dioxide [CO₂] and oxygen [O₂]) all process sampling was identical to the previous test.

The results of the 350°C and 600°C pilot tests showed mercury could be reduced from approximately 300 ppm to approximately 15 ppm and 8 ppm, respectively. The pilot-scale results agreed well with the bench-scale results.

Residuals from all tests were rendered nonhazardous prior to return to Energy Systems. These residuals included cyclone solids, scrubber aqueous liquids and solids, water treatment solids, spent activated carbon, high-efficiency particulate air (HEPA) residuals, samples and containers, and personal protective equipment. Some of the residuals generated were hazardous under Resource Conservation and Recovery Act (RCRA) toxicity characteristic (TC) criteria, and required treatment. Treatment methods employed were thermal desorption, chelation/chemical precipitation, acid washing/leaching, amalgamation/stabilization, and carbon adsorption. Treated and untreated soil was also returned to Energy Systems after comprehensive analysis.

Data obtained from the tests were used to develop a conceptual design and capital and operating costs estimates for a full-scale thermal desorption system for treating LEFPC floodplain soils. The level of detail of the cost estimate was intended to provide adequate input for evaluation of thermal desorption as a remedial alternative in the ongoing feasibility study. The engineering assessment included defining major equipment and operational requirements and discussing scale-up methodology and issues.

2.0 CONCLUSIONS

This pilot-scale study demonstrated that thermal desorption is applicable to remediate the LEFPC floodplain soils. Specific conclusions related to the program objectives listed in Section 1.0 are as follows:

- The process removed mercury from 300 ppm to below 15 ppm at treatment conditions of 350°C for 10 minutes at temperature, and to below 10 ppm at 600°C for 10 minutes at temperature.
- Moderate time and temperature changes in the desorption process do not cause a significant deviation in mercury removal performance, indicating that the overall treatment process would be relatively insensitive to normal full-scale process fluctuations. Mercury analysis of all input and output streams from the pilot tests enabled overall accountability and fate of mercury in the process to be determined. Approximately one half the mercury content of the feed soil was accounted for in all the process residuals. The distribution of mercury through all the off-gas treatment system components showed more than 85 percent was collected in the wet scrubber, with about 60 percent of this isolated as elemental liquid mercury. The mercury results were consistent for the two treatment test conditions of 350°C and 600°C.
- The treated soil passed TCLP and was therefore nonhazardous.
- The desorber off-gas can be cleaned using a series of conventional air pollution control devices to approximately 99 percent or greater removal of all measured contaminants (i.e., particulates, mercury, and organics). Mercury emissions were controlled by greater than 99.99 percent. Detailed characterization of organic and inorganic constituents of the off-gas and final vent gas provides a good basis for selecting emission control technology.
- Materials handling characteristics of the soil have been evaluated, and provide a basis for design of conventional and reliable equipment for a full-scale process. The upper limit of moisture content that can be handled without a materials handling problem was established; preparation of soil for treatment should not be a major processing step.
- Several process residuals are generated that could be RCRA hazardous; the project demonstrated that these can be treated using conventional chemical, physical, or thermal technologies to make them nonhazardous. Elemental mercury can potentially be recovered from the solid residuals to facilitate off-site disposition of the mercury to a reclaimer.

- Based on a conceptual full-scale, 31 metric tons per hour (35 tons per hour [tph]) process design, a budget cost estimate for using this technology is \$12.3 million capital and \$50 per ton operating costs. No major issues of concern related to scale-up have been identified. Several scale-up issues, including residuals treatment and disposal, need further evaluation to finalize the overall costs.

3.0 RECOMMENDATIONS

Based on the successful engineering-scale demonstration of thermal desorption to achieve mercury concentrations of near or below 10 ppm, no further testing of the soil treatment process is considered necessary for completing the feasibility study. However, several process issues require additional study to ascertain their impact on the cost of this remedy. Options for management and disposition of the solid residuals, particularly sludge from the off-gas treatment system, need engineering, regulatory, and cost evaluations. Treatment requirements and process alternatives for controlling wastewater and air emissions from the thermal desorption process should also be defined and evaluated. Bench-scale tests could potentially be used to generate small quantities of these residuals for actual testing of treatment alternatives.

4.0 PROCESS DESCRIPTION AND HISTORY

4.1 PROCESS DESCRIPTION

The process used for this demonstration was thermal desorption using an indirectly-heated rotary desorber unit. The indirectly-heated rotary thermal desorber is comparable to a rotary calciner, which is a conventional and well understood thermal processing technology. Indirect heating results in minimum load to the off-gas treatment (air pollution control) system. This type of desorber provides controlled treatment conditions of solids temperature, residence time, and atmosphere. Rotary thermal desorbers can be constructed and operated for very large throughputs, and can handle a relatively wide range of feed characteristics. Both of these attributes are important for achieving reasonable cost. A wide range of off-gas treatment systems can be used comprised of conventional unit operations to meet off-gas conditions and final emission criteria. This process was selected for application to LEFPC soils based on significant previous IT experience with the technology and on the availability of a proven pilot-scale test facility.

Figure 4-1 is a general overview of the thermal desorption process as it would be applied to LEFPC soil on a full-scale basis. Excavated soil is delivered to a feed preparation and handling operation where blending and oversize segregation and processing take place. Prepared soil is continuously fed to the treatment system.

During thermal desorption, the soil is heated to temperatures (e.g., 350°C) sufficient to remove the mercury from the soil. The soil is heated and desorbed as it is conveyed through the rotating metal calciner tube, which is indirectly heated by firing natural gas or propane into the stationary insulated chamber (furnace) surrounding the tube. At 350°C, most organic compounds will also desorb.

The treated soil is cooled, moistened, and stored in a stockpile. Final disposition can include returning the soil to the site or disposal at a waste disposal facility.

A purge gas is introduced to the desorber to help flush desorbed contaminants from the unit to the off-gas treatment system. The off-gas leaving the desorber consists of air, water vapor, mercury vapor, organic vapors, entrained soil particles, and any radionuclides associated with these particles.

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DRAWN BY: S. CARDWELL	DRAWN BY:	ENGR. CHCK BY: D. HELSEL	PROJ. MGR.: D. HELSEL	PROJ. NO.: 483138

FIGURE 4-1

PROCESS BLOCK FLOW DIAGRAM
THERMAL DESORPTION OF LEFPC SOIL

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OAK RIDGE, TENNESSEE

--- ALTERNATIVE PATHWAYS

The off-gas is treated in a multistage off-gas treatment system. The system consists of conventional air pollution control (APC) devices such as wet spray scrubbers, demisters, condensers, wet electrostatic precipitators, high-efficiency particulate filters, and carbon adsorbers. This system removes particulates, cools and condenses water and organics, and separates volatile materials.

A fan maintains a slight negative pressure on the entire treatment system and exhausts a small flow of noncondensable gas to the atmosphere.

Various residuals are generated from the off-gas treatment system, including an aqueous effluent, sludges consisting primarily of fine soil particles with mercury and organic constituents, and spent activated carbon. The disposition of these residuals depends on their characteristics and the acceptability and cost of mercury reclamation and disposal options. Figure 4-1 suggest several options for sludges, including treatment on site to remove/separate mercury, direct recycle to the thermal desorber, or shipment off site to a permitted treatment or reclamation facility.

4.2 HISTORY OF THE PROCESS

Indirectly-heated rotary desorber processes have been operated in the United States for soil remediation, but to a limited extent. However, in Europe, such processes have treated up to 50 tons per hour of contaminated soil at temperatures similar to those found to be suitable for the LEFPC soil.

No evidence of full-scale use of indirectly-heated thermal desorber processes for remediation of mercury-contaminated soils has been found. However, similar types of process equipment are used for processing mercury ores. Thermal processing has been identified by EPA as one of the processes meeting Best Demonstrated Available Technology (BDAT) requirements for inorganic mercury solid/sludge wastes. BDAT for mercury-contaminated soils has not yet been identified by EPA.

IT has practiced thermal desorption treatment of a wide variety of contaminated soils and sludges. Numerous bench- and pilot-scale tests have been conducted to 1) demonstrate contaminant removal efficiency, 2) define off-gas and emission characteristics and evaluate emission control systems, 3) determine the importance of treatment conditions (time, temperature, and purge gas), and 4) determine if treated soil met site-specific requirements, such as passing TCLP to be classified as nonhazardous. Most of this development and

treatability experience has focused on contaminants that have low volatility and require relatively high- treatment temperatures. Contaminants have included polychlorinated biphenyls (PCB), polynuclear aromatic hydrocarbons (PAH), chlorophenols, polychlorinated dibenzo-p-dioxins and furans, and chlorinated pesticides.

IT completed a treatability project in 1993 on mercury-containing brine sludges generated in chlorine production plants. The waste sludge had percent levels of mercury sulfide and generated significant quantities of mercury in the off-gas. A series of bench- and pilot-scale tests were performed at various conditions.

IT has developed conceptual designs for mobile indirectly-heated rotary thermal desorption processes for several different soil remediation and sludge treatment applications, and a preliminary design for a 10-ton-per-hour transportable system was prepared for a previous application.

Research and treatability testing of this type of thermal desorption process has been done by several other environmental engineering companies. Successful results for pilot-scale and demonstration tests for low-volatility contaminants have been reported. Very limited experience treating mercury-contaminated soil has been reported.

5.0 EXPERIMENTAL MATERIALS AND METHODS

5.1 DESCRIPTION OF TEST EQUIPMENT

5.1.1 Soil Preparation Equipment

The equipment used for soil preparation consisted of three custom fabricated carbon steel trays. The trays are 243.8 by 121.9 by 45.7 centimeters (cm) (96 by 48 by 18 inches), and designed so that the tines of a small Rototiller™ would fit within the end radius of the tray. This design ensured proper mixing of the soil. The small Rototiller™, a shovel, a mattock, and hoe were used to mix the soil in the tray. The trays of soil were covered with plastic sheeting to control moisture losses. Plastic was placed beneath each tray to limit the spread of contamination, and to aid in cleanup after the homogenization operations. A photograph of the soil preparation activities is included in Appendix A.

5.1.2 Bench-Scale Test Equipment

5.1.2.1 RTA Equipment

The bench-scale study used IT's Rotary Thermal Apparatus (RTA). A photograph of the RTA is included in Appendix A. The RTA is a batch-loaded rotating tube thermal unit used to evaluate the effect of time, temperature, and purge gas rate and composition on the thermal treatment of solids and sludges. A schematic of the RTA test is shown in Figure 5-1. The rotating tube portion of the system is 12.7 cm (5 inches) in diameter by 30.5 cm (12 inches) long and is fabricated from Incoloy™ to resist oxidation during high temperature tests. The cylinder rotates at five revolutions per minute (rpm) and is externally heated with a custom-made 7500 joule per second (J/s) (7000-watt) Lindberg® furnace. The chain-driven tube is suspended on both ends by brass rollers and sealed by graphite packing rings at the inlet and outlet distribution boxes.

The heat-up rate and operating temperature are controlled with a Lindberg® 59554-B temperature controller. Temperatures of the soil bed and the gas in the rotating cylinder are measured with two calibrated type-K thermocouples. These temperatures, the temperature of the oven, and other off-gas system temperatures were recorded on a multipoint recorder. The off-gases (purge gas, water vapor, and desorbed contaminants) from the cylinder exit through a 91.4-cm (3-foot)-long heated quartz tube into a heavy glass-walled spray tower scrubber which is 5.0 cm (2 inches) in diameter and 40.6 cm (16 inches) high. A caustic solution is recirculated through the spray tower and externally cooled by using a Haake® laboratory

chiller. Uncondensed gases passing the spray tower are pulled through a 15.2-cm (6-inch)-deep carbon bed by an air-aspirated venturi pump before being discharged into a HEPA-filtered laboratory fume hood.

The same RTA apparatus was used for the speciation study after some modification of the gas collection system. A detailed description of this modified equipment is given in Appendix B.

5.1.2.2 Tray Desorption Test Apparatus

In addition to the planned RTA series of supplemental bench-scale, desorption tests were performed using a "tray test" apparatus recommended by the EPA in the 1992 document *Guide for Conducting Treatability Studies Under CERCLA: Thermal Desorption Remedy Selection* as the standard for conducting thermal desorption screening studies.

The tray test is conducted in a muffle furnace purged with the appropriate gas. The apparatus consists of a Lindberg® Model 51848 muffle furnace with an electronic temperature controller and a 1600 J/s (1,600 watt) heater. The oven has a double-shell construction with interior surfaces made of Moldatherm®, a molded aluminum-silicate insulation material. This oven is capable of operating at temperatures up to 1100°C and has a relatively fast heat-up rate due to its low mass. The interior space is approximately 9.9 by 10.9 by 21.1 cm (3.9 inches wide by 4.3-inches high by 8.3 inches deep). A loose block (1.27 cm [1/2 inch] thick) of Moldatherm® insulation is placed on the bottom of the oven to provide additional separation between the tray and the hot interior surface of the oven.

A specially-designed tray issued to hold the soil as it was heated to temperature. The tray, which weighs approximately 430 grams, is 8.9 by 3.3 by 19.3 cm (3.5 inches wide by 1.3 inches high by 7.6 inches) long and is constructed of Incoloy™ to resist oxidation during high temperature tests. Typically, approximately 50 to 100 grams of soil is placed in the tray for a test.

During the test the oven is continuously purged through a 0.95-cm (3/8-inch)-diameter Incoloy™ tube in the back wall of the oven. The purge gas is directed against the back wall to promote even heating and distribution. The purge gas flow rate is measured with a standard rotameter and maintained at approximately 90 cubic centimeters (cc) per minute during the test.

Two National Institute of Standards and Technology traceable type-K thermocouples were used to measure the temperatures. One is a sheathed thermocouple placed approximately 3 cm (approximately 1 inch) above the test material at the center of the oven. This thermocouple is used to measure the "Test Temperature." The second thermocouple is used to measure the temperature within the test matrix. The thermocouples and the oven temperature indicator are calibrated using a standard reference source. The purge gas rotameter is calibrated using a wet test meter. Temperatures are recorded using a multipoint recorder. Experimental test times are measured using a quartz digital chronometer.

5.1.3 Pilot-Scale Studies

IT's pilot-scale thermal desorber is essentially a scaled-down version of a full-scale system. It is a pilot-scale, indirectly heated, rotary tube calciner (desorber) unit employing a continuous feed and a multistage off-gas treatment system. The pilot system has in past studies given comparable results to bench-scale tests; bench-test results can be used to establish pilot-test conditions. Important features of the system include:

- The unit is a closed system, with a sealed feed entry, designed for minimal practical air infiltration and the ability to control and recirculate purge gas if desired.
- The desorber is instrumented to control and measure the soil temperature and residence time as well as temperature of the furnace (heating surface) and gas; these data are directly applicable for scale-up; soil and gas temperature profile data are measured along the complete unit.
- The soil is gently mixed and flows through the desorber in essentially plug flow.
- The off-gas treatment system consists of seven stages of treatment to remove all types of constituents, including mercury, to very low levels.
- The desorber and off-gas system is designed to reduce plating out of mercury or condensation of organics prior to the control devices.

The thermal desorber is a standard-design pilot calciner that consists of a continuously rotating tube partially enclosed with a gas-fired furnace shell. A schematic of the pilot system is shown in Figure 5-2. Photographs of the calciner and off-gas treatment system are included in Appendix A. The tube, constructed of Castalloy H-H, has a 16.5-cm (6 and 1/2-inch) internal diameter and is 4.3 m (14 feet) long; the heated section is 2.3 m (6 feet, 8 inches) long. Small flights are placed at intervals within this tube to provide soil agitation. A stationary thermowell extends from the discharge end into the tube with six thermocouples

PILOT THERMAL DESORBER SCHEMATIC

Figure 5-2

to monitor the soil temperature and three to monitor the gas temperature along the tube length. The tube can be rotated at speeds from 1.5 to 16 rpm and also can be inclined to adjust the flow rate of solids. Typically, a 2- to 3-degree slope is used.

The soil bed volume in the desorber depends on the material flow characteristics, the desorber inclination and rotational speed, and, particularly on the diameter of the "dam" or retaining ring at the discharge end. The soil residence time is a function of the soil bed volume and the soil feed rate. The soil feed rate is controlled by the rotational speed of a feed screw conveyor. Retention time tests were conducted to determine the slope and rotational speed of the desorber tube required to promote flow of the soil through the tube at the feed rate. Solids discharging from the separator while operating at steady-state are weighed on a digital electronic scale to enable determination of the soil feed rate.

The furnace is a refractory-lined chamber with 14 equally spaced burners controlled by a standard burner control system with appropriate safety features. Propane was used as the fuel. Burner firing rate is manually controlled to give the desired soil temperature profile. The desorber is rated at 337,000 kilojoules per hour (kJ/hr) (320,000 British thermal units per hour [Btu/hr]) maximum heat duty. The maximum heat that can be transferred to material in the desorber tube is estimated to be 105,000 kJ/hr (100,000 Btu/hr). This value depends primarily on the temperature gradient between the soil being processed and the furnace temperature.

The discharge end section of the desorber tube is enclosed by the air cooler casing. Cooling of solids within the tube at the discharge end is increased by forced air circulation through the air cooler casing. Soil exits the desorber tube through a gas plenum/transition section and a rotary air-lock valve into a metal receiver can. A sight glass on the discharge plenum of the desorber allows the soil flow to be visually monitored.

Purge gas is introduced at a low flow rate (0.057 cubic meters per minute [m^3/min] [2 actual cubic feet per minute {acfm}]), at the soil discharge end to help flush desorbed contaminant vapors and to maintain the proper atmosphere for the treatment process. The off-gas which flows from a plenum at the soil feed end of the desorber containing the purge gas, volatilized contaminants and water, and some particulates, was transferred through a short electrically-heated, insulated duct to the off-gas treatment system.

Figure 5-3 shows a flow diagram of the pilot system showing the desorber and the off-gas treatment system, and related instrumentation. The off-gas treatment system was comprised of the following components:

- A hot cyclone removes a majority of entrained particulates.
- A quench, spray scrubber is 15.4 cm (6 inches) in diameter and 1.2 m (4 feet) tall. A demister pad is located at the top of the scrubber to minimize entrainment of water droplets. The scrubber liquid is collected in a tank and recirculated by a pump through a set of bag filters and through a heat exchanger cooled by a packaged refrigeration system. Caustic is added to the scrubber liquid prior to operation to control/maintain the pH to alkaline or neutral.
- A wet electrostatic precipitator (WESP) captures very fine particulates and aerosols.
- A chilled, noncontact condenser reduces the moisture content of the scrubbed gas and removes condensible organic vapors. The condensate is collected in a receiver.
- A mist eliminator (Brinks) removes any remaining entrained droplets.
- A HEPA filter removes any residual particles.
- A two-stage carbon adsorber removes residual organic vapors and mercury vapors.
- An induced-draft fan draws off-gas from the desorber and creates a slight negative pressure throughout the system.

The outlet (vent) gas from the off-gas treatment system is discharged to the atmosphere through a roof vent. The desorber system operates at a slight negative pressure to prevent fugitive emissions. The negative pressure is maintained by using a small blower to pull the gases through the desorber and off-gas treatment system. A dry test meter and rotometer measure the vent gas flowrate and volume during a test period.

5.1.4 Materials Handling Tests

In order to simulate the soil dropping from a conveyor in a full-scale system into a feed chute, a small-scale chute system was assembled. The chute system is displayed in a photograph in Appendix A. The drop chute was comprised of two 1.8-m (6-foot) sections of 30.5 cm (12-inch) diameter PVC pipe. The two sections were joined with a 30.5 cm (12-inch) polyvinyl chloride (PVC) union and supported vertically by a free-standing bracket.

FIGURE 5-3. PILOT THERMAL DESORBER SYSTEM PROCESS FLOW DIAGRAM

The bottom of the pipe opens to a 1.5 meter (m) (5-foot) long, 316 stainless steel feed chute. The chute had a semicircular design with a 30.5 m (12-inch) diameter. The feed chute was constructed so its angle to the drop chute was variable. All tests were videotaped so the actual "drop" could be watched at slow-motion speed for visual determinations.

The reagglomeration test simulated the probable behavior of the soil feed as it enters the kiln. The reagglomeration test hardware consisted of a plastic 208-liter (55-gallon) drum and rotated at the appropriate speed on a drum roller. The center of the top and the bottom of the drum were cut out, leaving a 7.6 cm (3-inch) dam from the drum's sides. This allowed for a visual inspection of the sample during testing and for each test to be videotaped. A photograph of the reagglomeration test apparatus is included in Appendix A.

The back-end (treated soil) materials handling tests simulates the use of a drag-flight conveyor. The treated soil was pulled up with a "dewatering beach," which consisted of an inclined plate of aluminum sheet metal measuring 61 by 183 cm (2 by 6 feet) in length. The dewatering beach was contained in a Nalgene tank, 1.2 m (4 feet) long by 0.61 m (2 feet) wide by 0.46 m (1.5 feet) deep. The front of the inclined plate was placed about 6 cm (12 inches) from the front of the tank at a 35° angle. A photograph of the drag-flight test set-up is included in Appendix A.

5.1.5 Residuals Treatment

Residual Liquids. For the residuals treatment tests, a modified (208-liter) open-top drum, stir paddle, 2-inch diaphragm pump, specially made laboratory glass filtration vessel, and pH probe were used for the liquids. The drum was made from standard 208-liter (55-gallon) plastic drum by cutting out the top. A large plastic paddle was used to agitate the solution after addition of chemicals. The pH was monitored using the pH probe. The final flock was dewatered using a 25.4-cm (10-inch)-diameter two section glass vacuum filtration vessel. The filter was comprised of two 25.4-cm (10-inch)-diameter glass sections and a 25.4-cm (10-inch)-diameter filter media pad. The glass sections are attached to the media and filter using silicone grease and clamps. Vacuum is applied to the pad using a vacuum pump.

Scrubber Solids and Liquid Treatment Solids. Residuals generated from the water treatment process, and residuals from the scrubber filter, were treated using the RTA to desorb the mercury from the soil/sludge.

Filter Bags from Desorber Tests. For treatment of the filter bags from the scrubber system, a 37.8-liter (10-gallon) Nalgene tray was used as the treatment vessel, and a 18.9 liter (5-gallon) bucket was used for rinsing.

Other Solids. Other residual solids, such as HEPA filters, cyclone solids, carbon, elemental mercury were treated as necessary using the previously described equipment. Residuals generated from these processes were treated and consolidated with similar wastes.

5.2 TEST PROCEDURES

5.2.1 Soil Receipt and Preparation Procedures

To ensure that any experimental variability identified in the testing program is a result of the variation of the treatment conditions and not associated with the feed material, it was necessary to thoroughly homogenize the soil. A homogeneous, uniform soil feed minimizes variability that may be caused by the feed.

Ten drums of LEFPC soil were received from Energy Systems, at a total weight of 1,847 kg (4,064 pounds [lbs]). Three and one-third drums of soil were emptied into each tray. The "as received" soil was frozen, making immediate homogenization impossible. The frozen soil was covered with plastic and allowed to thaw for 2 days. The plastic served to maintain the moisture in the soil as the thawing process occurred.

Once thawed, the blocks of soil were broken up using a hoe, mattock, and shovel. The soil was thoroughly mixed and oversize particles (greater than one-half inch) were removed by screening through a one-half inch hardware screen. These oversize particles included grass and rocks. The total mass of grass collected was 40.8 kg (89.8 lbs). The total mass of rocks collected was 12.9 kg (28.4 lbs). The grass and rocks were segregated and not treated.

A small Rototiller™ was used to thoroughly turn the soil and ensure proper mixing. Once each tray was thoroughly mixed, the soil in each tray was separated into divisions of one-thirds. The one-third increments from each tray were then put in the subsequent trays until an aliquot from each preceding tray was in all the trays. The soil was then mixed again to ensure a homogeneous mixture. Eight total grab samples of the mixed soil in the three trays were collected and analyzed for mercury. Homogeneity of the soil required a relative standard deviation (RSD) of less than 30 percent.

Once homogeneity was verified, characterization samples were collected for analysis at the IT Analytical Services (ITAS) St. Louis laboratory. In addition, a sample of the soil was screened into size fractions to determine coarse size distribution. Several drums of the homogenized soil were collected for use during the front end materials handling tests.

An 18.9-liter (5-gallon) pail of the homogenized soil was collected and sent to the Technology Development Laboratory (TDL) for bench-scale evaluation. Forty-five kg (100 lbs) of homogenized soil were collected for Energy Systems for further soil studies at the Oak Ridge National Laboratory.

A sample was also collected for percent moisture determination and Atterberg limits (soil plastic and liquid limits). The percent moisture of the "as received" soil was 24.4 percent, which was too high because of limitations of the pilot-scale feed system; therefore, it was necessary to dry the soil to a lower moisture content. The drying process required uncovering the soil and allowing each tray to air dry. Physical parameters, such as reagglomeration by squeezing in a gloved hand, were checked during the drying process to determine the stopping point of the process. Once the moisture content of the soil reached the point at which it did not reagglomerate when squeezed in a gloved hand, another sample was collected for percent moisture evaluation (17.5 percent).

5.2.2 Bench-Scale Desorption Thermal Desorption Test Procedures

5.2.2.1 RTA Test Procedures

The general operating procedure for the RTA is given in Appendix C.

5.2.2.2 Tray Desorption Test Procedures

The procedure used for the tray screening tests is described in Appendix C. This procedure is comparable to the recommended EPA protocol.

5.2.3 Pilot-Scale Desorption Procedures

The general operating procedure for the pilot-scale thermal desorber tests is detailed in Appendix C.

5.2.4 Residuals Treatment Procedures

One of the program requirements was to ensure that any residuals generated from the process that were RCRA hazardous (failed TCLP) were capable of being rendered nonhazardous. If

any process residual failed TCLP, that stream had to be treated and pass TCLP prior to return to Energy Systems. TCLP or modified TCLP (MTCLP) testing of each stream was in accordance with the Sampling and Analysis Plan (SAP) approved by Energy Systems and EPA Method 1311. If the characterization (total analysis) of the residual or the type of residual (potential to contain a toxicity characteristic [TC] analyte) demonstrated that the individual TC analytes were not present or were present at such a low concentration the residual could not fail the TCLP, then TCLP was not run per Section 1.2 of TCLP.

The scrubber liquids were treated in two steps. The treatment procedures were defined through bench-scale treatability tests using small portions of the liquid having the highest concentration of TCLP constituents. The first step consisted of chemical treatment to precipitate mercury followed by settling and filtering the liquid and dewatering the resulting precipitant solids. A chelate (DeGussa TMT 15) was used to form an insoluble mercury chelate; ferric sulfate was then added and the pH raised to produce a floc to coprecipitate/adsorb the mercury chelate. Details of the procedure are included in Appendix C. The second step to remove organics involved adding granular-activated carbon at a dosage of two weight percent of the water mass and mixing the resulting slurry for several hours. After settling, the water was decanted to new drums and the carbon dewatered and air dried.

The scrubber solids and scrubber liquid treatment sludge were treated using the RTA to thermally desorb the mercury from the solids. Specific procedures for thermal desorption are described in Appendix C. The mercury generated from the residual treatment was recovered and composited with the mercury recovered from the desorber tests.

The scrubber filter bags, Brinks demister media, and HEPA filter media were treated to remove metals using the acid washing/leaching procedure detailed in Appendix C.

The spent vapor phase sulfide-impregnated carbon from the off-gas treatment system from one pilot test was treated by applying a chelating agent solution to bind mercury.

5.2.5 Health and Safety Test Procedures

This project was conducted under the requirements of a comprehensive set of health and safety procedures and plans. Project tasks that were associated with laboratory-scale operations were directed by the facilities' standard operating procedures, Chemical Hygiene Plans and Radiation Protection Programs. In addition to these requirements, pilot-scale

activities were conducted in accordance to the project-specific HSP and IT's Radiation Safety Guide for Pilot-Scale Demonstrations.

Exposures to contaminants in LEFPC soils during laboratory operations were controlled through the use of fume hoods and vented enclosures, gloves, lab coats, and safety glasses. Routine radiological surveys were performed during these operations.

Personnel assigned to the pilot-scale operations were trained in the requirements of the health and safety plan. Pilot-scale tasks were performed in a regulated zone that was secured to prevent access by unauthorized personnel. Exclusion zones (EZ) and contamination reduction zones (CRZ) were established as required within the regulated area. These zones were demarcated with caution signs and rope barricades or access doors. Personnel that entered these zones were assigned personal protective equipment (PPE) appropriate for their assigned task and exposure potential. The PPE ensemble for pilot-scale thermal desorption activities was selected to provide protection against chemical splashes, inhalation of airborne dusts, mists and organic vapors, and head and foot injuries. The PPE consisted of a RACAL Breathe-Easy 1® powered air-purifying respirator (PAPR) with AP3 cartridge (organic vapor/HEPA), poly-coated Tyvek® coveralls, steel-toed chemical resistant boots, and nitrile gloves. Protection for mercury vapors was not prescribed because concentrations were expected to be below the permissible exposure limits (PEL). Both real-time air monitoring and breathing zone sampling for mercury vapor confirmed that exposures were below the regulatory limits.

Ambient air monitoring for mercury was conducted throughout the EZ with a Jerome Mercury Vapor Analyzer and at locations where fugitive emissions from process equipment were most likely to occur. Breathing zone sampling was conducted on personnel having the highest probability for exposure. Personnel performing the following tasks were monitored: pilot operations supervisors, data recorder, soil feeders, and outfall soil technicians. Sampling and analysis for mercury was conducted by National Institute for Occupational Safety and Health (NIOSH) Method 6009 using MSA ESCORT™ ELF sampling pumps calibrated to a flow rate of approximately 0.15 liters per minute. Low-flow control was achieved by using a Gemini® Twin-Port Sampler. The air sampling trains were calibrated with a Bios DC-1 Calibrator. Samples were collected on a single section, 200 milligrams (mg) Hydrar solid sorbent tube and sent to DataChem Laboratories in Salt Lake City for mercury analysis.

Site radiation protection procedures require personnel monitoring of radiation exposures for all personnel working with radioactive materials in the regulated areas. Personnel exposures are monitored with thermoluminescent dosimeters (TLD) sensitive to beta and gamma radiation. Dosimeters are analyzed by Landauer, Inc., a National Voluntary Laboratory Accreditation Program processor of personnel radiation dosimetry.

Frisking for radioactive contamination was required for personnel leaving the EZ. In addition, all personnel leaving the regulated area were required to frisk their hands and feet prior to exiting. Routine radiation and contamination monitoring were performed in the regulated areas throughout the project.

5.3 SUMMARY OF TESTS AND CONDITIONS

5.3.1 Bench-Scale Desorption Tests and Conditions

The primary bench-study performed in the RTA was used to evaluate time and temperature conditions and the most effective type of purge gas. Table 5-1 presents a matrix of the tests and conditions evaluated by the RTA study.

The first series of RTA tests were to determine the effectiveness of 350°C for removing the mercury from the soil. The second series of tests were for investigating, at one of the residence times in Table 5-1, the effect of air, steam, and nitrogen as different purge gases.

The third series consisting of four tests was to determine the effect of particle size of the RTA feed on mercury removal. The feed soil was screened through 1/2-inch wire cloth to produce a very coarse (1/2- to 1-inch) material. This material was treated in the RTA at the same conditions as the fine soil. The treated lumps of soil were analyzed for mercury two ways. One sample of treated lumps was crushed and blended for analysis. For another portion of treated lumps, the outside of each lump was scraped away and the cores were then crushed, blended, and analyzed. The final series of RTA tests were conducted at selected conditions to fill in specific additional data needs.

The supplemental tray desorption screening tests were performed at a range of temperatures from 350°C to 650°C. Ten tests were conducted, all using nitrogen as a purge gas and using a time-at-temperature of 10 minutes except for one test. Two of the tests were conducted using a "blank" sediment sample having very low mercury as a reference.

Table 5-1

Experimental Conditions for RTA Tests

Test Series	Temperature (°C)	Time (mins)	Purge Gas
1	350	10/15/20	Nitrogen
2	350	10	Steam, air, nitrogen
3	350	10	Air
4	350	60/10	Air, steam

5.3.2 Pilot-Scale Desorption Tests and Conditions

5.3.2.1 Test 1, Desorber "Shakedown" Test

A series of pilot-scale tests were to be performed. The first test was to establish operating conditions for the desorber in order to obtain the throughput and treatment goals desired. Test 2 was the verification test performed at 350°C and 10 minutes. Per Energy Systems request, a third test was performed at 600°C and 10 minutes.

Prior to performing the first pilot-scale test, a wipe test was performed on select desorber system hardware to verify no residual mercury or radioactivity was contained in the system from previous operations. The results of the wipe test were published in a report to Energy Systems dated April 1994. The results demonstrated that no consequential amount of mercury or radioactivity were present. Appendix D is a report describing the cleanliness testing and results.

Test 1 was used to develop operating criteria for the pilot-scale thermal desorber for treating the LEFPC soil to below 20 ppm. Such operational parameters as desorber tilt (5.7 cm per 1.2 m [2-1/4-inches per 4 feet]), cylinder speed (1.5 rpm), screw feed (3 rpm), and dam height (1.9 cm [0.75 inches]) were established. Once conditions were reached, this was a short test of approximately 1 hour at steady state. This test was performed at 350°C with 10 minutes retention time at temperature, and an outfall of 27.3 to 29.5 kg/hr (60 to 65 lbs/hr). Temporally related soil feed and discharge, and scrubber liquid and solids samples were collected and analyzed for mercury. The scrubber liquid was also analyzed for VOCs. Data from these analyses indicated that the discharge soil averaged less than 20 ppm. No other samples were collected. A record was maintained of the desorber operational parameters.

During Test 1, no operational upsets or problems occurred during the steady state operation.

Upon completion of the Test 1, the system was disassembled and cleaned before the next test. A new HEPA filter, Brinks pad, and carbon were installed. The demister pad in top of the scrubber was also cleaned; no visible mercury was found in the demister pad, but a small volume of elemental mercury was found in the scrubber tank. This elemental mercury was collected separately.

5.3.2.2 Test 2, 350°C Verification Test

Test 2 was the official verification test. The conditions developed during Test 1 were used to treat 242.7 kg (534 lbs) of soil. Temporally related samples, composite treated soil, off-gas, scrubber liquids and solids, vent gas, carbon, and Brinks demister pad were sampled and analyzed for various contaminants including mercury, VOCs, SVOCs, PCB, and selected metals. Figure 5-4 shows the sampling locations. Split samples of the treated soil were collected and submitted to Energy Systems for analysis. The test was also used to generate 100 pounds of soil for further Energy System studies, and 197.3 kg (434 lbs) of soil for backend material handling tests by IT. Certain operating parameters were identified as critical for the test. Tables 5-2 and 5-3 list those parameters and their frequency of collection. Process data sheets are included in Appendix E.

During Test 2, three slight system upsets occurred. The first upset, which occurred just as steady state was reached, involved jamming of one of the desorber strike hammers. This device is a steel bar mounted externally on the desorber to strike the tube twice during each cycle to knock material off the internal wall. The upset lasted only 5 minutes. The problem was alleviated by removing the hammer. Soil buildup was not a problem with this material.

Upset number two was caused by bridging of the feed soil in the screw feeder prior to arriving at steady state after the first upset. The initial soil, with a moisture content of less than 18 percent, was satisfactory during the test, but as the level of the drum decreased, the soil moisture content increased and packing of the soil became obvious. The desorber fire control operator noticed a temperature spike in the desorber profile. Upon investigation it was discovered that the feed to the system was bridged. After approximately 30 minutes of work, the feed system was unjammed, and the test resumed.

The final upset occurred during the steady state operation. This upset was a facility power failure. The power was off for only a short time and no temperature excursions outside the norm occurred; therefore, the test was able to resume when power returned. Backup air-driven pumps were activated to ensure effective operation of the scrubbing system, thereby preventing potential air emission.

5.3.2.3 Test 3, 600°C Verification Test

Test 3 was performed at different operating conditions and no gas sampling (except Orsat). Throughput and desorber settings were the same. Treatment temperature was 600°C for 10

SP	SAMPLE
01	Feed Soil
02	Treated Soil
03	Cyclone Solids
04	Composite of Scrubber Liquid A, B, C; 04D is Scrubber Filter solids; 04F is Float Solids
05	HEPA Filter
06	Carbon Adsorbers (P - primary, S - secondary)
07	Desorber Off-gas
08	Vent Emissions
09	Brinks Media

FIGURE 5-4. SAMPLING POINTS FOR PILOT SCALE THERMAL DESORBER VERIFICATION TESTS

Table 5-2**Desorber Operating Parameters and Recording Frequency
During 350°C Verification Test**

Parameter	Frequency	Range	Units
Soil temperature	30 minutes	325 to 390	°C
Feed soil weight	Each feed	6.4 to 11.8	kg
Discharged soil weight	Each discharge	6.4 to 15.4	kg
Soil feed rate	Every 30 minutes	32 to 36	kg/hr
Soil residence time (total)	Start, midpoint, end	20 to 25	minutes
Soil residence time (at temperature)	Start, midpoint, end	9 to 11	minutes
Purge gas flow	30 minutes	0.57	m ³ /min
Vent gas flow	30 minutes	0.051 to 0.34	m ³ /min
O ₂ in vent gas	Every hour	16 to 18	percent
CO ₂ in vent gas	Every hour	2.5 to 3.5	percent

Table 5-3**Desorber Operating Parameters and Recording Frequency
During 600°C Verification Test**

Parameter	Frequency	Range ^a	Units
Soil temperature	30 minutes	578 to 616	°C
Feed soil weight	Each feed	4.4 to 11.2	kg
Discharged soil weight	Each discharge	3.6 to 29.9	kg
Soil feed rate	Every 30 minutes	33 to 37	kg/hr
Soil residence time (total)	Start, midpoint, end	20 to 22	minutes
Soil residence time (at temp)	Start, midpoint, end	9 to 10	minutes
Purge gas flow	30 minutes	0.57	m ³ /min
Vent gas flow	30 minutes	0.14 to 0.26	m ³ /min
O ₂ in vent gas	Every hour	15.1 to 17.0	percent
CO ₂ in vent gas	Every hour	2.5 to 3.5	percent

^aRange if values recorded during steady-state period.

minutes at temperature. Orsat analysis of oxygen and carbon dioxide were performed. No upsets were experienced during operation. Process data sheets are included in Appendix E.

Certain operating parameters were identified as critical for the test. Table 5-3 lists those parameters and their frequency of collection.

5.3.3 Materials Handling Tests and Conditions

5.3.3.1 Physical Property Tests

The physical property tests were performed to assess handling characteristics such as adhesion, cohesion, and properties important to the design of feed systems. The "as received" soil was tested for an initial moisture content and Atterberg limits.

Lime addition, $\text{Ca}(\text{OH})_2$ (Calcium hydroxide), was also evaluated in an effort to produce a material which did not reagglomerate and had a lower moisture content than the sample's plastic limit. An addition of 1 and 2 percent lime by weight was added to two initial soil samples.

5.3.3.2 Feed Chute Tests (Drop Tests)

A summary of the tests and conditions for the feed chute tests is given in Table 5-4.

5.3.3.3 Reagglomeration Test

The reagglomeration test was designed to observe any tendency of the soil to reagglomerate in the kiln. If the soil formed a ball or "sausage" in the middle of the rotating drum, the soil was air-dried to reduce the moisture content and the test was repeated. If the soil did not form a ball, water was sprayed onto the soil until agglomeration occurred.

Table 5-5 summarizes the test conditions for the reagglomeration tests.

5.3.3.4 Back-End Materials Handling Tests and Conditions

To simulate a drag-flight conveyor for Test 1, 22.7 kg (50 lbs) of water was placed in the Nalgene tank. Then 22.7 kg (50 lbs) of the treated soil was poured into the water to make a 1:1, by weight, soil slurry. To demonstrate the drag-flight conveyor, a garden hoe with a modified blade of aluminum sheet metal measuring 15.2 cm (6 inches) tall by 45.7 cm (18 inches) wide was used to pull the soil up the dewatering beach at a rate of 3.0 m per minute (9.8 feet per minute).

Table 5-4

Drop Test Matrix

Moisture (%)	Chute Angles (degrees)	Drop Height (ft)
23.7	71, 60, 45	13
17	45	13
29.6	45	13
39.1	45, 45*, 71	13

* Redrop of previous sample to test for accumulation.

Table 5-5

Reagglomeration Test Matrix

Moisture (%)	Rotational Speed (RPM)
9	2
39.8	2
30.4	2
36	2

The soil was pulled 0.91 m (3 feet) up the dewatering beach, after which the soil was stockpiled and weighed. Samples were collected for moisture and the angle of repose of the pile measured. The angle was then again measured after vibration. This same procedure was then repeated again except the soil was held at the top of the tank for a total of 1 minute to allow all available free liquid to drain.

For Test 2, another 22.7 kg (50 lbs) of water was added to the soil slurry in the Nalgene tank. The previous procedures were again repeated.

For Test 3, another 22.7 kg (50 lbs) of water was added to the tank to create a 3:1 water to soil slurry. The above procedures were again repeated.

All three tests were videotaped and pictures were taken for each slump test (angle of repose). The moisture content tests were performed in a continuous emissions monitoring (CEM) moisture content microwave oven. The variability of this machine is usually plus or minus 1 percent.

5.3.4 Health and Safety Summary

Both the bench- and pilot-scale tests were conducted without a first-aid or Occupational Health and Safety Administration (OSHA) recordable accident or radiological contamination incident.

As shown in Table 5-6, all of the exposures to mercury vapors during the three pilot-scale tests were below the OSHA PEL of 0.05 mg/m^3 (8-hour time-weighted average).

In addition to the breathing zone samples collected, ambient air monitoring for mercury vapors was conducted throughout the EZ and regulated area with a Jerome Mercury Vapor Analyzer. Mercury vapor concentrations were also measured in workers' breathing zones and in close proximity to system and container openings during routine operations, filter changes, and system maintenance. Ambient mercury vapor concentrations throughout the EZ ranged from less than 0.003 to 0.015 mg/m^3 (the Jerome has a sensitivity of 0.003 mg/m^3). Mercury vapor concentrations measured inside the soil feed hopper, in an outfall soil bucket, and just above cyclone catch material, were 0.032 , 0.038 , and 0.006 mg/m^3 , respectively. The highest mercury vapor concentration measurement (0.12 mg/m^3) was obtained inside the bag filter housing during change out of the filter. A measurement made in the breathing zone of a worker performing a bag filter change was lower by an order of magnitude (0.012 mg/m^3).

Table 5-6**Mercury Breathing Zone Sample Results
for the LEFPC Pilot-Scale Thermal Treatment Tests**

Sample No.	Date of Test	8-hour TWA (mg/m ³)	Percent of OSHA PEL for Hg
5776-4	3/23/94	0.007	14
5780-4	3/23/94	0.008	16
5772-4	3/23/94	0.015	30
5771-4	3/23/94	0.010	20
5777-4	3/23/94	0.008	16
5775-4	3/23/94	0.014	29
5772-3	3/10/94	0.020	40
5771-2	3/10/94	0.045	89
5775-2	3/10/94	0.006	13
5780-2	3/10/94	0.016	31
5777-2	3/10/94	0.017	34
5772-2	3/10/94	0.017	34
5776-2	3/10/94	0.013	27
5776-1	3/4/94	0.001	2
6780-1	3/4/94	0.001	1
5772-1	3/4/94	0.004	7
5771-1	3/4/94	0.002	4
5777-1	3/4/94	0.003	5

Although elevated mercury vapor concentrations (i.e., greater than one-half the PEL) were found at system openings and during described filter change operations, general area and breathing zone measurements (real-time and sampling) confirmed that exposures to personnel were below the PEL.

6.0 SAMPLING AND ANALYTICAL METHODS

6.1 SOLIDS AND LIQUIDS SAMPLING

Samples were collected by taking a representative aliquot of the material to be sampled and transferring it to a sample container of appropriate type and size to hold the sample size needed for the required analyses, as listed in the SAP. Unless otherwise specified, sample containers were clean widemouth glass sample bottles with Teflon[®]-lined screw caps which will not introduce contamination into the sample. Samples were preserved as specified in the SAP.

6.1.1 Soils and Solids Sampling

Soil samples were taken after homogenization, at the feed, and after treatment. Samples for homogenization were taken from eight locations distributed over the entire pile of blended wet soil. Samples of the feed (sample location 1) were taken from the bucket used for feeding the desorber. The temporally related treated samples (sample location 2) were taken by placing a clean bowl under the lid of the discharge chute and collecting the sample. Cyclone solids samples (sample location 3) were taken at the conclusion of each verification test from the total amount of solids obtained after thorough mixing. Carbon adsorber samples (sample location 6) were taken at the conclusion of each verification test after emptying the carbon bed into a pan and mixing thoroughly.

6.1.2 Sludges, Sample Location 4

Sludge samples from the off-gas treatment system were collected from the filter bags in the scrubber water recirculating system after manually transferring the liquids from the WESP, condenser, and any rinsings into the scrubber recirculating system. After allowing the liquid to recirculate, the filter bags were removed and solids were scraped out of the bags into a pan and mixed thoroughly before sampling.

6.1.3 Float Solid, Sample Location 4

The float sample from the additional verification test at 600°C was collected by skimming off the floating phase from the combined scrubber liquids and vacuum-filtering this material separate the solids. The solids were transferred to an amber glass sample bottle with a Teflon[®]-lined screw cap.

6.1.4 Volatile Organic Compound Solids, Sample Locations 1, 2, 4, and 6

VOC samples were collected from the homogenized feed soil during characterization, composite-treated soil for TCLP, composite scrubber solids, and carbon as specified in the SAP. Cyclone solids were not analyzed for VOCs because of the limited amount of sample collected in the 350°C verification test. Samples were collected as soon as possible from the material to be sampled by transferring a representative aliquot of the material into two volatile organic analysis (VOA) vials with a minimum amount of sample agitation and open handling. The vials were filled with material and contained as little void as possible. The vials were then capped with a Teflon®-lined septum screw cap.

6.1.5 Grain (Particle) Size and Atterberg Limit Samples, Sample Locations 1, 3, and 4

Larger soil sample sizes were required for grain size and Atterberg limits analyses on the homogenized soil during characterization and front end materials handling testing. Sampling was performed by transferring a representative aliquot for analysis into a plastic bucket with a lid enclosure. Soils were mixed and blended to ensure homogeneity prior to sampling and a clean scoop was used to transfer material to the sample container. Grain (particle) size analyses by hydrometer were performed on the cyclone solids and the composite scrubber solids; these samples were collected by transferring a representative aliquot to a sample bottle.

6.1.6 Demister Pads and HEPA Filter

For analysis of the demister pads and HEPA filter from the pilot-scale thermal testing, the filter media was removed from its housing (HEPA) and was shredded, mixed, and then placed into sample bottles for analysis. The sample bottles were capped with Teflon®-lined lids.

6.2 WIPE SAMPLES FOR CLEANLINESS

Wipe samples of the pilot-scale thermal desorber were taken to verify equipment cleanliness. Samples were taken independently for gross alpha/beta and mercury contamination. Gross alpha/beta screens were performed on 3.8 cm-inch-diameter paper smears of equipment surfaces, each taken by wiping 100 square centimeters (cm²) of surface area. Mercury samples were taken by wiping 100 cm² of surface area using gauze material dampened with an aqueous solution of nitric acid. The wipe samples were then placed into individual sample bottles for labeling and analysis.

6.3 LIQUID SAMPLES

6.3.1 Aqueous Samples Non-VOC Analyses, Sample Location 4

Aqueous samples for all except VOC analyses were collected by taking a representative aliquot of the liquid to be sampled and transferring it to a clean glass sample bottle with a Teflon®-lined screw cap. The sample bottle was of appropriate size to hold the sample size needed for the required analyses as listed in the SAP. Samples were preserved at the time of collection as specified in the SAP.

Prior to collecting aqueous liquid samples at the end of each pilot desorber test, the WESP and condenser liquids were added to the scrubber water recirculation system. After compositing the liquids, recirculation was started to ensure that the liquid was homogeneous. Samples were taken either from a sampling port in the recirculation system directly into the sample bottle.

6.3.2 Aqueous VOC Samples, Sample Location 4

Aqueous VOC samples were collected as soon as possible from the material to be sampled by transferring a representative aliquot of the material into two 40-milliliter (mL) VOA vials with a minimum amount of sample agitation and open handling. The vials were filled with liquid to contain no head space. The vials were capped as soon as possible with a Teflon®-lined septum screw cap, with no air bubble present in the sample upon inversion of the vial. Samples were preserved at the time of collection as specified in the SAP.

The liquids were composited as described in Section 6.3.1 and the VOC sample was taken from the sample port on the recirculation line.

6.4 OFF-GAS SAMPLING

Off-gas sampling was performed during the final verification test at 350°C. No gas sampling (by sampling train) was performed during the shakedown test or the final test at 600°C. Details of the off-gas sampling methods and procedures are contained in Appendix F.

6.5 ANALYTICAL METHODS

Sample analyses were performed at three analytical levels: Levels II, III and IV, as defined by "Data Quality Objectives For Remedial Response Activities," EPA, March 1987, and interpreted for this project given the analytical methods requested in the request for proposal (RFP). Definitions of Levels II, III, and IV are presented in Section 7.1.

Level II analyses included process screening analyses for mercury and gross alpha/beta conducted either at IT's Environmental Technology Development Center (ETDC) in Oak Ridge, Tennessee during soil homogenization and pilot-scale thermal testing, or at IT's Technology Development Laboratory (TDL) in Knoxville, Tennessee during bench-scale testing. Level II analytical work was also performed during process residuals treatment and materials handling testing at the TDL and ETDC. This work included analyses for mercury as well as gross alpha/beta screening on treated material.

Level IV analyses were selected to provide a minimum of 10 percent of the analyses on selected parameters during the final verification tests and to provide consistency in data where data comparisons were most significant. The remaining analyses defined in the SAP were performed at analytical Level III for the final verification tests.

Geotechnical or physical property determinations are usually categorized as "other" in terms of the analytical level applied; however, for the purposes of this project, geotechnical measurements that were performed at the geotechnical laboratory at ETDC by standard American Society for Testing and Materials (ASTM) methods were categorized as Level III analyses.

6.5.1 Analytical Level II Procedures

Level II analyses are designed to provide rapid turnaround of results to aid in process development. The analytical methods are based on standard analyses, but may have modifications to provide results as close to real time as possible. Results from Level II analyses were used to guide process development efforts and support pilot-scale thermal testing.

Level II analyses included process screening analyses for mercury by CVAA, RCRA metals by inductively coupled argon plasma-atomic emission spectroscopy and gross alpha/beta conducted either at ETDC in Oak Ridge, Tennessee, or at TDL in Knoxville, Tennessee. In addition, Modified TCLP (MTCLP) extractions were performed on stabilized solids during thermal treatment residuals processing.

Table 6-1 lists the Level II analyses that were performed.

6.5.2 Analytical Level III Procedures

Level III analyses were performed on solid and liquid samples at an ITAS laboratory either at Middlebrook Pike in Knoxville, Tennessee or at St. Louis, Missouri. Level III analyses were

Table 6-1**Level II Screening Analytical Methods**

		Sample Preparation		
Parameter	Abrev.	Water	Soil	Analysis
Chemical Analyses:				
Mercury	Hg	7470	7471 ^a	7470/1 ^a
Metals: TCLP metals	Metals		3050	6010
Modified TCLP: Mercury	MTCLP		1311	7471 ^a
TCLP Metals	MTCLP		1311	6010
Radiochemical Analyses:				
Gross alpha/beta	Gross a/b			GPC

^aSingle analysis; not performed in triplicate.

Analysis method numbers refer to EPA SW-846, Third Edition, unless otherwise noted.

GPC - Gas Flow Proportional Counter.

Reference method for modified TCLP (MTCLP) extraction.

also performed on VOST and Semivolatile Organic Sampling Train (SVOST) off-gas samples at Southwest Research Institute in San Antonio, Texas. The analytical methods were standard methods (EPA, Standard Methods, etc.) and reporting documentation was the standard Certificate of Analysis, except for the VOST and SVOST samples which were reported in CLP format.

Table 6-2 lists the Level III as well as Level IV (discussed in Section 7.3) analyses that were performed and the methods that were used.

Table 6-3 summarizes the off-gas sampling and analytical methods that were used.

Analysis of the first VOST tube pair from the desorber off-gas showed high sample loadings that saturated instrument response and interfered with internal standards. Subsequent desorber off-gas VOST tube analyses were performed using an alternate method. The alternate method was performed by desorbing the VOST tube pair into methanol chilled with dry ice and then analyzing the methanol by SW-846 Method 8260 at the appropriate dilution.

6.5.3 Analytical Level IV Procedures

Level IV analyses were performed at IT's analytical laboratory in St. Louis, Missouri (ITAS-St. Louis). Project-specific QC samples were analyzed with each sample matrix and CLP format reports were provided.

Table 6-2 lists the Level III and Level IV analyses that were performed and the methods that were used.

Table 6-2

Level III and Level IV Analytical Methods

		Sample Preparation		
Parameter	Abrev.	Water	Soil/Solid	Analysis
Chemical Analyses:				
Mercury	Hg	7470	7471 ^a	7470/1 ^a
Arsenic	As	7060	3050	7060
Cadmium	Cd	3010	3050	7131
Metals: TCLP metals	Metals	3010	3050	6010
Sulfate	Sulf.	300.0 ^b	300.0 ^b	300.0 ^b
Total organic carbon	TOC	415.1 ^b	415.1 ^b	415.1 ^b
Volatile organic compounds	VOC	5030	5030	8260
Semivolatile organic compounds	SVOC	3520	3540	8270
Polychlorinated biphenyls	PCB	3520	3540	8080
Polychlorinated dioxins and furans	PCDD/F	8280	8280	8280
TCLP: Mercury TCLP metals Arsenic Cadmium Selenium Lead Volatile organic compounds Semivolatile organic compounds Pesticide Herbicide	TCLP		1311 1311 1311 1311 1311 1311 1311 1311 1311 1311	7471 ^a 6010 7060 ^c 7131 ^c 7740 ^c 7421 ^c 8240 8270 8080 8150
Geotechnical Analyses: Unconfined compressive strength Grain size	UCS Gr Size			ASTM D2166 ASTM D422
Radiochemical Analyses: Total uranium Isotopic uranium	Total U Iso U	KPA	KPA/G-Spec A-Spec	

^aSingle analysis; not performed in triplicate.^bEPA Manual of Methods for the Chemical Analysis of Water and Wastes.^cPerformed on treated soil for the 600° C run only.

Analysis method numbers refer to EPA SW-846, Third Edition, unless otherwise noted.

G-Spec - Gamma Spectroscopy

A-Spec - Alpha Spectroscopy

KPA - ASTM 5174-91

Table 6-3

Off-Gas Sampling and Analytical Methods

Parameter	Abrev.	Sampling	Analysis
Particulate: Particle size Weight	Particle size Particulate	M5 M5	ASTM D422 Weight
Gases: Acid gases Ammonia	A Gases A Gases	M5 M5	300.0 ^a 350.1 ^a
Monitoring: Oxygen Carbon Monoxide	O ₂ Co		3 ^b 10 ^b
Mercury	Hg	MMT	7470/7471 ^c
Arsenic/cadmium	As.Cd	MMT	7060/7131
Volatile organic compounds	VOC	VOST	5040/8240 ^d
Semivolatile organic compounds	SVOC	MM5	8270
Total uranium	Total U	MMT	KPA

^aEPA Manual of Methods for the Chemical Analysis of Water and Wastes.

^bMethods from 40 CFR, Part 60, Appendix A.

^cSingle analysis; not performed in triplicate.

^dA modified VOST analysis was performed due to high sample loadings; see text.

Analysis method numbers refer to EPA SW-846, Third Edition, unless otherwise noted.

M5 - Modified version of EPA Method 5 Sampling Train (EPA Method 0050).

MM5 - EPA Modified Method 5 Sampling Train (EPA Method 0010).

MMT - Modified version of EPA Multi-Metals Sampling Train (EPA Method 0012).

7.0 QUALITY ASSURANCE

7.1 ANALYTICAL OBJECTIVES

7.1.1 Analytical Methods

Analytical data quality objectives (DQO) are qualitative and quantitative statements used to design a study that will limit uncertainty to an acceptable level. DQOs provide a systematic process for verifying that analytical data are adequate for the intended use.

Five levels of analytical support (analytical levels) have been defined in "Data Quality Objectives For Remedial Response Activities," EPA, March 1987. Sample analyses were performed at three analytical levels: Levels II, III and IV, as interpreted for this project.

Level II. Analyses performed on site at the facility where treatment testing was performed. Analyses are designed to provide rapid turnaround of results to aid in process development. The analytical methods are based on standard analyses, but may have modifications to provide results as close to real time as possible. Analyses use limited quality control procedures and are normally considered screening level.

Level III. Analyses performed off site at an established laboratory. Analyses designed to provide results within the accuracy of routine laboratory operation using internal quality assurance/quality control (QA/QC) program controls. The analytical methods are standard methods (EPA, Standard Methods, etc.) and reporting documentation is the standard certificate of analysis.

Level IV. Analyses performed off-site at an established laboratory that provides Contract Laboratory Program (CLP) level of analytical effort and QA/QC for the methods specified. Analyses are designed to provide results within the CLP QA/QC and reporting requirements as are consistent with the stated methods. Project-specific QC samples are analyzed with each sample matrix, and CLP reporting documentation is provided. Reporting documentation includes a case narrative, summaries of sample, QC and calibration results, and copies of all sample chain-of-custody information and raw data, including sample and calibration data, test logs, logbooks, etc.

Level II analyses included process screening analyses for mercury and gross alpha/beta conducted either at IT's Environmental Technology Development Center (ETDC) in Oak

Ridge, Tennessee during soil homogenization and pilot-scale thermal testing, or at IT's Technology Development Laboratory (TDL) in Knoxville, Tennessee, during bench-scale testing. Level II analytical work was also performed during process residuals treatment and materials handling testing at the TDL and ETDC. This work included analyses for mercury as well as gross alpha/beta screening on treated material.

Level IV analyses were selected to provide a minimum of 10 percent of the analyses on selected parameters during the final verification tests and to provide consistency in data where data comparisons were most significant. The remaining chemical analyses defined in the SAP were performed at analytical Level III for the final verification tests.

Geotechnical or physical property determinations are usually categorized as "other" in terms of the analytical level applied; however, for the purposes of this project, geotechnical measurements that were performed at the geotechnical laboratory at ETDC by standard American Society for Testing and Materials (ASTM) methods were categorized as Level III analyses.

Detection limits for all methods used were the best possible considering the methodology, instrumentation, and sample matrices.

7.1.2 Analytical Completeness

Precision, accuracy, representativeness, completeness, and comparability (PARCC) requirements are the standards against which chemical analysis data are judged. PARCC requirements, except comparability, were stated in the QAPjP. There were no requirements for data comparability.

Data completeness is defined as the percentage of useable data points from the set of total data points that were required to obtain a specified confidence level. Table 7-1 presents the results of data completeness through the pilot testing/final verification test phases of the project. All values were greater than the 90 percent requirement except for VOC results. This was caused by the cancellation of the VOC analyses for all but the carbon adsorption bed sample on the pilot test, Test 2 (final verification, 350°C) due to elevated sample temperature (12°C) during storage. The temperature of storage for these samples exceeded the allowable upper limit of 6°C by six degrees during the process of shipment to the analytical lab. According to the SAP, a complete set of VOC results were to be obtained

Table 7-1

Summary of Analytical Data Completeness

Analysis	Completeness
Metals (except mercury)	93%
Mercury	97%
Total U	100%
SVOC	90%
VOC	70%
PCBs	100%
Acid Gases	100%

during the final verification test. These results were subsequently obtained during the additional pilot test: Test 3 (600°C).

In addition to collecting physical samples for analysis, operational data were also acquired during the pilot-scale verification testing. Key operational data to be collected, data collection frequency, and data completeness requirements were also specified in the QAPP. Data were acquired during system steady-state operation. Table 7-2 presents a summary of frequency and completeness for these data. Accuracy of these measurements were within the tolerances of the measurement equipment used. There were no requirements for measurement precision.

7.2 QUALITY ASSURANCE PROCEDURES

IT's Process Development Laboratory has an established Quality Assurance Program that specifies minimum quality requirements. To supplement this program, a QAPjP was developed. The project-specific QAPjP detailed specific requirements for a variety of quality assurance issues, including:

- Project organization and responsibilities
- Quality assurance objectives for measurement data
- Sample custody
- Equipment calibration
- Treatability testing and analytical procedures
- Data reduction, review, and reporting
- Internal quality control checks
- Project-specific performance and system audits
- Equipment preventive maintenance
- Procedures for assessing data precision, accuracy, and completeness
- Corrective actions
- Document and record control
- Personnel training and qualification.

The project SAP detailed requirements for sampling and sample analysis during each phase of the project.

Key operational data were collected using equipment that had been recently calibrated. Calibration requirements were the more stringent of either the manufacturer's specifications or project specific requirements. Equipment used to collect noncritical operational data were checked out prior to use, but not necessarily calibrated (e.g. clock, level, tape measure, etc.).

Table 7-2

Summary of Pilot-Scale System Key Operational Data Completeness

Data Obtained	Frequency	Completeness
Soil temperature	Every 30 minutes	100%
Purge gas flow	Every 30 minutes	100%
Vent gas flow	Every 30 minutes	100%
Feed soil weight	Each feed	100%
Discharge soil weight	Each discharge	100%
O ₂ and CO in vent gas	Every hour	100% for O ₂ 50% for CO
Soil residence time	Start, midpoint, and end of test	100%

Several peer reviews were conducted during the course of the project. Reviews were conducted of the project work plan, pilot-scale system safety, pilot-scale system operational readiness, analytical data, and this report. Peer reviews were conducted by personnel who are technically qualified by education and/or experience, and have no direct involvement with project operations. A quality system review was conducted by a representative of Martin Marietta Energy Systems prior to pilot-scale system operation. Analytical data were reviewed by the Analytical Task Manager and the Quality Assurance Officer. The Project Manager and Quality Assurance Officer reviewed the project file after the preliminary report (oral briefing) was presented.

Key project personnel have prior operational experience with either (or both) the bench-scale apparatus or pilot-scale desorber. These individuals conducted a series of training sessions to prepare other project personnel for the pilot-scale desorber demonstration. Training was provided in the areas of health and safety, quality assurance, and equipment operation. A preliminary test of the thermal desorber was made to check-out the system and give operators hands-on training.

Most sample analyses were performed according to industry accepted methods (SW-846, ASTM, etc.). Some screening level analyses used slightly modified procedures to provide near real-time data. Selected analyses performed by outside laboratories were verified by in-house analysis.

A Nonconformance/Variance Report form was used to record discrepancies and deviations from project plans. Variances are preapproved deviations; a nonconformance is a violation of a specific project requirement. A summary of these nonconformances and variances is presented in Section 7.4.

7.3 QUALITY ASSURANCE RESULTS

Results of QC Sample Analyses. The detailed QC sample results are summarized along with the corresponding sample in the sample results summary tables in Appendix G.

Precision and accuracy results from Level III and Level IV analyses are discussed in the following paragraphs with respect to the stated requirements for the analysis. Requirements for precision and accuracy were outlined in the QAPjP.

Metals QC data for cadmium and mercury results were masked by the high sample concentrations of these metals (QC spike was usually less than one tenth of the sample amount) and little recovery data are available. Precision, however, as measured by the relative percent difference (RPD) of the QC sample results, was generally in control with no significant problems. Arsenic results suffered the same problems, but to a lesser degree. The arsenic spike amount was about one-half to one times the sample amount and spike recovery results were obfuscated by sample analysis variability.

Semivolatile compound QC data for soil and aqueous samples showed acceptable surrogate recoveries with the exception of two low phenolic surrogate recoveries on the TCLP extract from the treated soil from Test 2. This sample also showed low recoveries for phenolic spiked compounds. Most matrix spike (MS) and matrix spike duplicate (MSD) recoveries were acceptable, with some low recoveries noted for pentachlorophenol and pyrene for the treated soil composite and cyclone solids samples. The liquids and solids often had surrogates and MS/MSD spikes diluted out because of high semivolatile sample concentrations; in those cases, no QC results were obtained. The carbon adsorber bed samples consistently showed little or no surrogate recovery upon analysis, demonstrating that the extraction of the semivolatile compounds from carbon was incomplete and results should be considered as minimum amounts.

Volatile compound QC data for soil and aqueous samples were within stated requirements with no notable exceptions. The carbon adsorber bed samples, except for the primary carbon bed sample from Test 3, showed low surrogate recoveries for 4-bromofluorobenzene and toluene-d₈, but recoveries for dibromofluoromethane were within requirements for all samples.

PCB QC data for the treated soil composite and cyclone solids samples, which contained little PCB, were within requirements. However, the QC data for the liquid and solid samples were obscured by sample PCB concentrations and little data are available.

The QC data obtained from VOST and SVOST samples showed no notable problems with surrogate recoveries outside of the CLP requirements, except for one VOST tube pair which had low recoveries due to high sample concentrations interfering with surrogate responses. Analysis of this sample prompted the use of the alternate method of analysis (discussed in Section 6.0) for the remaining VOST samples.

7.4 SUMMARY OF VARIANCES AND NONCONFORMANCES

Nonconformance/Variance Reports were used to document deviations from established project plans. A complete list of variances and nonconformances is presented in Appendix H.

A total of 27 deviations (15 nonconformances and 12 variances) were recorded for the project. Based on the root cause, the cause of these deviations can be divided into four categories, planning, sample characteristics, plan changes due to schedule compression, and a form change.

Thirteen of these deviations can be attributed to incorrectly specifying certain procedural details in the written product. A more thorough review of the project plans by all disciplines would have prevented most of these planning errors.

Sample characteristics were responsible for seven deviations. Moisture content, size of debris, insufficient sample for analysis, and too much sample were all causes of deviations.

A change in the Request for Analysis form contributed to four deviations. A computer generated form was used in place of the standard ITAS form. There were several handwritten changes on the form, and the laboratory interpreted the information differently than was intended. This situation might have been prevented if the standard ITAS form had been used.

The last three deviations were due to changes to the project plan caused by the project time schedule compression.

With two major exceptions, most of the deviations had little to no effect on the project objectives. One exception (TDL-020-94) involved two coolers which were returned by Federal Express due to improper packaging/labeling. These coolers contained the volatile samples from the scrubber liquid, scrubber solids, and cyclone solids from the 350°C pilot-scale desorber test (Test 2). The temperature of the samples was measured at 12°C, and the volatile analyses were cancelled. The other exception (TDL-023-94) involved a miscommunication on the Request for Analysis form, resulting in semivolatiles not being analyzed on the primary carbon filter in the off-gas treatment system. In each case, backup data were obtained during either the preliminary test (Test 1) or the 600°C test (Test 3).

8.0 TEST RESULTS AND DISCUSSION

8.1 SOIL PREPARATION AND CHARACTERIZATION

8.1.1 Results

Tables 8-1 through 8-5 present the characterization results of the untreated, prepared soil. No table is included for VOCs because none were detected. Trace levels of various PAHs (approximately 9 mg/kg total) were identified. Arochlor-1260 was the only PCB detected; the concentration was 1.85 mg/kg. Barium and lead were present at moderate concentrations; two of the metals, arsenic and cadmium, were not present at significant concentrations. Table 8-1 results for eight grab samples show that the soil was well homogenized with an average mercury concentration of 283 ppm (wet basis) and a RSD of 11 percent.

The moisture content of the soil as received was 24.4 percent; the Atterberg limits were 32 for the liquid limit and 50 for the plastic limit. The total organic carbon (TOC) value for the soil was 4.7 percent (S.Y. Lee, University of Tennessee, September 7, 1994, personal communication).

Examination of the soil particle size shows that the greatest fraction (approximately 60 percent) is silt. The U.S. Department of Agriculture (USDA) classification is silty loam and the U.S. Geological Survey (USGS) classification is sandy and silty clay. A moderate fraction (e.g., about 20 percent) of the soil was classified as clay (less than 2 micron). Analytical data for the characterization samples is included in Appendix G.

8.1.2 Observations

No free liquid was present in the "as received" soil prior to or after thawing. The only moisture present was the "sweating" of the soil inside the drum. At 24.4 percent moisture content, the "as received" soil would reaggregate and "ball" when squeezed in a gloved hand, indicating that the soil needed to dry prior to feeding to the pilot-scale thermal desorber. Air drying of the soil in the trays for several days resulted in the moisture dropping to 17.5 percent for use in the first two pilot tests. Some additional drying occurred in storage such that the soil used in the third test had 14 percent moisture. Grass and rocks greater than one-half inch were removed from the soil. The percentage removed was 2.8 percent of the total soil received.

Table 8-1

Soil Characterization - Mercury Analysis for Homogeneity

As Received Sample	Hg Concentration
GRAB 1	351
GRAB 2	288
GRAB 3	265
GRAB 4	262
GRAB 5	254
GRAB 6	297
GRAB 7	264
GRAB 8	286
AVERAGE	283 (374) ^a
RSD	11%

^aAverage mercury on dry solids basis.

NOTE: Results in mg/kg, ppm, as received moisture (24.4 percent).

Table 8-2

Soil Characterization - Inorganic Analysis

Analyte	Concentration
Arsenic	5.3
Barium	178
Cadmium	8.4
Chromium	53.4
Lead	78.1
Mercury	258 (341) ^a
Selenium	ND(14.8)
Silver	9.4

^aMercury value of composite on a dry solids basis.

NOTE: Results in mg/kg, ppm, based on average of duplicate samples; as received moisture.

Table 8-3

**Soil Characterization
Total and Isotopic Uranium Analysis**

Analyte	Concentration
U-238	18.6
U-235, U-236	1.04
U-234	28
Total U	47.6

NOTES: Results in pCi/g, based on average of duplicate samples; as received moisture.
Total Specific Activity - $1.49\text{E-}4 \mu\text{Ci/g}$.

Table 8-4**Soil Characterization
Semivolatile Analysis**

Analyte	Concentration
2-Methylnaphthalene	40 J
Acenaphthylene	103 J
Fluorene	37 J
Phenanthrene	535
Anthracene	120 J
Fluoranthene	1100
Pyrene	925
Benzo(a)anthracene	510
Chrysene	575
bis(2-ethylhexyl)phthalate	175 J
Benzo(b)fluoranthene	1050
Benzo(k)fluoranthene	315 J
Benzo(a)pyrene	665
Indeno(1,2,3-cd)pyrene	490
Dibenzo(a,h)anthracene	120 J
Benzo(g,h,i)perylene	450

J - Estimated value.

NOTES: Results in $\mu\text{g/kg}$, ppb, based on average of duplicate samples; as received moisture.
Other analytes not detected; detection limit 330-1600 $\mu\text{g/kg}$.

Table 8-5**Soil Characterization
Particle Size Analysis**

Sieve No.	Diameter, mm	Percent Finer
10	2	99
40	0.85	98.2
60	0.425	96.7
100	0.25	94.9
140	0.149	91.6
200	0.106	88.4
	0.075	83.6
	0.05427	76.9
	0.03974	69.8
	0.02933	60.8
	0.01921	53.7
	0.01161	42.9
	0.00842	35.8
	0.00608	30.4
	0.00432	26.8
	0.00303	22.4
	0.00131	15.2

8.2 THERMAL DESORPTION

8.2.1 Bench-Scale Desorption Results

The results for the bench-scale desorption testing are summarized in Tables 8-6 and 8-7. From Table 8-6 data, only one RTA test achieved a residual mercury concentration below 10 ppm; this test had the longest residence time at temperature of 1 hour. There was no significant difference between all the RTA results considering the typical variability to be expected in sampling and analytical accuracy for multiple tests from the same prepared soil batch. Residence time (between 10 and 20 minutes) and purge gas type do not have a major influence on mercury removal. The oxygen concentration in the RTA vent gas from the first four experiments was higher than expected due to leakage through the seals, which were replaced. The use of nitrogen and steam purge reduced the oxygen level to approximately 2 to 5 percent for Tests 5 and 7. Oxygen was apparently consumed during the air purge tests; the oxygen level dropped to 10 to 20 percent during a portion of Tests 6 and 9.

According to the tray test results, increased temperature resulted in lower residual mercury values, but the apparent influence of temperature is not significant. Although all the results were below 10 ppm at temperature above 400°C, there is not a definitive correlation in the range from 450 to 650°C. However, at higher temperatures, the physical and chemical characteristics of the soil would be more altered due to decomposition of organic matter and other thermal effects.

Based upon the results of the bench studies and after consultation with Energy Systems, the decision was made to perform the initial pilot tests at 350°C and 10 minutes.

Bench-Scale Speciation Study Results. The results of the speciation study are described in Appendix B.

8.2.2 Pilot-Scale Desorption Results

8.2.2.1 Soil and Residuals Results

A summary of the analytical results for the verification test at 350°C are given in Tables 8-8 through 8-14. Results for the verification test at 600°C are given in Tables 8-15 through 8-20. Most results are given on a dry basis to enable comparison between the feed soil and the solid residuals (i.e., to evaluate if any constituent concentrated in any residuals that were comprised principally of soil particles.). Detailed analytical data is given in Appendix G.

Table 8-6**Lower East Fork Poplar Creek
Mercury Desorption RTA Test Summary**

Run #	Time (minutes)	Soil Temperature (°C)	Purge Gas	Purge Gas Rate	Final Hg (ppm)	Oxygen (percent) ^a
1	10	350	Nitrogen	1 L/MIN	14.1	19.7 - 14.1
2	15	350	Nitrogen	1 L/MIN	16.1	17 - 11.8
3	20	350	Nitrogen	1 L/MIN	15.4	16.3 - 11.3
4	10	350	Steam	1 L/MIN	13.3	17.7 - 13.7
5	10	350	Nitrogen	1 L/MIN	15.1	4.8 - 2.7
6	10	350	Air	1 L/MIN	12.1	20.2 - 10.0
7	10	350	Steam	1 L/MIN	11.4	3.5 - 2.1
8	60	350	Air	1 L/MIN	9.3	18.2 - 20.7
9 ^b	10	350	Air	1 L/MIN	7.4 - 8.7 ^c	18.8 - 12

^aRange of oxygen concentration during time at temperature.

^bTest using large >1/2" lumps of LEFPC soil.

^cRange of results for overall large lumps and corings from lumps.

Table 8-7

**Lower East Fork Poplar Creek
Mercury Desorption Tray Test Summary**

Run #	Time (minutes)	Soil Temperature (°C)	Purge Gas	Purge Gas Rate	Final Hg (ppm)
1	10	350	Nitrogen	0.6 L/MIN	16.1
2	10	350	Nitrogen	2 L/MIN	ND(0.1) ^a
3	10	350	Nitrogen	2 L/MIN	ND(0.1) ^b
4	10	400	Nitrogen	0.6 L/MIN	11.2
5	10	450	Nitrogen	0.6 L/MIN	9.9
6	10	500	Nitrogen	0.6 L/MIN	8
7	10	550	Nitrogen	0.6 L/MIN	7.1
8	20	550	Nitrogen	0.6 L/MIN	9.5
9	10	600	Nitrogen	2 L/MIN	7.8
10	10	650	Nitrogen	2 L/MIN	6.3

^aClean sand.

^bEstuary sediment NIST standard with 63 ppb mercury.

Table 8-8**350°C Verification Tests Mercury Analysis
Temporally Related Soil Samples**

Feed Soil		Treated Soil	
	458		11.6
	467		16.2
	473		18.6
	492		10.8
	476		14.6
	584		14.4
	519		14.6
	507		12.9
	464		12.2
	591		11.1
Average	503	Average	13.7
RSD %	9.7	RSD %	18

NOTE: Results in mg/kg, ppm, dry solids basis.

Table 8-9

350°C Verification Test Metals Analysis

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Carbon
Arsenic	6.9	8.3 ^b	9.3	0.0	9.1	ND(50)	NA ^c
Barium	235	NA	NA	NA	NA	185	NA
Cadmium	111	10.8	12.5	NA	13.8	ND(1)	NA
Chromium	70.6	NA	NA	9.0	NA	ND ^d (2)	NA
Lead	103	109	NA	NA	NA	ND(10)	NA
Mercury	341	14.6	35.4	6.2	6260.0	1.9	204
Selenium	ND(14.8)	0.5	NA	NA	NA	ND(25)	NA
Silver	12.4	NA	NA	0.0	NA	ND(1)	NA

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bOne of duplicate samples; the other sample had less than the detection limit of 8.5 mg/kg.

^cNA - Not analyzed.

^dND - Below method detection limit given in parenthesis.

NOTE: Results in mg/kg, on a dry solids basis except scrubber liquid, mg/L.

Table 8-10**350°C Verification Uranium and Gross Alpha/Beta Analysis**

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary Carbon
Uranium							
U-238	24.7	NA	NA	NA	NA	NA	NA
U-235/U-236	1.3	NA	NA	NA	NA	NA	NA
U-234	37.0	NA	NA	NA	NA	NA	NA
Total U	63.1	15.9	26.4	0.1	25.7	<3.68	NA
Gross Alpha	69.1	104.0	119.0	0.51 ^b	NA	90.0	36 ^b
Gross Beta	39.5	85.0	92.5	b	NA	43.7	b

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bGross alpha and beta total.

NOTE: Results in pCi/g, on a dry solids basis, except scrubber liquid, pCi/mL; average of duplicate samples for uranium values.

Table 8-11**350°C Verification Test Volatiles Analyses**

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids ^b	HEPA	Carbon
Benzene	ND(5)	NA	NA	87	845	NA	120000
Toluene	ND(5)	NA	NA	92	2850	NA	74000
Ethyl benzene	ND(5)	NA	NA	14	1250	NA	132000
Styrene	ND(5)	NA	NA	140	6850	NA	10400
Isopropylbenzene	ND(5)	NA	NA	ND(10)	445	NA	ND(12000)
Propylbenzene	ND(5)	NA	NA	8	2100	NA	NA
Xylene (Total)	ND(5)	NA	NA	NA	NA	NA	18800
O-Xylene	NA	NA	NA	30	2200	NA	NA
P/M-Xylene	NA	NA	NA	35	3450	NA	NA
N-Butylbenzene	ND(5)	NA	NA	5	5600	NA	ND(12000)
1,2,4-Trichlorobenzene	ND(5)	NA	NA	2	840	NA	ND(12000)
Naphthalene	ND(5)	NA	NA	370	465000	NA	ND(12000)
1,2,4-Trimethylbenzene	ND(5)	NA	NA	12	8200	NA	2900

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bData from shakedown test; VOCs were not analyzed on 350°C verification test.

NOTE: Results in µg/kg, ppb, on a dry solids basis except for scrubber liquid, µg/L.

Table 8-12

350°C Verification Test Semivolatile and PCB Analysis

(Page 1 of 4)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Carbon
2-Methylnaphthalene	52	ND(330)	ND(330)	85 ^b	13400 ^c	NA	NA
Acenaphthylene	136	ND(330)	ND(330)	ND(250)	3270 ^d	NA	NA
Anthracene	159	ND(330)	ND(330)	ND(250)	6600	NA	NA
Benzo(a)anthracene	675	ND(330)	ND(330)	ND(250)	4200	NA	NA
Benzo(a)pyrene	880	ND(330)	ND(330)	ND(250)	2800	NA	NA
Benzo(b)fluoranthene	1400	ND(330)	ND(330)	ND(250)	4800	NA	NA
Benzo(g,h,i)perylene	595	ND(330)	ND(330)	ND(250)	1200 ^b	NA	NA
Benzo(k)fluoranthene	417	ND(330)	ND(330)	ND(250)	ND(1600)	NA	NA
Chrysene	761	ND(330)	ND(330)	ND(250)	6700 ^d	NA	NA
Dibenzo(a,h)anthracene	159	ND(330)	ND(330)	ND(250)	367 ^b	NA	NA
Fluoranthene	1500	ND(330)	53 ^b	ND(250)	19100	NA	NA
Fluorene	243	ND(330)	ND(330)	ND(250)	2400 ^b	NA	NA
Indeno(1,2,3-cd)pyrene	648	ND(330)	ND(330)	ND(250)	1200 ^b	NA	NA
Naphthalene	ND(330)	ND(330)	58 ^b	260	13200 ^c	NA	NA
Phenanthrene	708	ND(330)	53 ^b	31 ^b	26300 ^c	NA	NA
Pyrene	1200	ND(330)	ND(330)	ND(250)	13900 ^c	NA	NA

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bEstimated value.

^cDiluted sample.

^dDiluted sample and estimated value.

NOTE: Results in µg/kg, ppb, on a dry solids basis except scrubber liquid, µg/L.

Table 8-12

(Page 2 of 4)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA
Phenols						
2,4-Dimethylphenol	ND(330)	ND(300)	ND(300)	830	ND(1600)	NA
2-Methylphenol	ND(330)	ND(300)	ND(300)	ND(250)	2000 ^d	NA
4-Methylphenol	ND(330)	ND(300)	ND(300)	3400 ^d	5400 ^d	NA
4-Nitrophenol	ND(1600)	ND(1600)	ND(1600)	ND(1200)	7100 ^b	NA
Phenol	ND(330)	34 ^b	100 ^b	14000 ^d	13000 ^c	NA

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bEstimated value.

^cDiluted sample.

^dDiluted sample; estimated value.

NOTE: Results in µg/kg, ppb, on a dry solids basis except scrubber liquid, µg/L.

Table 8-12

(Page 3 of 4)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Carbon
Others							
1-H-Isoindole-1,3-(2H)dione*	ND	250 ^b	ND	ND	ND	NA	NA
2-Furancarxaldehyde(5-methyl)*	ND	ND	ND	8300 ^b	13900 ^b	NA	NA
Benzaldehyde*	ND	210 ^b	180	5700	9200 ^b	NA	NA
Benzoic acid	ND	89 ^b	1200 ^b	ND(1200)	ND(8000)	NA	NA
bis(2-ethylhexyl)phthalate	214	ND(330)	76 ^b	ND(250)	ND(1600)	NA	NA
C12H10 (biphenyl)*	ND	ND	ND	ND	35100 ^b	NA	NA
Dibenzofuran	ND	ND(330)	ND(330)	ND(250)	5600	NA	NA
Pyridine*	ND	290 ^b	1000 ^b	12000 ^b	17500 ^b	NA	NA
Tetradecane*	ND	ND	ND	ND	2400 ^b	NA	NA

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bEstimated value.

* - Tentatively Identified Compounds

NOTE: Results in µg/kg, ppb, on a dry solids basis except scrubber liquid, µg/L.

Table 8-12

(Page 4 of 4)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Carbon
PCBs							
Aroclor-1242/1016	ND(33)	ND(33)	48	ND(1.0)	ND(33)	NA	NA
Aroclor-1248	ND(33)	ND(33)	ND(33)	5.5	43900	NA	NA
Aroclor-1254	ND(33)	ND(33)	ND(33)	3.4	41500	NA	NA
Aroclor-1260	2447	ND(33)	100	2	22300	NA	NA

^aScrubber liquid in a composite of all liquids from the off-gas treatment system.

NOTE: Results in µg/kg, ppb, on a dry solids basis except scrubber liquid, µg/L.

Table 8-13

350°C Verification Test TCLP Metals Analysis - Treated Soil

Analyte	TCLP Results	Regulatory Limit
Arsenic	ND (0.02)	5
Barium	2.0	100
Cadmium	0.13	1
Chromium	0.027	5
Lead	ND (0.04)	5
Mercury	0.002	0.2
Selenium	ND (0.25)	1
Silver	ND (0.003)	5

NOTE: Results in mg/L, ppm.

Table 8-14

350°C Verification Total and TCLP Test Organics Analysis - Treated Soil

Analyte	Treated Soil	(Ave. of Dups) TCLP	TCLP Regulatory Limit
Volatiles			
Benzene	ND	0.02	0.5
Semivolatiles			
Pyridine	0.29	0.054	5

NOTE: Results in mg/kg for soil and mg/L, ppm for TCLP.

Table 8-15**600°C Verification Tests Mercury Analysis
Temporally Related Soil Samples**

Feed Soil		Treated Soil	
	391		7.4
	295		4.5
	316		6.4
	244		6.1
	302		5.0
	433		6.1
	369		5.8
	353		6.4
	315		8.2
	478		8.0
Average	349.6	Average	6.4
RSD %	20.1	RSD %	18.7

NOTE: Results in mg/kg, ppm, dry weight basis (14 percent moisture).

Table 8-16**600°C Verification Test Metals Analysis**

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Float Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary Carbon	Sec. Carbon
Arsenic	6.9	8.5	11.1	6.2	0.1	5.8	128	NA	NA
Barium	235	NA	NA	NA	NA	NA	144	NA	NA
Cadmium	111	7.8	19.3	21.0	0.0	31.3	ND(0.5)	NA	NA
Chromium	70.6	NA	NA	NA	NA	NA	ND(2)	NA	NA
Lead	103	NA	NA	NA	NA	NA	162	NA	NA
Mercury	341	8.4	6.8	15300	2.3	5080	26.0	686	ND(0.1)
Selenium	ND (14.8)	NA	NA	NA	NA	NA	52.8	NA	NA
Silver	12.4	NA	NA	NA	NA	NA	ND(1.0)	NA	NA

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

NOTE: Results in mg/kg, ppm, dry weight basis except scrubber liquid, µg/L.

NA - Not analyzed.

ND - Below method detection limit in parenthesis.

Table 8-17

600°C Verification Uranium and Gross Alpha/Beta Analysis

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary Carbon	Sec. Carbon
Uranium								
U-238	24.7	NA	NA	NA	NA	NA	NA	NA
U-235/U-236	1.3	NA	NA	NA	NA	NA	NA	NA
U-234	37.0	NA	NA	NA	NA	NA	NA	NA
Total U	63.1	26.2	27.8	0.1	53.0	ND(49)	NA	NA
Gross Alpha	69.1	45.4	140.0	1.3	104.0	90.0	30.5	30.8
Gross Beta	39.5	44.5	73.3	1.2	37.0	43.7	10.6	6.1

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

NOTE: Results in pCi/g, except scrubber liquid, pCi/mL.

NA - Not analyzed.

Float Solids were not analyzed.

Table 8-18

600°C Verification Test Volatiles Analysis

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary/Secondary Carbon
Methylene chloride	ND(5)	NA	NA	ND(100)	7800	NA	ND(120000)/ND(620)
Benzene	ND(5)	NA	NA	220	ND(6200)	NA	2800000/ND(620)
Toluene	ND(5)	NA	NA	145	7000	NA	1300000/ND(620)
Ethyl benzene	ND(5)	NA	NA	ND(100)	7100	NA	130000/ND(620)
Xylene (Total)	ND(5)	NA	NA	60	10600	NA	160000/ND(620)
Styrene	ND(5)	NA	NA	130	10600	NA	130000/ND(620)
Naphthalene	ND(5)	NA	NA	2200	25600	NA	ND(120000)/ND(620)
1,2,4-Trimethylbenzene	ND(5)	NA	NA	ND(100)	5500	NA	ND(120000)/ND(620)
N-Butylbenzene	ND(5)	NA	NA	ND(100)	6600	NA	ND(120000)/ND(620)

^aScrubber liquid is a composite of all liquids from the off-gas cleaning system.

NOTE: Results in µg/kg, ppb, on a dry weight basis except for scrubber liquid, µg/L.
Float Solids were not analyzed for VOCs.

Table 8-19

600°C Verification Test Semivolatile and PCB Analysis

(Page 1 of 3)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Float Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary Carbon
PAHs								
2-Methylnaphthalene	52	ND(330)	ND(330)	570000	320 ^d	85200	NA	7400 ^b
Acenaphthylene	136	ND(330)	ND(330)	190000	64 ^b	19600 ^b	NA	ND(16000)
Anthracene	159	ND(330)	ND(330)	180000	ND(200)	23000 ^b	NA	ND(16000)
Benzo(a)anthracene	675	ND(330)	ND(330)	97000 ^b	ND(200)	15200 ^b	NA	ND(16000)
Benzo(a)pyrene	880	ND(330)	ND(330)	64000 ^b	ND(200)	8300 ^b	NA	ND(16000)
Benzo(b)fluoranthene	1400	ND(330)	ND(330)	110000	ND(200)	14800 ^b	NA	ND(16000)
Benzo(g,h,i)perylene	595	ND(330)	ND(330)	28000 ^b	ND(200)	15100 ^b	NA	ND(16000)
Benzo(k)fluoranthene	417	ND(330)	ND(330)	32000 ^b	ND(200)	ND(16000)	NA	ND(16000)
Chrysene	761	ND(330)	ND(330)	130000	ND(200)	19600 ^b	NA	ND(16000)
Dibenzo(a,h)anthracene	159	ND(330)	ND(330)	ND(97000)	ND(200)	ND(16000)	NA	ND(16000)
Fluoranthene	1500	ND(330)	ND(330)	390000	ND(200)	60000	NA	ND(16000)
Fluorene	243	ND(330)	ND(330)	220000	38	23900 ^b	NA	ND(16000)
Indeno(1,2,3-cd)pyrene	648	ND(330)	ND(330)	25500 ^b	ND(200)	15200 ^b	NA	ND(16000)
Naphthalene	ND(330)	39	ND(330)	660000	1500	153000	NA	70700
Phenanthrene	708	ND(330)	ND(330)	740000	46	106000	NA	ND(16000)
Pyrene	1200	ND(330)	ND(330)	230000	ND(200)	36600	NA	ND(16000)

^a Scrubber liquid is a composite of all liquids from the off-gas treatment system.^b Estimated value.^c Diluted sample.^d Diluted sample, estimated value.

NOTE: Units in µg/kg, ppb, on a dry weight basis except scrubber liquid, µg/L.

Table 8-19

(Page 2 of 3)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Float Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary Carbon
Phenols								
2,4-Dimethylphenol	ND (330)	ND(330)	ND(330)	ND(97000)	ND(500)	4600	NA	ND(16000)
2-Methylphenol	ND (330)	ND(330)	ND(330)	11500 ^b	7400	8900	NA	ND(16000)
4-Methylphenol	ND (330)	ND(330)	ND(330)	ND(97000)	22000 ^c	25600	NA	ND(16000)
4-Nitrophenol	ND (1600)	ND(1600)	ND(1600)	ND(470000)	ND(1000)	69800	NA	ND(80000)
Phenol	ND (330)	ND(330)	ND(330)	56500 ^b	57000 ^c	64700	NA	ND(16000)
Others								
1-H-Isoindole-1,3-(2H)dione*	ND	ND	ND	ND	ND	ND	NA	ND
2-Furancarxaldehyde(5-methyl)*	ND	ND	ND	ND	ND	ND	NA	ND
Benzaldehyde*	ND	ND	ND	ND	28000	29800	NA	80200
Benzoic acid	ND(1600)	ND(1600)	ND(1600)	ND(470000)	ND(2500)	ND(80000)	NA	ND (80000)
bis(2-ethylhexyl)phthalate	ND(330)	ND(330)	ND(330)	ND(97000)	ND(200)	ND(16000)	NA	ND (16000)
C12H10 (biphenyl)*	ND	ND	ND	325000	ND	46000	NA	ND
Dibenzofuran	ND(330)	ND(330)	ND(330)	590000	130 ^b	76700	NA	ND (16000)
Pyridine*	ND	ND	ND	ND	120000 ^b	17900	NA	ND
Tetradecane*	ND	ND	ND	ND	ND	ND	NA	ND

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

^bEstimated value.

^cDiluted sample.

* - Tentatively Identified Compound (TIC).

NOTE: Results in µg/kg, ppb, on a dry weight basis except scrubber liquid, µg/L.

Table 8-19

(Page 3 of 3)

Analyte	Feed Soil	Treated Soil	Cyclone Solids	Float Solids	Scrubber Liquid ^a	Scrubber Solids	HEPA	Primary Carbon
PCBs								
Aroclor-1242/1016	ND(33)	ND(33)	ND(33)	ND(20000)	ND(10)	ND(3300)	NA	NA
Aroclor-1248	ND(33)	ND(33)	ND(33)	300000	ND(10)	25600	NA	NA
Aroclor-1254	ND(33)	ND(33)	ND(33)	120000	ND(10)	19600	NA	NA
Aroclor-1260	2447	ND(33)	ND(33)	48000	ND(10)	9200	NA	NA

^aScrubber liquid is a composite of all liquids from the off-gas treatment system.

NOTE: Results in µg/kg, ppb, on a dry weight basis except scrubber liquid, µg/L.

Table 8-20

600°C Verification Test TCLP Metals Analysis - Treated Soil

Analyte	TCLP Results	Regulatory Limit
Arsenic	0.021	5
Barium	0.99	100
Cadmium	0.026	1
Chromium	0.023	5
Lead	0.0053	5
Mercury	0.0001	0.2
Selenium	<0.0018	1
Silver	<0.015	5

NOTE: Results in mg/L, ppm.

The series of temporally related feed and treated mercury results (Tables 8-8 and 8-15) for 350°C and 600°C show reduction to approximately 14 and 6 ppm, respectively. No significant trend was found in these data. The feed soil mercury values for the 600°C test are higher than all other feed soil grab and composite results; no reason for these high values was determined through investigation of the analyses.

Tables 8-21 and 8-22 show the mercury accountability for the two verification tests. For both tests, about 45 percent mercury was accounted for. Mercury was recovered primarily (85 percent) in the scrubber system; it concentrated in the scrubber solids and as elemental (liquid) mercury. The carbon adsorber also collected some mercury. An accountability of 70 percent or more was an IT test goal, but with the low total quantity of mercury in the soil and the size and complexity of the desorber and off-gas treatment system, high recovery could not be realized. The data for 600°C test show less mercury collected in the scrubber and more collected in the carbon. In fact mercury broke through the primary carbon adsorber. The small amount of float material collected from the 600°C tests shows high concentrations of mercury.

Treated soil from both tests passed TCLP for metals and organics. The only organics found in the feed soil (PAHs and PCBs) were reduced to below the analytical method detection limit. Other SVOCs (principally the tentatively identified compounds [TICs]) detected in the untreated soil) were found in the treated soil from the 350°C test, but at concentrations below 1 mg/kg. Various PCDD/Fs were detected at levels under 1 µg/kg (ppb) for the treated soil from the 350°C test; OCDD was detected at less than 1 µg/kg for the 600°C treated soil.

Tables 8-23 and 8-24 show the overall mass of residuals generated for both the 350°C and 600°C tests. For the scrubber and WESP, water was charged to these units prior to operation; therefore, the values in Tables 8-23 and 8-24 represent the increase in liquid resulting from the test.

For the 350°C test, most of the VOC data (Table 8-14) is from the shakedown test, because the scrubber liquid and sludge VOC samples for the 350°C verification test exceeded prescribed temperature during shipment and were not analyzed. The carbon VOC data are from the verification test but are qualified because the temperature was exceeded.

The SVOC data for the residuals show phenols, pyridine, and other compounds not present in the original soil, as well as PAHs and PCBs. The type of SVOCs present in the residuals

Table 8-21

Hg Accountability for 350°C Verification Test

Sample pt. Number and Location	Mercury, Conc. (mg/kg)	Total Mass (kg)	Hg Mass (mg)	% Account.
# 1-Feed Soil	290 ^a	330	95694	100.00
# 4d-Scrubber solids	3925	6.02	23629	24.69
Recovered Elemental Hg ^b	100	0.012	12000	12.54
# 2-Treated soil	14.6	250	3650	3.82
# 4c-Scrubber liquid	7.6	103	857	0.90
# 6-Carbon adsorber	185	3.02	559	0.58
# 3-Cyclone solids	35.4	0.223	7.89	0.01
Brinks demister	4.9	1.34	6.57	0.01
# 4a-WESP receiver	0.6	10.59	6.35	0.03
# 4b-Condenser receiver	4.3	1.12	4.82	0.01
# 5-HEPA filter	1.9	1.7	3.23	0.00
Vent gas	--	--	<0.02	0.00
Sum of Hg			40725.68	42.56

^aMoisture content of soil feed to pilot desorber was 17.5% vs. 24.4% in composite feed characterization sample.

^bLiquid mercury collected/isolated from all residuals; concentration is assumed 100 percent.

Table 8-22

Hg Accountability for 600°C Verification Test

Sample pt. Number and Location	Mercury Conc. (mg/kg)	Total Mass (kg)	Hg Mass (mg)	% Account.
# 1-Feed soil	299 ^a	228	68127	100.00
Recovered Elemental Hg ^b	100	0.014	13569	19.92
# 4d-Scrubber solids	2930	3.74	10958	16.08
# 6-1st carbon adsorber	650	2.73	1775	2.60
# 2-Treated soil	8.2	171	1402	2.05
Brinks demister	829	1.38	1144	1.68
Float scrubber solids	15300	0.032	490	0.72
# 4a-WESP receiver	24	7.85	188	1.72
# 4c-Scrubber liquid	2.3	96	50	0.07
# 5-HEPA solids	26	1.7	44	0.06
# 4b-Condenser receiver	13	1.17	15	0.02
# 3-Cyclone solids	6.8	0.91	6.19	0.01
# 6-2nd carbon adsorber	0.1	2.49	0.25	0.00
Vent gas	--	--	<0.02 ^c	0.00
Sum of Hg			29638.29	43.50

^aMoisture content of soil feed to pilot desorber was 17.5% vs. 24.4% in composite feed characterization sample.

^bLiquid mercury collected/isolated from all residuals; concentration is assumed 100 percent.

^cVent gas value assumed the same as 350°C test.

Table 8-23

Summary of Liquid Process Residuals for 350°C and 600°C Verification Tests

Sample Point	350°C Test Mass (kg)	600°C Test Mass (kg)
Scrubber liquid total/increase	103/57	96/40
WESP liquid total/increase	10.6/2.6	7.9/0
Chilled condensate	1.1	1.2
Total	175.4/60.7	146.3/41.2

Table 8-24**Distribution of Residual Solids for Verification Tests**

Sample Point	350°C Test			600°C Test		
	Total Mass (kg)	Dry Solids	Percent of Dry Feed Soil	Total Mass (kg)	Dry Solids	Percent of Dry Feed Soil
Feed Soil	330	272	100	228	196	100
Treated Soil	250	250	93	171	171	85
Cyclone Solids	0.22	0.22	0.081	0.91	0.91	0.45
Scrubber Solids	6.02	3.77	1.4	3.74	2.20	1.1

from the 600°C test were similar (e.g., phenols, PAHs) to those found in the 350°C test, but the concentrations were higher. The PCB results for the residuals indicate an apparent shift to lower chlorinated Aroclors not identified in the original soil (i.e., Aroclors 1254, 1248, and 1242/1016 versus 1260). For the 350°C test, PCBs concentrated to greater than 50 mg/kg (the Toxic Substance Control Act [TSCA] limit) in the scrubber sludge.

The TOC concentrations of the scrubber liquid from the 350°C and 600°C tests were 260 mg/L and 1250 mg/kg, respectively. These values are an order of magnitude greater than the total quantified organics (i.e., sum of VOCs and SVOCs in Tables 8-11, 8-12, 8-18, and 8-19) for the scrubber liquid. The majority of organic compounds dissolved in the scrubber liquid which contribute to the TOC are not identified by either the VOC or SVOC analytical methods. It is postulated that there are many low molecular weight, oxygenated, water-soluble organic compounds, such as ketones, alcohols, aldehydes, and carboxylic acids, present in this liquid that are not detected or cannot be properly quantified by these analytical methods. These types of compounds might be expected from oxidative decomposition of soil organic matter during thermal desorption. The presence of significant concentrations of acetone and 2-butanone support this potential explanation for poor accountability of the TOC. These compounds would tend to be effectively removed in the wet scrubber and to remain primarily in the liquid phase, although the scrubber solids would contain a certain fraction. These compounds would not be expected to contribute organic load to the carbon because they have low relative volatility in the scrubber liquid. The uranium concentrations and isotope distributions in the residuals are as would be expected from this type of study.

Tables 8-25 and 8-26 show the organic content of the principal residuals expressed as an equivalent concentration in the soil feed. The values for volatiles, semivolatiles, and PCBs were calculated by combining the concentrations of individual compounds within each category (from Tables 8-11, 8-12, 8-18, and 8-19), multiplying these total concentrations times the mass of each residual (from Tables 8-23 and 8-24), and dividing the resulting organic mass by the total quantity of soil treated (from Tables 8-21 and 8-22).

For the 350°C test, the total amount of quantified organic compounds in all three residuals represents an equivalent of about 30 mg/kg (ppm) of organic in the untreated soil. This is more than three times the sum of quantified organics measured in the untreated soil.

The TOC value of 260 mg/kg in Table 8-25 represents the equivalent total organic concentration in the feed soil corresponding to the TOC content of the scrubber liquid. This

Table 8-25

Summary of Organic Content of Off-Gas Treatment Residuals - 350°C Test

	Organic Mass Relative to Feed Soil - (mg/kg)				
	Volatiles	Semivolatiles	PCBs	Total	TOC Equivalent
Scrubber liquid ^a	3	14	<0.01	17	260
Scrubber solids	0.91	2.4	1.1	4.4	NA
Carbon adsorber	8.7	NA	NA	>8.7	NA
Total	12.6	>16.4	1.1	>30.1	--

^aRepresents combined aqueous liquid phase from scrubber, condenser, and WESP.

NA - Not analyzed.

Table 8-26

Summary of Organic Content of Off-Gas Treatment Residuals - 600°C Test

	Organic Mass Relative to Feed Soil - (mg/kg)				
	Volatiles	Semivolatiles	PCBs	Total	TOC Equivalent ^a
Scrubber liquid ^b	1.3	99	<0.01	100.3	1250
Scrubber solids	2.8	7.6	0.5	10.9	NA
Carbon adsorber	59	2	NA	61	NA
Total	63.1	108.6	0.5	172.2	--

^aTOC equivalent is the estimated organic mass based on the TOC result.

^bScrubber liquid is a composite of all liquids from the off-gas treatment system.

NA - Not analyzed.

value is 15 times the sum of the quantified individual organic compounds in this liquid. Using the TOC equivalent value of 260 mg/kg for the scrubber liquid in place of the 17 mg/kg total quantified organics, the total organic mass of the residuals represents over 270 mg/kg organic in the feed soil.

As noted previously, the 600°C test results show significantly more organics in the residuals compared to the 350°C test. The largest increase is the SVOCs in the scrubber liquid (99 versus 14 mg/L) and VOCs in the carbon (59 versus 9 mg/L). Both the total identified organics and the TOC equivalent values are approximately five times the 350°C test results. As for the 350°C results, the quantified VOCs and SVOCs in the scrubber liquid accounted for only approximately 8 percent of the TOC equivalent. The total organic content of the residuals is approximately 170 mg/kg using only the quantified organics, and greater than 1,300 mg/kg using the TOC equivalent for the scrubber liquid. This value can be compared with the total organic matter content of the untreated soil, which was 4.7 percent.

Total uranium and gross alpha/beta values (Tables 8-10 and 8-17) indicate that there is no significant partitioning of radionuclides to any residual. The residuals are generally lower in uranium than the untreated soil. The cyclone solids and scrubber sludge are comprised principally of soil particles and would be expected to have comparable levels of metals and associated radioactivity. Background (blank) values for the water used in the scrubber system and the solid media (HEPA and carbon) were not measured for reference, so the contribution of the off-gas constituents to the uranium and alpha/beta values for these media cannot be ascertained. Without more detailed characterization of the soil and residuals, such as quantitation of uranium isotopes and other radionuclides, determination of the potential for concentration of radioactive constituents in certain residuals cannot be made.

8.2.2.2 Observations

Test 1, "Shakedown" Test. During initial start-up, the feed throughput was greater than 100 pounds per hour, causing backup in the hot cyclone. This condition was soon corrected by adjusting the desorber operating parameters and controlling the feed rate.

Upon completion of the test, the desorber system was partly disassembled. No foam or organic layer was present on the scrubber solution. A fine "float" material was slightly visible, but not enough to be collected. After draining the scrubber system, 2 grams of

visible elemental mercury was recovered in the scrubber tank and the scrubber tank drain valve. No visible elemental mercury was found in any other location.

The transition duct between the desorber and hot cyclone was disconnected and examined for mercury or any buildup that might be present. The duct was visually clean.

Test 2, 350°C Test. Upon completion of the test, during cleanup of the desorber and off-gas treatment system, elemental mercury was found throughout the scrubber system. The greatest amount was in the demister pad located on top of the scrubber column. Twelve grams of elemental mercury were recovered from the demister pad and scrubber system. Tiny mercury beads were present when the pad was removed, and other beads were found after the pad was removed and cleaned. The beads from cleaning were not obvious initially. The pad had a green-gray liquid film that, when removed and dried, produced mercury beads. The mercury was collected and weighed. Beads were also collected from the scrubber tank, the scrubber housing, and from adjacent piping.

As with the shakedown test, no appreciable amount of float material was present on the top of the scrubber solution.

Test 3, 600°C Test. Upon opening the scrubber tank, there was a small amount (32 grams) of float material on top of the scrubber solution. This material was trapped in a layer of bubbles. The material was collected, allowed to settle, and then filtered. Samples of the solid material were collected for selected analysis.

As with the verification test at 350°C, mercury was found in the demister pad at the top of the scrubber. Elemental mercury was again found in the residual film present on the pad. Thirteen and one half grams were collected from the pad and scrubber tank, housing, and piping.

The demister pad was slightly melted. The pad was polypropylene with a melting point of 171°C. This melting would indicate that the gas stream was not fully cooled during the complete period of hot desorber operation.

8.2.2.3 Gas Sampling Results

The results of sampling and analysis of the off-gas and vent gas are presented independently, followed by a comparison of the two sets of results to demonstrate the removal efficiency of

the off-gas treatment system. Parameters that were evaluated include particulate; metals (mercury, arsenic, cadmium, and uranium); volatile and semivolatile organics; acid gases and ammonia; and oxygen, carbon monoxide, and carbon dioxide (for the vent gas only). Appendix F includes a report describing the gas sampling and analysis procedures and results in detail.

The gas analysis results for individual compounds are presented in concentration units. All concentrations are normalized and based on the dry gas flow at standard temperature and pressure. Because the off-gas contained high moisture content and was at elevated temperature, the actual concentration in mass-per-volume units of most parameters in the off-gas is significantly lower than the values reported in the tables. However, the actual composition of the vent gas would be very similar to the reported dry gas composition.

For some individual compounds and for groups of compounds (e.g., total VOCs), a total mass is calculated based on the amount of off-gas or vent gas (dry basis) discharged from the desorber during the entire treatment period. Total mass values enable a comparison between the gas sampling results and the analytical results for the various residuals. A mass unit ratio is calculated by dividing the total constituent mass by the total amount of soil fed to the desorber during the same period. Unit ratios provide a comparison of the gas loadings to the untreated soil for purposes of scale up of the off-gas treatment system. Unit ratios also allow an appraisal of the generation of particular constituents as a result of the thermal desorption process.

8.2.2.3.1 Off-Gas Results

Particulates and Metals. Table 8-27 summarizes the particulate and metals results for the off-gas. The total calculated amount of particulate represents approximately 0.2 percent of the dry soil feed. The off-gas sampling point was downstream of the hot cyclone and therefore represents the composition entering the wet scrubber system. This particulate load is much lower than the amount of carryover determined from the analysis of the wet scrubber residuals from the off-gas treatment system.

The total mercury mass represents 47 percent of the total mercury mass determined from the combined off-gas residuals. The unit ratio of 80 ppm is approximately 25 percent of the average soil feed composition (313 mg/kg dry basis).

Table 8-27**Summary of Particulate and Metals Results - Off-Gas**

Parameter	Gas Concentration (mg/m ³)	Total Mass During Test Period (mg)	Unit Ratio - Gas-to- Feed Soil (mg/kg)
Particulate	5608	471,000	1930
Mercury	229	19,300	79
Arsenic	0.22	20	0.08
Cadmium	0.25	21	0.08
Uranium	4.1	350	1.4

The metals values for arsenic, cadmium, and uranium are very low compared to mercury, as would be expected following multiple stages of particulate removal.

Volatile and Semivolatile Organics. The results indicate the presence of most unsubstituted aromatic hydrocarbons, several aliphatic hydrocarbons (paraffins and olefins), several oxygenated paraffins (e.g., ketones), and furans. In addition, chlorinated hydrocarbons and carbon disulfide were detected. The most significant VOCs included benzene and toluene, acetone and 2-butanone, furan and 2-methyl furan, chloromethane, and carbon disulfide.

Quantitative assessment of the VOC results for the off-gas is difficult because the concentrations of many of the compounds exceeded the upper calibration limit for the prescribed standard method, which involves desorption of the sample from the tenax and tenax/charcoal tubes directly to a GC. As described in Appendix F, three of the four VOST tube pairs were analyzed by an alternative method, which involved desorbing the sample from the tubes into methanol and analysis of the resulting methanol solution. This method had limitations, including potentially low absorption efficiency of the methanol for nonpolar, highly volatile compounds, and the high detection limit for all compounds compared with the prescribed procedure. Some compounds found at high concentrations using the prescribed method had relatively low or nondetectable concentrations using the alternative method.

Table 8-28 summarizes the results for all VOCs found above the quantitation limit. Values are given for both the standard method (one VOST pair) and the alternative method (three VOST pairs) for comparison. All results for the alternative method were significantly higher than for the standard method, except for carbon disulfide and chlorinated hydrocarbons (principally chloromethane). These two VOCs have very high vapor pressures and may not be collected by the methanol.

The total mass and unit ratio values were calculated based on the higher of the two values. Based on the calculated unit ratios, total VOCs contained in the off-gas correspond to approximately 360 mg/kg (ppm) in the untreated soil. As noted in Section 8.1.1, no VOCs were detected during characterization of the untreated soil.

A large number of SVOCs were found in the off-gas, including phenolics, PAHs, and other cyclic hydrocarbons, some oxygenated (eg. aldehydes). The total SVOC content was similar to the total VOC content. Phenol and methyl phenols contributed most of the confirmed SVOCs; the major TIC contributed approximately 40 percent of the total SVOCs. This data

Table 8-28

Summary of Volatile Organic (VOC) Results - Off-Gas

Parameter	Gas Concentration - Standard Method (mg/m ³)	Gas Concentration - Alternate Method (mg/m ³)	Total Mass During Test Period (mg)	Unit Ratio - Gas- to-Feed Soil (mg/kg)
Oxygenated Paraffins				
Acetone	3.2 ^a	8.9		
2-Butanone	3.1 ^a	3.8		
Other	0.3 ^a	0		
Total	6.6	12.7		
Aromatic Hydrocarbons				
Benzene	0.76 ^a	13.3 ^c		
Toluene	0.16 ^a	12.5 ^c		
Xylenes	ND	4.4 ^c		
Other	ND	6.3 ^c		
Total	0.92	36.5		
Chlorinated Hydrocarbons				
Carbon Disulfide	1.6 ^a	ND		
Major TICs ^b				
Furan	0.12 ^b	22.3		
2-Methyl furan	0.22 ^b	24.5		
Hexane	ND	6.0		
Total Other VOCs	0.001	3.2		
Total VOCs	10.96	105.2	8820	362

^aConcentration exceeded calibration range - estimated value.^bTentatively identified compound - estimated value.^cValue includes the detection limit for one or more components of the sampling train (e.g., condensate).

ND - Below method detection limit.

Table 8-29

Summary of Semivolatile Organic (SVOC) Results - Off-Gas

Parameter	Gas Concentration (mg/m ³)	Total Mass During Test Period (g)	Unit Ratio - Gas-to-Feed Soil (mg/kg)
PAHs		6790	280
Napthalenes	6.9		
Phenanthrene	1.1		
Other PAHs	5.2		
Total PAHs	13.2		
Phenols			
Phenol	25.3		
Methyl Phenols	7.4		
Total Phenols	32.7		
Major TICs			
5-methyl-2-furancarboxaldehyde	17.6		
1 H-pyrrole-2-carboxaldehyde	1.6		
Benzaldehyde	10.7		
Pentylcyclohexane	2.8		
Total Major TICs	32.7		
Total Other SVOCs	2.2		
Total SVOCs	80.8	6790	280

Table 8-30

Summary of Acid Gas and Ammonia Results - Off-Gas

Parameter	Gas Concentration (mg/m ³)	Total Mass During Test Period (g)	Unit Ratio - Gas-to- Feed Soil (mg/kg)
Chloride	20 ^a	1680	67
Fluoride	20 ^a	1680	67
Nitrate	5.6	47	19
Ammonia	790	66,400	2720

^aValue includes detection limit for second impinger.

corresponds with the residuals data, except no pyridine was detected in the off-gas. Table 8-29 summarizes the SVOC results. The unit ratio value calculated for total SVOCs represents 280 mg/kg (ppm) in the untreated soil. PCBs, which were present at low concentrations in the untreated soil and were found in the scrubber solids, were not analyzed in the off-gas.

Acid Gases/Ammonia. The off-gas contained only trace levels of most acid gases based on analysis of anions. Table 8-30 summarizes the results of this sampling train. Chloride, fluoride and nitrate were detected, with the total of these less than 50 mg/m³. This represents approximately 150 mg/kg of acid gas from the untreated soil. Sulfate (potentially originating from oxidation of sulfide in the soil) in the off-gas could not be determined due to the use of sulfuric acid in the first impinger of the sampling train to recover ammonia. Ammonia was found in the off-gas at a relatively high levels. The ammonia mass is equivalent to almost 0.3 percent of the feed soil mass. The source of ammonia is not know, but could be nitrogenous organic matter in the soil. Ammonia, as well as pyridine, which was found in the scrubber liquid, are both produced from the gasification/pyrolysis of coal, which is derived from vegetative matter.

8.2.2.3.2 Vent Gas Results

Particulates and Metals. Table 8-31 summarizes the particulate and metals results for the vent gas. No particulates were detected. Based on the detection limit, the particulate load in the vent gas was less than 1 mg/m³ of gas. Mercury was found only in the second impinger of the sampling train which contained the stronger oxidant, permanganate. The unit ratio of 0.7 micrograms per kilogram (µg/kg) (parts per billion [ppb]) is approximately 0.0002 percent of the mercury contained in the soil feed.

No arsenic or cadmium were detected. Uranium was measured at a very low concentration (approximately twice the QC blank).

Volatile and Semivolatile Organics. The only VOC quantified in all four VOST tube pairs was chloromethane. Ten other VOCs, including six TICs, were detected, some above the quantitation limit, but all were at extremely low concentrations. These VOCs were hydrocarbons, halogenated hydrocarbons, and carbon disulfide. All four pairs of VOST tubes were analyzed by the standard method.

Table 8-31

Summary of Particulate and Metals Results - Vent Gas

Parameter	Gas Concentration (mg/m ³)	Total Mass During Test Period (mg)	Unit Ratio - Gas-to- Feed Soil (mg/kg)
Particulate	<1	<84	<3.4
Mercury	ND(0.0002)	<0.017	0.0007
Arsenic	ND(0.001)	<0.084	<0.003
Cadmium	ND(0.00009)	<0.001	<0.00004
Uranium	0.0021	0.18	0.007

ND - Not detected.

Table 8-32

Summary of Volatile Organic (VOC) Results - Vent Gas

Parameter	Gas Concentration - Standard Method (mg/m ³)	Total Mass During Test Period (g)	Unit Ratio - Gas-to- Feed Soil (mg/kg)
Oxygenated Paraffins			
Acetone	ND		
2-Butanone	ND		
Other	ND		
Total	ND		
Aromatic Hydrocarbons			
Benzene	ND		
Toluene	0.003 ^a		
Xylenes	ND		
Other	ND		
Total	0.003		
Chlorinated hydrocarbons	1.07 ^b		
Carbon disulfide	0.002		
Total other VOCs	0.006		
Total VOCs	1.08	91	3.7

^aValue includes the method detection limits for 3 of the 4 tubes.

^bBreakthrough may have occurred; result may be biased low.

ND - Not detected.

Table 8-33

Summary of Semivolatile Organic (SVOC) Results - Vent Gas

Parameter	Gas Concentration (mg/m ³)	Total Mass During Test Period (g)	Unit Ratio - Gas-to-Feed Soil (mg/kg)
PAHs		11	0.5
Naphthalenes	0.072 ^{a,b}		
Phenanthrene	0.005 ^b		
Other PAHs	0		
Total PAHs	0.077		
Phenols			
Phenol	0.014 ^b		
Methyl phenol	0		
Total phenols	0.014		
Major TICs			
Dimethyl benzene	0.024 ^{a,c}		
Total TICs	0.024		
Total other SVOCs	0.018 ^c		
Total SVOCs	0.133		

^aEstimated value.

^bValue includes the detection limit for one component of the sampling train.

^cSample was diluted for quantitation.

Table 8-34

Summary of Acid Gas and Ammonia Results - Vent Gas

Parameter	Gas Concentration (mg/m ³)	Total Mass During Test Period (g)	Unit Ratio - Gas-to- Feed Soil (mg/kg)
Chloride	0.62	52	2.1
Fluoride	ND(0.02)	<1.7	<0.07
Nitrate	0.01	0.8	0.03
Ammonia	ND(0.02)	<1.7	<0.07

ND - Not detected.

Table 8-32 summarizes the results for all confirmed VOCs found above the quantitation limit for at least one VOST pair. Chloromethane represented greater than 99 percent of the total VOCs. A combined value is given in this table for all other VOCs detected, including TICs. The total of all these VOCs yielded a unit ratio of less than 4 mg/kg of the feed soil.

Several SVOCs were found in the vent gas, but only four SVOCs were above the method quantitation limit. Naphthalene was the most significant SVOC, representing more than half of all the SVOCs detected. Phenol, an aromatic hydrocarbon, and phthalates were also present. Table 8-33 summarizes the SVOC results. The mass and unit ratio values for total SVOCs represent 0.5 mg/kg (ppm) of the soil feed.

Acid Gases/Ammonia. As shown in Table 8-34, the vent gas contained several acid gases, but no ammonia based on analysis of anions in the sampling train impinger solutions. Chloride was found at less than 1 mg/m³. Nitrate was detected, but at only approximately 1 percent of the chloride content. As noted for the off-gas, sulfate contribution from the vent gas could not be determined. Ammonia was not detected.

8.2.2.3.3 Comparison Of Off-Gas and Vent Gas

In order to evaluate the performance of the off-gas treatment system, the concentrations of the various analytical parameters in the samples of the off-gas and vent gas were compared. Table 8-35 shows the concentrations for each parameter and selected compounds or compound classes. The overall mass removal efficiency was calculated by comparing the two sets of concentration data, because these are both on a dry standard gas basis.

The particulates and all metals were reduced by greater than 99.9 percent. Mercury was reduced by greater than 99.999 percent. VOCs and SVOCs were reduced by 98.9 and 99.8 percent, respectively. The lower removal efficiency for volatiles was due to the presence of chloromethane in the vent. This compound does not adsorb well on activated carbon, and would tend to be displaced by other organics which were adsorbed. Acid gases and ammonia were reduced by 98.6 percent and greater than 99.99 percent respectively.

8.3 MATERIALS HANDLING

Tables 8-36 through 8-38 present the results of the materials handling tests. The data indicates that as the moisture content of soil approaches the plastic limit (32 percent) of the untreated soil the soil tends to fail both front-end materials handling tests. For materials

Table 8-35**Removal Efficiency of the Off-Gas Treatment System**

Parameter	Off-Gas Concentration (mg/m ³)	Vent Gas Concentration (mg/m ³)	Removal Efficiency (%)
Particulates	5608	<1	>99.98
Mercury	229	ND(0.0002)	>99.999
Other metals	4.6	0.003	99.93
VOC	105	1.1	98.9
SVOC	81	0.13	99.8
Acid gases	46	0.63	98.6
Ammonia	790	ND(0.02)	>99.99

ND - Not detected.

Table 8-36**Front-End Materials Handling Tests-Drop Test Results**

Sample	Quantity (kg)	Moisture (%)	Chute Angle (degrees)	Drop Ht. (meters)	Observation
Sample 1	30	23.7	71	3.96	Passed
Sample 2	30	23.7	60	3.96	Passed
Sample 3	30	23.7	45	3.96	Passed
Sample 4	36	17	45	3.96	Passed
Sample 5	36	29.6	45	3.96	Passed with minor accumulation
Sample 6a	35.6	39.1	45	3.96	Failed, 8.9 kg accumulation
Sample 6b	12.4	39.1	45	3.96	Redrop of 6a, failed
Sample 7	35.6	39.1	71	3.96	Failed, 3.3 kg accumulation

Table 8-37

**Reagglomeration Tests
Front-End Materials Handling Tests**

Sample	Moisture (%)	Observation
1	9	No agglomeration occurred
2	29.8	Balling occurred
3	36	Stuck to side of rotating drum
4	30.4	"Sausage" formed

Table 8-38**Back-End Materials Handling Tests**

Test No.	Weight Ratio of Water to Soil in Quench Tank	Travel Time (min)	Percent Moisture Drained Solids	Stockpile AR (Degrees)	Vibrational AR (Degrees)	Mass Collected (lbs)
1A	1:1	0.3	29.83	30	8	8
1B	1:1	1	27.08	15	8	5.6
2A	2:1	0.3	26.19	24	8	6.8
2B	2:1	1	28.19	31	8	5.2
3A	3:1	0.3	24	32	8	7
3B	3:1	1	26.16	30	8	3.8

Note: Angle of Inclination, 35°; Travel Speed, 10 ft/min

Table 8-39**Residuals Summary Prior to Treatment**

(Page 1 of 3)

Residual Category	Residual Description	RCRA Class	Reason	Treatment
Aqueous Liquids	Scrubber Liquid-Test 1	Hazardous	Hg, Pyridine (Assumed)	Precipitation, Filtration; Carbon Adsorption
	Scrubber Liquids-Tests 2 and 3	Hazardous	Hg, Pyridine (Analysis)	Precipitation, Filtration; Carbon Adsorption
	Decon Water-All tests	Hazardous	Hg (Analysis)	Precipitation, Filtration
	Decon/Miscellaneous Water	Hazardous	Hg (Assumed)	Precipitation, Filtration
	Backend Materials-Handling Water	Non-hazardous	(Assumed) ^a	None

Table 8-39

(Page 2 of 3)

Residual Category	Residual Description	RCRA Class	Reason	Treatment
Off-gas Treatment Sludges/Solids	Scrubber Filter Solids-All Tests	Hazardous	Hg (TCLP Hg Analysis)	Thermal Desorption
	Water Treatment Sludge (from Scrubber Liquid and Decon Water)	Non-hazardous	TCLP Hg (Analysis)	Thermal Desorption ^b
	Cyclone Solids-All tests	Non-hazardous	Assumed ^c	None ^d
	Water Treatment Carbon	Non-hazardous	TCLP Pyridine (Analysis)	None
	Elemental Liquid Mercury	Hazardous	Assumed	Amalgamation, Stabilization
Off-Gas Treatment Materials	Scrubber Liquid Filter Bags	Hazardous	Hg (TCLP Hg Analysis)	Acid Washing
	Brinks Media	Hazardous	Hg (Assumed)	Acid Washing
	HEPA Filters-Tests 1 and 2	Non-hazardous	Total Hg less than 20x TCLP	Acid washing ^e
	HEPA Filter-Test 3	Hazardous	Total Hg exceeded 20x TCLP	Acid washing

Table 8-39

(Page 3 of 3)

Residual Category	Residual Description	RCRA Class	Reason	Treatment
	Carbon-Tests 1 and 2	Hazardous	Hg, benzene (TCLP analysis for metals and VOCs)	Chemical treatment
	Carbon-Test 3	Non-hazardous	TCLP analysis	None
Soil	Untreated soil (unused)	Non-hazardous	TCLP analysis	None
	Treated soil-all tests	Non-hazardous	TCLP analysis	None

^aTreated soil passed TCLP; therefore, it was assumed that water drained from treated soil used in back-end materials handling test would pass TCLP.

^bWater treatment solids were thermally treated even though the TCLP passed.

^cUntreated soil passed TCLP; therefore, it was assumed that cyclone solids, which are comprised of fine soil particles having much lower total mercury than the feed soil, would also pass.

^dCyclone solids were consumed in analysis or added to untreated soil.

^eAcid washing was performed on all HEPA filter media.

handling of the soil not to be a problem, the moisture content must be maintained several percent below the plastic limit.

The back-end materials handling data presented in Table 8-38 shows that the treated soil can be stockpiled and will drain significantly when handled with a drag-flight conveyor. The angle of repose of the pile responds to slight vibration by decreasing.

Lime was added to the soil, but no drop or similar test was performed because the lime did not change soil characteristics. The relatively low moisture content of the soil was not affected by the lime addition.

8.4 RESIDUALS TREATMENT

The purpose of the residuals treatment was to ensure that none of the residuals returned to Energy Systems was classified as a RCRA hazardous waste. Each residual was evaluated to determine whether it could pass TCLP limits. Any residuals having a total concentration of any TC constituent, above a value that could fail TCLP (i.e., 20 times the TC limit) were analyzed for TCLP, or if failure was likely based on process knowledge, the residual was treated and then analyzed for TCLP. The results of the treatment procedures show that all the residuals that failed TCLP were treated to render them nonhazardous.

Table 8-39 is a list of all initial residuals from the entire project, identifying which were classified hazardous and why, and specifying the treatment procedure. Following is a discussion of the results for each residual that was treated. Detailed analytical results for the treated residuals are included in Appendix G.

Scrubber Liquid. The aqueous solution from the two verification pilot tests exceeded TC limits for mercury and pyridine. The scrubber liquid from the shakedown test was not analyzed but was assumed to be similar to that of the 350°C verification test since the process conditions and amount of soil treated were comparable. Therefore, this scrubber liquid was treated in the same manner as the other scrubber liquids using chelation/chemical precipitation followed by carbon adsorption as described in Section 5.2.4 and Appendix C. Initially, during bench-scale treatability screening test, chemical oxidation using Fenton's reagent (hydrogen peroxide plus ferrous sulfate) was investigated. Despite high oxidant dosage and extended reaction times, pyridine levels were not sufficiently reduced.

The chemical treatment/filtration method reduced mercury in all scrubber liquids from several mg/L to 0.008 mg/L, well below the TC limit of 0.2 mg/L. Carbon adsorption was effective for reducing pyridine. For Test 3 scrubber water, which contained a much greater concentration of pyridine (120 mg/L) than Test 1/2, the treated water had less than 1 mg/L remaining. TCLP of the carbon used for treatment showed it to be nonhazardous.

Decon Water and Miscellaneous Water. The water resulting from rinsing out the off-gas treatment equipment was combined and treated using chemical precipitation in the same manner as the scrubber liquid. Mercury was reduced to 0.054 mg/L. Carbon adsorption treatment was not required since the pyridine concentration was below the TC limit.

Miscellaneous decon water, including the acid washes from treatment of the filter bags, Brinks media, and HEPA filters, was also treated using the same method. Analysis of other metals, including lead, cadmium, arsenic and selenium, was performed after treatment, since these metals were found in certain solid media that were acid washed. The treated water passed TCLP for all metals as well as pyridine, which was analyzed for since it was present in the other residuals.

Scrubber Filter Solids. The sludge collected in the filter bags from all three pilot tests had mercury levels significantly exceeding 20 times the TC limit of 0.2. TCLP analysis of the composited sludges gave a mercury value of 9.6 mg/kg, confirming that this residual was RCRA hazardous. The composite sludge was air dried and placed in the RTA for thermal desorption treatment. Mercury was not detected in the TCLP extract of the treated solids; the total mercury had been reduced to 20 mg/kg. The mercury collected from the RTA off-gas system was combined with the elemental mercury collected from the three pilot tests.

Water Treatment Sludge. The precipitated and dewatered solids generated from treatment of the scrubber liquids and decon water were composited and treated in the RTA in the same manner as the scrubber filter solids. The total mercury concentration of these solids prior to treatment ranged from 600 to 3000 mg/kg. However, the TCLP mercury value was below the TC limit apparently due to the chelation of the mercury during water treatment. Desorption reduced the total mercury of the composite solids to 18 mg/kg; the TCLP mercury was 0.14 mg/kg.

Elemental Mercury. The liquid mercury (about 30 g) collected from all sources was assumed to be hazardous. It was combined and treated with powdered zinc and powdered

sulfur to produce an amalgam. This mixture was then stabilized using cement and water. The resulting TCLP mercury was very low (0.008 mg/L).

Scrubber Liquid Filter Bags. The synthetic fabric filter bags used to remove suspended solids from the recirculated scrubber liquid retained some solids after scrapping to remove the sludge. TCLP mercury analysis of fabric specimens from various bags after water washing did not quite pass. Dilute nitric acid was used to wash/leach the bags, resulting in a TCLP mercury for specimens of the acid washed bags of 0.05 mg/L.

Brinks Demister Media and HEPA Filters. The demister media was acid washed since analysis of total mercury of a specimen of media showed over 800 mg/kg. No mercury was detected in the TCLP extract of the cleaned media.

Analysis of total metals for the HEPA filter media from Test 3 showed mercury, arsenic, lead and selenium concentrations exceeded 20 times the respective TCLP limits. Therefore, all the HEPA filter media was composited and washed/leached with dilute nitric acid. The TCLP metals were all nondetectible.

Carbon from Off-Gas System. The sulfide impregnated carbon from the primary adsorber of the 600°C test and the combined primary-secondary adsorbers of the 350°C test had total mercury concentrations exceeding 20 times the TCLP limit. In addition, the benzene concentration of the primary carbon from the 600°C test was nearly 3000 mg/kg. A composite of the primary and secondary carbon from Test 1 plus Test 2, and a composite from Test 3 were submitted for TCLP mercury and TCLP VOCs with mixed results. The carbon from Test 3 passed easily, while the carbon from Tests 1 and 2 failed for mercury and benzene. This carbon used for tests 1 and 2 was from a different, older lot that had been used for prior testing. This carbon was treated by applying a small amount of TMT chelating/complexing agent. The TCLP mercury was reduced from 4.5 mg/L to 0.002 mg/L; benzene was reduced from 1.1 mg/L to 0.3 mg/L.

9.0 ENGINEERING ASSESSMENT

The information from the pilot tests was used to assess the application of a full-scale thermal desorption facility to treat LEFPC soil. This section presents a discussion of the scale-up methodology used to translate the pilot test results into a 35-ton-per-hour treatment facility. The conceptual facility is described with its design basis and a material balance for major constituents. Process equipment and operational requirements are defined, as are the associated capital and operating costs. Finally, principal scale-up issues are discussed and areas are identified where further information would be useful in developing a complete, final design for a thermal desorption facility for LEFPC soil.

The basis for the conceptual facility described in this section is operation of the desorber at 350°C. Because pilot test results were also obtained at 600°C, some evaluation is included of the impact of a higher temperature operation on the design and cost aspects of a full-scale facility. A separate design and cost estimate was not performed, so any comparison between two treatment processes operating at the two temperature conditions is qualitative.

9.1 SCALE-UP METHODOLOGY

IT's approach to process scale-up was to integrate the results of separate tests of the various key unit operations/subsystems. This approach provides a meaningful engineering basis and is more practical than attempting to test a complete, pilot-scale version of a full-scale process.

The major process areas that required scale-up information included: a) soil feed materials handling; b) thermal desorption treatment conditions; c) particulate entrainment from the desorber; d) treated soil material handling; e) off-gas and final emission characterization and; f) wastewater effluent and solid residuals characteristics relative to treatment and disposal. The following section discusses scale-up issues around some of the key unit operations.

Front-End Materials Handling. Experience has shown that direct scale-up of material handling equipment for soil can be problematic. Geometric and operational constraints are encountered that generally preclude the use of analogous equipment at the small- and large-scale. Design of the feed system is very important in assuring reliable operation of a thermal treatment system. Design of the front-end materials handling section entails evaluation of both small-scale test data and information on the characteristics of the soils. The moisture content and soil type (e.g., clay content, grain size distribution, etc.) affect the storage and handling characteristics significantly. Key physical properties such as Atterberg limits were

measured and observations of cohesiveness made for the particular LEFPC soil obtained for this project.

Three types of feed systems include screw conveyors, feed chutes with air-lock valves, and slinger belts. On high clay soils, the as-excavated moisture content can frequently be too high for reliable operation of screw feeder systems without the incorporation of additives such as lime. The slinger belt system can handle highly adhesive soils and is almost an "omnivorous" feed system. It is, however, expensive and difficult to seal (for air leakage).

Feed chutes are the simplest and most reliable feed system, but the soil must not have characteristics that would result in sticking to the chute surfaces. The critical factor in the design of the feed chute is the chute angle, which must be steep enough that the soil drops from the apron conveyor and sides into the desorber. This angle can be determined by testing a small-scale replica of the chute, which is easily tested on a "stand alone" basis. The materials handling tests performed on LEFPC soils using a pilot feed chute demonstrated that this feed system could function well at soil moisture levels that could be expected from a suitable excavation and feed blending operation.

Another front-end materials handling issue is potential agglomeration in the feed end (drying section) of the desorber. The tests conducted in this project identified the critical moisture content for this behavior and demonstrated that agglomeration should not be a significant problem; reducing the moisture content of the feed soil should not normally be required.

Thermal Desorber Treatment Conditions. IT's pilot thermal desorber is essentially a scaled-down version of a full-scale unit, employing the same principles of heat and mass transfer. It was operated at the same solids residence time at the target treatment temperature and atmosphere (e.g., air purge) that would be used in a full-scale desorber. The complete time-temperature profile of the soil during processing in the pilot unit was measured. The scale-up of the desorber to achieve those same conditions will involve heat and material balance calculations that will use the projected feed moisture and desired soil throughput. Considerable experience in developing and designing indirectly-heated rotary calciners and comparable process equipment for various solids thermal treatment applications is available from the manufacturers of this type of equipment. This engineering knowledge was used by the manufacturers to determine the heat duty and size of the full-scale unit.

Particulate Entrainment. Even the low gas velocities in a thermal desorption system compared to gas velocities in a direct-fired incinerator will result in some carry-over of soil fines into the off-gas treatment system. Particulate entrainment was evaluated for the full-scale desorber using several approaches. Entrainment rates were calculated for the full-scale conceptual desorber based on empirical equations relating particle behavior in beds of solids exposed to a gas flow. Entrainment for the pilot system was also calculated and compared with actual measured entrainment results from the three tests. The particle size distribution of untreated soil was measured for input into this calculation. The total off-gas flow and respective velocity for the full-scale desorber calculation was based on the material balance calculations for the full-scale system derived from the measured pilot test purge gas flow. The entrainment calculated for the pilot desorber agreed well with the 1.5 percent entrainment actually measured. The entrainment calculated for the full-scale desorber was also 1.5 percent.

Entrainment history for previous pilot tests was also considered. In addition, IT's experience in operating full-scale rotary kiln incinerators on various soils/sludges and the projections of the desorber manufacturers was considered. In our experience, mathematical methods of estimating entrainment tend to yield conservative values.

Off-Gas Treatment System. The components of the proposed full-scale off-gas treatment system are proven control devices. The spray quench scrubber, noncontact chilled condenser, HEPA filters, and carbon adsorption units do not require confirmation of performance; engineering specifications can be developed based on knowledge of the inlet gas composition and temperature. The WESP has been proven to be efficient on a wide range of mists, aerosols, and other fine particulates, and can also be specified based on projected inlet gas compositions for routine applications.

The overall performance of the pilot off-gas treatment system was measured by sampling and analysis of the off-gas and final vent, and by monitoring key process conditions such as temperature. All parameters were quantified that are necessary to establish full-scale equipment requirements. Parameters included particulates, metals, organics, acid gases, and carbon dioxide/monoxide. The performance of all the individual control devices was evaluated in the pilot tests by sampling and analysis of the liquid residuals or treatment media (e.g., demister, filter, carbon) and visual observations of the condition of the equipment components and media. Mercury collection was measured for all devices to aid in preparation of a material balance.

The gas sampling, residual sampling, observations, and process monitoring data provided a basis for selecting the off-gas treatment system configuration and duty for each component. Some changes were made between the pilot and full-scale systems. The hot cyclone was eliminated due to the very low fraction of total entrainment that was collected by this device. Two demister units were placed in parallel downstream of the quench scrubber to coalesce and collect fine mercury droplets. The chilled condenser was placed before the WESP (rather than after) to enable fine condensed droplets of mercury to be removed rather than pass through and contribute unnecessary load on the carbon adsorbers. A two-stage carbon adsorption system was incorporated in the full-scale system to enable regeneration of most spent carbon. The proposed system consists of standard vapor-phase activated carbon units for organic vapor removal followed by a special sulfide-impregnated carbon unit for mercury removal. Full-scale equipment designs were determined by equipment vendors based on the estimated duty as derived from the material balance. All devices were standard items.

Back-End Materials Handling. Two systems can be considered for cooling the treated soil from the desorber. The most reliable uses a quench sump and a drag-flight conveyor. The critical design consideration is the ability of the drag-flight to dewater the treated soil as it pulls it out of the quench sump and up the "beach." If the soil is too fine, it will come out of the drag-flight as a slurry that will not drain and cannot be handled easily. Analysis of the particle size distribution and testing of a mockup of the drag-flight system provide the basis for selection of this type of system for the full-scale facility. Moisture and angle of repose data on the quenched treated soil was also obtained to confirm the use of stockpiles for temporary storage prior to transport to final disposition.

Residuals Treatment. A study of treatment technologies and disposition options for the various liquid and solid residuals was not included as a part of this project. However, treatment testing was performed in order to render nonhazardous those residuals that were TC hazardous. Characterization of all the residuals for key parameters provides a reasonable basis for projecting the treatment requirements for a full-scale facility. The actual treatment of the aqueous liquids and sludges from the pilot scrubbing system gives further engineering information to define process requirements. For the aqueous effluent, these data and experiences with similar wastewater were used to scale-up the effluent treatment system. It was assumed that the treated effluent could be applied to the treated soil prior to final disposition. For the mercury-containing sludges, however, no provision was included for further treatment; it was assumed that the sludges would be shipped off site to a treatment facility, recycled to the thermal desorber, or treated to concentrate the mercury on site using a

thermal or other type process. As discussed in Section 9.7, additional treatability testing and engineering and cost evaluation is necessary to select the most cost-effective treatment approach for the sludges, as well as the aqueous liquids.

9.2 PROCESS DESCRIPTION

9.2.1 Design Basis

For purposes of developing the conceptual design, calculating the material balance, and defining equipment and operating requirements, the following basis was used:

- Operation of the treatment system is continuous; feed preparation activities are part time (e.g., 16 hours per day, 5 days per week).
- Average soil feed rate to the thermal desorber is 35 tph.
- Annual treatment (production) is 276,000 tons of soil feed, assuming 90 percent on-stream factor.
- Soil moisture in the feed to the desorber is 25 percent.
- Mercury concentration in the soil feed is 300 mg/kg (ppm).
- Organic compounds in the soil feed total 9 mg/kg; generation of organics as off-gas constituents during treatment is equivalent to an additional 250 mg/kg of soil feed.
- Mercury concentration in the treated soil is 15 mg/kg.
- Most mercury is recovered as liquid metal for shipment to reclaimers; thermal desorption is used to process sludge residues from the off-gas treatment system.
- No aqueous effluent is discharged from the thermal desorption facility; wastewater is treated and used to quench the treated soil.

The design basis would be the same for a higher temperature desorber system except for the operating conditions being 600°C for 10 minutes and the treated mercury concentration being less than 10 mg/kg.

9.2.2 Conceptual Process Description

Figure 9-1 is a process flow diagram for the proposed full-scale facility. Each of the major process areas are discussed in this section, including feed handling, thermal desorption, treated soil handling, off-gas treatment, effluent treatment, and residuals management.

Soil Feed Handling. The feed preparation system receives, prepares, and stores a consistent feed material for the thermal desorber. Material handling equipment is designed for incoming soil via trucks. It is assumed that some segregation of large oversize material, such as tree trunks and boulders, would be done as part of the excavation operation and would not be delivered to the feed preparation building. Soil is dumped on a concrete slab within a building where debris and material over 2 inches is removed. The oversize material is crushed, shredded on an intermittent basis, and then blended with the minus 2-inch feed stock. Alternatively, the oversize material, such as large rocks or tree roots, may be treated separately by using a washing system. This process is not included in the facility scope.

The soil is then blended by spreading the material and using a mechanical mixing device such as a Brown BearTM. During blending, drier material is mixed with wetter material to arrive at a reasonably uniform moisture content. During this blending and storage period, which may last several days, partial drying of the soil can be accomplished. For the purposes of developing the conceptual design, an average moisture content of 25 percent was assumed for the prepared feed soil. Based on the results of the materials handling tests, this moisture content should enable the soil to be reliably handled in the proposed front end materials handling (desorber feed) system. The entire feed preparation operation is performed under a large temporary building with substantial ventilation and provisions to prevent potential fugitive emissions.

A front end loader is used for transferring soil from the unloading area to the screening station and from the prepared soil stockpile to the thermal desorber's feed hopper. The feed hopper meters material onto a belt feed conveyor. The belt conveyor incorporates a belt scale for monitoring feed rate to the thermal desorber.

The design of the feed handling system would not change for a 600°C desorption process.

Thermal Desorption. To process 35 tph of moist soil, two conventional rotary calciners are used in parallel for thermal desorption. The thermal desorber is indirectly heated by firing

natural gas into the stationary insulated chamber surrounding the rotating drum. Figure 9-1 is a schematic of the desorber.

Prepared soil is continuously charged into each desorber through an air lock isolation valve and gravity feed chute. The soil is heated to approximately 350°C and held at that temperature long enough to desorb water and mercury; some of the organic compounds will also desorb. The overall residence time in the desorber is about 50 minutes, with the majority of this time being the heat up period.

Air is introduced as a purge or sweep gas to the desorber through the solids discharge hood. The desorber is operated under a very slight negative pressure produced by an induced draft fan located at the vent stack in the off-gas treatment system. The off-gas leaving the desorber consists of the water vapor, nitrogen, oxygen, carbon dioxide, mercury vapor, organic vapors, entrained soil particles, and any radionuclides associated with these particles. The off-gas is comprised primarily of water vapor (e.g., 40 to 60 percent), nitrogen and oxygen (e.g., 17 percent).

A thermal desorber designed to operate at 600°C would be somewhat larger to provide the additional heat input. Some changes to the materials of construction and to mechanical features might also be necessary.

Treated Soil Handling. The purpose of the treated soil handling system is to cool, moisten, and store the decontaminated soil leaving the thermal desorber. The hot soil falls from the desorber into a quench tank filled with water, which cools and moistens the soil and provides an air seal to the desorber. A wet drag-flight conveyor is used to drag the wet soil up an incline to allow drainage. The wet soil is discharged onto a radial stacking conveyor that transfers it to stockpiles. Drainage from the piles is collected and recycled to the quench. The soil is sampled and analyzed by pile or batch prior to transporting it to final disposition.

For a 600°C desorber process, the treated soil discharged to the quench would be much hotter.

Off-Gas Treatment. The purpose of the off-gas treatment (air pollution control) system is to remove the mercury vapor from the gas stream, and to remove other contaminants in conformance with emission limitations. Gas is pulled out of the desorber and through several stages of gas cleaning equipment by an induced draft fan.

The primary off-gas treatment stage is a direct-contact quench scrubber. Water is sprayed into the scrubber to reduce the gas temperature to approximately 40°C, thereby condensing water, organic and mercury vapors, and scrubbing particulates. By condensing water vapor and cooling the noncondensibles (e.g., nitrogen, oxygen), the quench significantly reduces the volumetric flowrate of off-gas. The scrubber liquid is a multiphase mixture containing water, organics, mercury, and soil particles. The mercury is principally sorbed onto or entrapped in the suspended solids. The organics, particularly those having low water solubility, will also tend to concentrate in these solids.

Scrubber liquid is collected in a quench sump and is pumped through a water-cooled heat exchanger. The cooled water is recirculated to the quench scrubber. A small fraction of the recirculated flow is diverted to a centrifuge to remove suspended solids, with the majority of the centrate returned to the recirculation loop. A portion of the centrate is purged from the scrubber water system and transferred to the effluent treatment system.

A mist eliminator follows the quench scrubber to remove entrained droplets from the quenched gas. The liquid collected on the coalescing media drains to the scrubber liquid recirculation system. The gas flows from the demister through a chilled condenser where additional water, organic and mercury vapors condense.

The chilled gas is treated in a WESP, which collects fine particulate matter and liquid droplets. The WESP functions by inducing an electrostatic charge to particles which causes them to be attracted to negatively charged collection surfaces. The collected material, along with water used to intermittently irrigate the collection surfaces, is discharged to the quench sump.

The gas leaving the WESP is reheated to reduce the relative humidity of the gas and prevent further condensation in the control devices downstream. After reheat, the gas passes through a HEPA filter to remove residual submicron particulate matter, including radionuclides. Two HEPA filters are installed in parallel to allow one to be removed from service for cleaning. Gas leaving the filters flows into a carbon adsorption system to remove residual organic and mercury vapors. Two standard carbon adsorbers for organic vapors are installed to allow one to be removed from service periodically for carbon replacement. A third special carbon adsorber using sulfur impregnated carbon is used to treat the gas to remove (through reaction) mercury vapors. This unit has sufficient mercury removal capacity to serve during the entire operating period of the treatment facility.

From the adsorbers, the gas flows into the induced draft fan which imparts a vacuum on the desorber and off-gas treatment system. The fan exhausts a small flowrate of vent gas to the atmosphere. The vent gas consists primarily of nitrogen and oxygen from the air purge, as well as from any air infiltration, and carbon dioxide generated from thermal decomposition of the soil organic matter. Traces of low molecular weight gases such as carbon monoxide and chloromethane, which are not condensible or adsorbable on carbon, may be present in the vent gas.

For a 600°C desorption process, the off-gas treatment system would have a greater load in terms of heat content, organic content, and potentially metals, acid gas, and ammonia. No data were obtained to characterize the off-gas from the 600°C test, but analysis of the residuals suggests increased carbon consumption from higher VOC content. The quench scrubber would be larger with a higher recirculated water flow rate and a larger cooling heat exchanger.

Aqueous Treatment. The aqueous treatment system removes mercury and other constituents from the aqueous purge stream from the off-gas treatment system. This stream contains low levels of suspended solids and associated (sorbed) mercury and organics, as well as dissolved mercury and organics. The treatment train consists of several stages of chemical addition, precipitation and clarification to remove mercury and suspended solids. Additives are used to convert the soluble mercury into insoluble, chelated form, to produce a precipitated solid, and to coagulate and flocculate the precipitated solids to enable effective gravity clarification. Additives include acid and caustic to adjust the pH to the proper condition for each treatment stage, and to produce a neutral final effluent. A circular clarifier settles and removes the suspended solids. The settled solids are pumped out of the clarifier to a thickening/holding tank and transferred to a filter press for dewatering and volume reduction. The clarified water is filtered to further reduce suspended solids as a pretreatment to the next treatment step.

The filtered water is treated in a conventional two-stage activated carbon adsorption system to remove certain dissolved organic compounds. Carbon adsorption is only expected to remove those compounds which have relatively good adsorption characteristics; other compounds are expected to pass through the adsorbers. Compounds such as aromatic hydrocarbons, phenols, pyridine, and PAHs are expected to be effectively removed. These are the compounds which are specifically regulated, and which may require treatment in order to return the treated water to the soil without impacting soil disposition. The treated water is sampled and

analyzed periodically to monitor carbon breakthrough. For the purposes of the conceptual design, carbon treatment is assumed to be required. This issue is further discussed in Section 9.7. The treated water is assumed to be incorporated into the treated soil by using it as makeup to the quench section of the drag-flight conveyor.

Aqueous treatment requirements would be more demanding for a 600°C process due to the significantly higher organic content of the scrubber liquid. If carbon is used for organic removal, usage would increase nearly in proportion to the organic load.

Residuals Management. The scrubber water centrifuge produces a slurry which is further concentrated in a filter press. The sludge from the effluent treatment process is also collected and filtered with the centrifuge slurry. The filter cake will contain primarily fine soil particles with mercury and organics, particularly SVOCs, which tend to accumulate with the solids. The mercury content of this cake is expected to range from 0.1 to 1.5 percent, depending on the mercury concentration in the untreated soil. This material is not a good candidate for acceptance by a commercial mercury reclaimer due to the quantity relative to existing commercial reclaimer capacity and due to the presence of organics. Further processing to separate/concentrate the mercury would facilitate disposal of this residual (discussed further in Section 9.7). For purposes of this conceptual design and cost estimate, it was assumed that the sludges would be treated on site in a small thermal separator (desorber) or retort process as an independent operation, with the treated solids returned to the soil treatment system and the mercury liquid shipped to a reclaimer.

Other major solid residuals include spent carbon from the effluent treatment system and the off-gas treatment system. Most of the spent carbon could probably be recycled by commercial regenerators. The acceptance by a regenerator of the standard carbon used for removing organic constituents from the off-gas and wastewater will depend on the total quantity of spent carbon and concentration of mercury that accumulates. For the wastewater, a high degree of mercury removal via chemical/physical treatment prior to carbon treatment will minimize mercury content. For the vapor phase carbon, mercury adsorption is normally very low compared with organic adsorption; mercury that is adsorbed would tend to be desorbed/displaced by organics as the carbon bed becomes exhausted (loaded).

However, the sulfide impregnated carbon, which will contain significant mercury, must be treated and disposed at a landfill. It is estimated that this residual will only be generated once during the entire period of operation. Treatment options include chemical treatment,

such as adding a chelating agent, or stabilization to reduce leaching potential (pass TCLP). Alternatively, the spent sulfide impregnated carbon could be processed through the main thermal desorber at the conclusion of the project or through a small thermal treatment unit used for processing the mercury sludges.

The residuals from a 600°C desorption system will be considerably higher in organic content and the solids may have somewhat different characteristics as a result of thermal alteration; therefore, treatment requirements would be affected.

9.3 MATERIAL BALANCE

An overall material balance was developed to define the principal constituents for the major process flows. Table 9-1 presents the material balance. Principal constituents included soil (solids), water, air, mercury, and total organics. Although the quantities of consumables were also estimated and are described in Section 9.5, consumables are not specifically incorporated into the material balance except for effluent treatment chemicals. The major flows included all feed streams and discharges from the process plus selected intermediate process streams. Selection of the intermediate process streams was based on the availability of data from the pilot tests and the relative importance of the particular stream in defining downstream process requirements.

All final residuals that are candidates for off-site treatment or disposal have been estimated from the material balance. Process emissions also have been estimated. The characteristics of these final discharges from the treatment process are discussed in this section.

The methodology used to develop the material balance was to establish a design basis as presented in Section 9.2, prescribe operating conditions for each process component, set assumptions for the performance of specific process components, set assumptions for the characteristics of particular process streams, and perform the total and component mass flow calculations around each unit operation. Operating and analytical results from the 350°C verification test were used for selecting the process conditions and stream compositions. Data from the other pilot tests were used as appropriate, such as filling information gaps from the 350°C test.

In addition to the design bases listed in Section 9.2, a set of design assumptions were made in order to develop the overall process material balance. These assumptions are listed in Appendix I.

TABLE 9-1

FULL-SCALE THERMAL DESORPTION PROCESS MATERIAL BALANCE

POPLAR CREEK

Project : 483138

popla5-KT-09-09-94

STREAM NAME COMPONENT	UNITS	WET SOIL	PURGE GAS	DESORBER OFF-GAS	TREATED SOIL	QUENCH UNDERFL.	QUENCH OFF-GAS	WESP OFF- GAS	SPENT CARBON W/ORG.	SPENT SULFIDE CARBON	COMBI. DRAIN	FINAL VENT	CENTRI. FEED
WATER	lb/hr	17,500		17,500		803,693	810	72	1.88	0.09	738	70	74,514
DRY SOLIDS	lb/hr	52,478		787	51,691	8,649	8	0	4.17	0.20	8	0	793
MERCURY (Hg)	lb/hr	21		20.22	0.78	98.18	0.74	0.04	trace	0.04	0.70	trace	20.18
ORGANICS	lb/hr	0.63		19	0.052	210	1.0	0.5	0.5	trace	0.5	trace	18.5
TOTAL CHEMICALS	lb/hr												
AIR FLOW	lb/hr		13,500	13,500			13,500	13,500	0	0		13,500	
TOTAL MASS FLOW	lb/hr	70,000		31,826	51,692	812,650	14,320	13,572	7	0	748	13,570	75,345
VOLUMETRIC FLOW	gpm			36		1,614	1.6				1.5	0.1	148
AIR FLOW (dry)	scfm		3,000	3,000			3,000	3,000				3,000	
TEMPERATURE	o F	70		347	347	110	110	40	77	77	85	77	110
TEMPERATURE	o C	21		175	175	43	43	4.4	25	25	29	25	43
SOLIDS % (of total wt)		75			100	1.06							1.05

TABLE 9-1 (continued)

FULL-SCALE THERMAL DESORPTION PROCESS MATERIAL BALANCE

POPLAR CREEK

Project : 483138

popla5-KT-09-09-94

STREAM NAME COMPONENT	UNITS	CENTRI. SLUDGE	QUENCH RECYCLE	PREC FEED	CLARIF FEED	UNDERFL. SLUDGE	CARBON FEED	LIQUID PHASE SPENT CARBON	FILTRATE	CARBON EFFL.	CENTRI. EFFL.	PURGE	FILTER SOLIDS
WATER	lb/hr	2,967	787,003	14,302	14,302	269	14,033	47	2,375	14,050	56,191	72,964	759
DRY SOLIDS	lb/hr	723	7,870	14.30	14.30	17.0	0.071	105	0.048	0.00	56	785	739
MERCURY (Hg)	lb/hr	19.48	78.70	0.143	0.143	0.142	0.0014	0.0007	0.00	0.00	0.56	19.48	19.62
ORGANICS	lb/hr	0.86	192	3.53	3.53	0.070	3.46	3.36	0.55	0.10	13.81	18.00	0.38
TOTAL CHEMICALS	lb/hr				2.8								
AIR FLOW	lb/hr												
TOTAL MASS FLOW	lb/hr	3,710	795,144	14,320	14,322	286	14,037	155	2,375	14,050	56,261	73,767	1,518
VOLUMETRIC FLOW	gpm	6.4	1,580	28.7	28.8	0.55	28.2		4.8	28.2	112.8	146.5	
AIR FLOW (dry)	scfm												
TEMPERATURE	o F		85	85	85	85	85	85	85	85	85	110	85
TEMPERATURE	o C		29	29	29	29	29	29	29	29	29	43	29
SOLIDS % (of total wt)		19.47	1.00	0.10	0.12	5.95	0.0005	67	0.0020	0.00	0.10	1.06	49

9.4 EQUIPMENT REQUIREMENTS

The major equipment was defined for the conceptual design in order to develop a budgetary capital cost. The equipment duty was established using the flowrates, compositions, and temperatures shown in the material balance. Conventional hardware was used for all equipment items. The type of equipment was selected using engineering judgement and experience in designing and operating treatment processes for similar streams, such as process emissions and wastewater. Because of the conceptual nature of the design, no evaluation of alternatives or optimization of equipment types or process configurations was performed. Only major equipment was defined in any detail. Equipment items, such as pumps, were not included in the equipment list.

Table 9-2 provides a list of major equipment with associated duty or size/capacity and number of units. For essentially all process equipment, a single unit was sufficient for the estimated duty. Two desorbers were necessary because the maximum capacity of standard commercial units was not capable of providing the thermal input and residence time for the 35 tph soil treatment rate. Multiple units were also needed for sequential chemical/physical treatment steps of the effluent treatment system.

Equipment that could be used for processing of residuals to achieve further volume reduction, to increase mercury content, or to remove organic contaminants to facilitate disposition by a mercury reclaimer or recycle to the thermal desorber was not included in the facility scope.

9.5 MAJOR OPERATIONAL REQUIREMENTS

Major operating and maintenance (O&M) requirements for the full-scale facility were defined to understand the logistical needs and costs of performing treatment of LEFPC soils. Requirements included labor (operating, maintenance and indirect), utilities, consumables such as chemicals and carbon, maintenance materials, and residuals disposal. Labor was estimated based on actual operating experience with comparable thermal treatment projects. Consumption of chemicals, carbon and other operating materials was estimated based on the pilot test data, previous IT experience, and experience of vendors with comparable applications (e.g., carbon loadings/life). Utilities were projected from the heat and material balance calculations. Fuel use was estimated by the thermal desorber manufacturers based on the heat duty (soil feed rate, moisture content, and treatment temperature) and typical heat transfer efficiency. Electrical power use was estimated based on estimates made for similar scope thermal treatment facilities. Table 9-3 summarizes the O&M requirements for the full-scale facility.

Table 9-2**Equipment List For Full-Scale Treatment Facility**

(Page 1 of 3)

Item	Description	Qty
Materials Handling - Feed Soil		
Grizzly	110 TPH, 110 CYH	1
2" Vibrator screen	110 TPH, 110 CYH	1
Conveyor	110 TPH, 110 CYH	1
Radial stacker conveyor	110 TPH, 110 CYH, 100 FPM, 15° Slope, 3 ft Belt Width, 50 ft Long	1
Shredder		1
Magnetic separator	6.5 KW, 5 ft wide belt, self-cleaning	1
Live bottom hopper	70 Tons, 70 CY (Carbon Steel Hopper)	1
Incline feed conveyor	70 TPH, 70 CYH, 100 FPM, 15° Slope, 2 ft Belt Width, 135 ft Long	1
Feed prep loader	Cat. #938 Wheel Loader	1
Feed hopper loader	Cat. #938 Wheel Loader	1
Soil stabilizer/mixer	Cat. SS-250	1
Thermal Treatment		
Kiln feed airlock valves	2 ft Square	1
Thermal desorber (indirectly heated)	1 ft ID x 94 ft Long	2
Materials Handling - Treated Soil		
Wet drag flight conveyor	70 TPH, 70 CYH	1
Radial stacker conveyor	70 TPH, 70 CYH, 100 FPM, 15° Slope, 2 ft Belt Width, 100 ft Long	1

Table 9-2

(Page 2 of 3)

Item	Description	Qty
Off-Gas Treatment		
Spray tower	13,700 ACFM - Gas flow - 31,800 lbs/hr	1
Spray tower heat exchanger	21 MM BTU/hr	1
Mist eliminator	Gas flow - 14,300 lb/hr - 3,500 ACFM	2
Chilled brine condenser	In @ 100°F - Out @ 45°F	1
Wet electrostatic precipitator	Gas flow - 13,500 lb/hr	1
Gas reheater	3100 ACFM, 45 to 70°F	1
Dual HEPA filter	Removal efficiency - 99.97%	1
Vapor-phase carbon adsorber	Rolloff container with 12,500 lb of carbon	2
Vapor-phase carbon adsorber (special)	8 ft dia vessel with 5000 lb of sulfide-impregnated carbon	1
ID fan	3,500 ACFM @ 12 in w.c.	1
Stack	15 in OD x 9 ft tall, unlined stack w/transition piece for ID fan and required ports	1
Effluent Treatment		
Centrifuge - solid bowl	160 GPM, 30 ft dia x 8 ft long, 2000 Gs	1
Clarifier w/flocculator center feed well and internals	32 GPM, 12 ft dia, coated carbon steel	1
Sludge thickening tank w/bottom rake	10,000 gal, 12 ft dia x 12 ft high, with rake, drive and controls	1
Filter press w/feed pump and controls	67 cu ft	2
Chemical tanks	2000-5000 gal	4

Table 9-2

(Page 3 of 3)

Item	Description	Qty
Agitators for above tanks	Variable speed	4
Automatic backwash filter	32 gpm, 8 lb/day of solids	7
Liquid-phase carbon adsorbers	10 ft diameter vessel with 20,000 lb of carbon	2

Table 9-3**Summary of Operational Requirements For Full-Scale Treatment Facility**

Operating Requirement	Estimated Quantity
Labor	
Operating crew	30 people
Maintenance crew	10 people
Site management/support staff	18 people
Clerical staff	9 people
Total labor	67 people
Utilities	
Natural gas	1.6 million cubic feet/day
Electrical power	2160 kw
Cooling water	1620 gpm
Materials/consumables	
Vapor-phase carbon	90 lb/day
Vapor-phase carbon-sulfide impregnated	4.5 lb/day
Liquid-phase carbon	2250 lb/day
Water treatment chemicals	1.35 tons/day
Management of treatment residuals (sludge)	15.6 tons/day

For the 600°C process, demand for fuel, cooling water, treatment chemicals, and carbon would increase. Fuel usage would be approximately 35 percent higher; cooling water is not expected to increase as much. Chemicals and carbon for effluent treatment would be higher due to the increase in organic content of the effluent due to thermal decomposition of soil organic matter. Carbon consumption for controlling VOCs in the off-gas would increase for the same reason. No quantitative estimates were made of these increases.

9.6 CAPITAL AND OPERATING COST ESTIMATE

A budgetary estimate was prepared of the total installed capital cost and O&M costs for the conceptual treatment facility scope as defined in the previous sections. The scope or battery limits of the facility is defined in Section 9.2; other equipment and O&M costs will be required for a complete remediation program and these costs need to be considered in evaluating the overall cost for a thermal treatment remedy. The approach, scope, and results of the budgetary cost estimates are described in this section.

9.6.1 Capital Cost Estimate

The approach used to develop the budgetary capital cost estimate was to apply installation cost factors to adjusted purchased equipment prices. First, budget prices were obtained for all major equipment from vendors or existing IT cost data for comparable items. In some cases, where vendors handled a wide range of equipment types, prices were provided for subsystems. Subsystems included several major equipment items used in sequence for the same process stream, such as the wet portion of the off-gas treatment system. For minor equipment items, such as small tanks, a price allowance was made based on general cost experience for similar hardware. A table summarizing the estimated purchase cost for all major equipment is given in Appendix I. For each equipment item, a labor adjustment was added for erection at the site. An allowance was made for freight charges as well as for equipment items not specifically identified and was added to the total adjusted purchase cost.

Installation factors were assigned to the total adjusted equipment cost. These factors were selected based on IT's experience designing and constructing other large capacity, transportable, thermal treatment systems for on-site soil remediation. The overall installation factor or cost multiplier included infrastructure costs, indirect costs, and engineering. Infrastructure costs consisted of equipment erection, site preparation, concrete, structural steel, buildings (for soil prep), piping, electrical, instrumentation, insulation, painting and paving. Indirect costs include spare process equipment, rental of construction equipment and facilities,

consumables, indirect labor, bonding, taxes, and warranty costs. Engineering costs included process and detailed engineering, construction management, and project management.

A table is included in Appendix I, which summarizes the individual installation factors and the calculation of total installed capital cost. The total installed cost is approximately three times the purchased equipment price.

Table 9-4 summarizes the capital cost of the conceptual facility, showing the relative importance of the principal process elements. The thermal treatment component represents about 58 percent of the total capital. The estimated range of accuracy of the estimate is plus or minus 25 percent. Therefore, the range of total capital cost is \$9.2 to \$15.4 million. This accuracy is considered suitable for use in conducting feasibility studies. The total capital cost for treatment represents approximately \$45 per ton of soil treated, based on a total remediation of 275,000 tons of soil, equivalent to 1 year of operation.

9.6.2 Operating and Maintenance Costs

An estimate of the principal O&M costs was made based on the operating requirements described in Section 9.5. The scope of these costs included operating the proposed treatment facility and disposing of waste residuals. The cost elements included labor, utilities, raw materials (consumables), maintenance materials, leased equipment, and waste disposal. The estimated O&M costs are considered accurate to plus or minus 25 percent.

No costs were included for excavation, transportation of soil to or from the facility, analytical or monitoring, or further processing of residuals that might be appropriate for overall cost effectiveness. Capital charges (e.g., depreciation and interest) have not been included. If the facility was leased from a remediation contractor, equipment charges would be assessed based on the particular pricing approach of the contractor. Indirect costs, such as taxes and insurance, are also not included.

Table 9-5 summarizes the estimated O&M costs based on a daily and yearly time frame; the unit cost per ton of soil feed is also given. The total estimated O&M cost for treating 275,000 tons of soil in 1 year is \$13.7 million. The other cost elements previously noted should be considered in evaluating the overall cost for this remedy.

Table 9-4

Summary of Estimated Capital Cost

Process Area	Estimated Capital Cost (\$ million)
Soil Feed Preparation and Handling	2.2
Thermal Desorption	7.1
Treated Soil Materials Handling	0.5
Off-Gas Treatment	0.7
Effluent Treatment	1.7
Residuals Treatment ^a	--
Total	12.3

^aNo capital is included for processing sludge from off-gas treatment system; O&M costs include on-site treatment service.

Table 9-5

Summary of O&M Costs For Full-Scale Treatment Facility

Cost Component	Estimated Cost million \$/year	Estimated Cost \$/ton feed soil ^a
Labor	2.6	9.5
Utilities	5.4	19.6
Materials/consumables	1.1	4.04
Management of residuals	4.6	16.7
Total	13.7	49.8

^aBased on 275,000 tons per year soil feed.

9.7 DISCUSSION OF SCALE-UP ISSUES

The major scale-up issues were outlined in Section 9.1. The evaluation of test data and development of the conceptual design provides adequate information to address most of these issues. The operating conditions for the thermal desorber to achieve the treatment goal of 10 mg/kg were verified. The effectiveness of a system of conventional air pollution control devices to remove mercury and other constituents from the off-gas was demonstrated. The significance of particulate entrainment to the off-gas characteristics and resulting residual production was determined. The major scale-up issue is residuals management. A discussion of this issue follows, along with identification of other secondary scale-up issues.

9.7.1 Residuals Management

The pilot testing provided characterization data for the liquid and solid residuals to enable assessment of their potential regulatory classification and need for treatment to avoid any RCRA hazardous wastes. Limited treatability tests and actual treatment of the aqueous liquids and sludges from the scrubber system confirms that TC wastes can be converted to nonhazardous. However, the characterization and treatment data are inadequate for selecting the most appropriate approach for managing the major process residuals, particularly the scrubber sludge and aqueous effluent. In addition to further characterization and treatability data, a more thorough investigation of options (i.e., vendors/processes) for on-site or off-site treatment or reclamation, or off-site disposal is needed, as well as confirmation of the regulatory restrictions that will impact use of these options.

The characterization of residuals for uranium and gross alpha/beta does not suggest any concentration of radionuclides is occurring, and this would not be expected in a thermal separation process, particularly if operated at 350 C. The residuals would be classified the same as the untreated soil based on the data from this project.

9.7.1.1 Scrubber Sludge Disposition

The scrubber sludge poses a disposal problem since it contains mercury above the land disposal restrictions of 260 mg/kg and regulated organics, including PCBs. The composition of this sludge and concentration of specific regulated contaminants will vary with the LEFPC soil composition and thermal desorption conditions. These elements will also be affected by the amount of entrainment from the desorber relative to the amount of contamination in the soil. Entrainment will be influenced by the amount of very fine particles in the soil and the moisture content, which impacts the gas velocities in the desorber. Both of these soil

characteristics are a function of the location of and conditions during excavation in the flood plain.

Minimization of total entrainment, as well as the portion of entrained particles that are collected in the wet scrubber system, will reduce the quantity of scrubber sludge and increase the concentration of organics and mercury. Use of a high-efficiency hot cyclone prior to the scrubber would reduce the volume of scrubber solids. The pilot system hot cyclone provided little particulate removal, which suggested that this control device not be included in the conceptual design. The percent reduction that might be achieved by a high-efficiency cyclone was not determined in this study. Use of alternative particulate collection devices, such as a baghouse, was not investigated during the pilot testing. Concern over fouling of the filter media by mercury and high molecular weight organics, such as PAHs, discouraged the use of any type of media filter.

The scrubber sludge will normally be classified under RCRA as a characteristic hazardous waste due to mercury exceeding the TCLP limit of 0.2 mg/L. It is possible that certain organic compounds could also exceed the TC limit; the sludge from this demonstration project failed the TC limit for pyridine. The sludge could also be classified as a TSCA waste due to the PCB content exceeding 50 ppm; this occurred for Test 2.

The EPA has designated retorting or incineration, depending on whether organics are present, as BDAT for high mercury content listed wastes. Commercial mercury reclaimers currently have inadequate capacity to handle the projected volume of residuals. Also, commercial mercury reclaimers are not likely to be able to accept TSCA waste and, in fact, may be restricted from accepting wastes containing certain other regulated organics, such as PAHs or phenols.

Alternative management strategies for the sludge include:

- Treatment on site by continuously recycling with the soil to the thermal desorption process; this approach is expected to lead to accumulation of both mercury and SVOCs (e.g., PCBs) in the desorber sludge, which will not improve the disposal characteristics. For sludge that has very low PCB concentration (and other problematic SVOCs), direct recycling/retreatment is more feasible.
- Treatment on site by periodically recycling batches of sludge without soil to the thermal desorption process. During block operation of the soil treatment system, conditions could be adjusted in the desorber, off-gas treatment system, and

scrubber water processing, to attempt to separate the mercury from the organics. A much smaller volume of high mercury content residue would be produced that would be a better candidate for reclamation.

- Treatment on site in a separate thermal separation/desorber/retorting process of much smaller size to remove mercury and organics, as necessary, to produce a nonhazardous solid. This solid (which is principally soil fines) could potentially be recycled to the thermal desorption process (without contributing to accumulation of contaminants in the sludge) or blended with the treated soil, depending on the concentration of contaminants. The resulting concentrated mercury residue could be a candidate for shipment to a reclaimer, if the organics (e.g., PCBs) were separated during the treatment process.

9.7.1.2 Aqueous Effluent Disposition

The other major process residual, aqueous effluent, also poses potential difficulties relative to final disposition. The preferred approach is application of this water, after necessary treatment, to the treated soil. This is often done for on-site incineration remediation projects. This approach avoids a wastewater discharge from the operation, and the attendant regulatory implications. Treatment requirements will depend on the regulatory criteria for the treated soil to be placed in its final location. The conceptual design included provisions to remove mercury and toxic organics that are adsorbable on carbon. There appears to be significant organic content, as well as potentially ammonia, that would not be treated by the proposed system. Further treatment may be necessary. Biological treatment would be a logical candidate for treating all the organics in this effluent, and offers a potential cost savings over carbon adsorption.

9.8 OTHER SCALE-UP ISSUES

Another scale-up issue is associated with front-end materials handling. The selected preparation and feeding approach for the conceptual design was based on the silty soil sample used in this demonstration. Soil having significantly higher fines (e.g., clay) may demand further preparation or an alternative feed system.

The degree of process emission control to meet regulatory and health risk criteria needs to be defined to confirm what control devices are necessary. The proposed conceptual facility has multiple devices to reduce mercury, radionuclides, and organics to the lowest achievable level. Certain controls, such as the HEPA filters or carbon adsorbers, may not be required, which would result in some savings in O&M cost.

Appendix A
PHOTOGRAPHS OF TEST EQUIPMENT

Thermal Treatment of Solids in Six-Inch Rotary Tube Apparatus

LEFPC Soil Preparation

Front-end Materials Handling Test (Drop Test)

Front-end Materials Handling - Reagglomeration Test

Pilot Thermal Desorber - Rotary Calciner and Controls

Pilot Thermal Desorber - Scrubber/Condenser System

Back-end Materials Handling Test - Drag Flight Simulation

Appendix B

**REPORT - DESORPTION OF MERCURY COMPOUNDS
FROM SOILS FROM LEFPC**

1.0 SUMMARY

The purpose of this study was to generate data comparing the desorption of elemental mercury, mercury sulfide, and native mercury species (due to contamination) from soils from the floodplain of the Lower East Fork of Poplar Creek (LEFPC). Numerous previous studies by others have indicated that the majority of the mercury in the soils from the LEFPC are present as mercury sulfides, which have very low aqueous solubilities and, consequently, low mobility in the environment. A more recent study by others, employing a different method of speciation, has suggested that significant elemental mercury is present in the LEFPC soils. Because elemental mercury has much higher solubility and vapor pressure than the sulfide forms, it has a higher potential for mobility and adverse environmental effects. The data from this study by IT Corporation (IT) shows that, at temperatures between 100 degrees Celsius ($^{\circ}\text{C}$) and 300°C , the desorption behavior of the mercury in contaminated soils from LEFPC more closely resembled mercury sulfide than elemental mercury, and supports the original conclusions on mercury speciation.

The goal of this study was to develop curves that showed the desorption of mercury from the LEFPC soil as a function of temperature. For this testing, IT used the Rotary Thermal Apparatus (RTA), a bench-scale thermal desorption system, to treat 500-gram batches of the test soils. To generate the required data, IT conducted five tests on samples of contaminated soil from the LEFPC, three tests on uncontaminated soil from the LEFPC watershed that had been spiked with elemental mercury, and three tests on soil spiked with mercury sulfide.

The tests showed that with a 30-minute treatment time at 100°C and 150°C , mercury concentrations in the contaminated LEFPC soils were unchanged, while 58 percent and 68 percent of the elemental mercury was removed from the spiked soil. At 200°C , 21 percent of the mercury was removed from the LEFPC soil, while 74 percent of the elemental mercury was removed from the spiked soil, indicating that the elemental mercury is more volatile than the mercury species in the contaminated soil.

For the soil spiked with mercury sulfide, removal at 200°C , 250°C , and 300°C was 50 percent, 50 percent, and 60 percent, respectively. This compares to 21 percent, 56 percent, and 94 percent mercury removal with the contaminated LEFPC soil. Except for the 200°C test, mercury sulfide was less volatile than the native mercury species.

During all tests, the off-gas from the RTA was analyzed so that a mercury balance could be developed. The off-gas from the RTA went through a scrubbing system consisting of a hot filter, three impingers filled with a dilute mixture of permanganate and sulfuric acid, and either a demister (a fiberglass pad) or a mercury adsorbent. The hot filter, impinger solution, demister, and demister rinse or adsorbent were all analyzed for total mercury. Based on total mercury recoveries (soil residual plus mercury collected in the scrubbing system) of 29 percent to 100 percent, the mercury removal efficiency from the off-gas was in the range of 24 percent to 82 percent. Although this efficiency was low, it is consistent with previous studies and may be due to the difficulty of mechanically recovering minute mercury beads from the scrubber system.

2.0 EXPERIMENTAL METHODS AND MATERIALS

2.1 SOIL PREPARATION

The purpose of this study was to generate data comparing the desorption of elemental mercury, mercury sulfide, and the native mercury species from soils from the flood plain of the LEFPC. Bench-scale thermal desorption tests were conducted on a sample of contaminated soil from the LEFPC floodplain and on a clean soil from the Poplar Creek floodplain that had been spiked with elemental mercury. For comparison, tests were also conducted on the clean soil spiked with mercury (II) sulfide.

2.1.1 Contaminated Soil

The contaminated LEFPC soil was prepared for the bench- and pilot-scale thermal tests described in the report on thermal desorption demonstration of mercury from LEFPC soils. The soil sample for these tests came from the same batch of soil as was used in the prepilot testing described in Section 5.3.1. The preparation of this soil is described in Section 5.2.1. Briefly, the soil was air-dried until it could be handled, screened to remove debris larger than 0.5 inches, and thoroughly mixed. Homogeneity was confirmed by analysis of several grab samples for mercury.

2.1.2 Spiked Soil

The clean soil for this study was obtained from an uncontaminated, undisturbed site in the LEFPC watershed. This soil sample was air-dried to about 20 percent moisture and screened to remove debris. The soil sample was then thoroughly blended. The clean soils were spiked in the following manner. A known quantity of soil sufficient for a single RTA test (500 to 600 grams) was weighed into a plastic Ziploc® bag. The soil in the bag was then spread evenly in the bag and the spiking contaminant was spread over the surface of the soil. For the elemental mercury, a microliter syringe was used to place numerous minute beads of mercury into the soil. A piece of weighing paper was used to sprinkle the mercury (II) sulfide onto the clean soil.

After the compound was deposited on the surface of the soil, the bag was sealed, excluding as much air as possible, and the soil folded over itself several times inside the bag. The soil in the bag was then shaken for 1 or 2 minutes, then allowed to sit for several days before use. The shaking was repeated several times before the bag was used. When the spiked soil was used, the bag was weighed before the experiment, the contents of the bag were transferred to

the RTA tube, and the emptied bag was reweighed. The feed concentration was calculated from the known weight of compound spiked onto the soil.

2.2 RTA TEST APPARATUS

The RTA is a rotating tube, bench-scale thermal apparatus used to evaluate the effect of time, temperature, and atmosphere for the thermal treatment of solids and sludges. Treated residues from the tests provide adequate sample for thorough analytical characterization. Figure A-1 is a schematic drawing of the RTA. Figure A-2 is a schematic of the RTA showing the off-gas scrubbing system configuration for this test.

This custom designed and fabricated bench-scale unit is designed to operate in the batch mode. The rotating tube portion of the system is 5 inches in diameter and 11.5 inches long and is fabricated from Incoloy to resist oxidation during high temperature tests. The cylinder rotates at 5 revolutions per minute (rpm) and is externally heated with a custom made 7,000-watt Lindberg furnace. The chain-driven tube is suspended on both ends by brass rollers and is sealed by graphite packing rings at the inlet and outlet distribution boxes.

The heat-up rate and operating temperature of the furnace are controlled with a Lindberg 59554-B temperature controller. Temperatures of the soil bed and the gas in the rotating cylinder are measured with two Type-K thermocouples calibrated against a National Bureau of Standards (NBS) traceable standard. These temperatures and the temperatures of the oven and the off-gas system are recorded on a multipoint recorder.

The RTA can be configured with a wide variety of off-gas treatment and sampling trains. For this mercury speciation study, the RTA off-gas first went through a heated filter. The purpose of this filter was to avoid biasing the mercury volatilization results by removing any entrained soil (containing mercury) from the gas stream. The off-gas then was pulled through a series of three impingers filled with a potassium permanganate/sulfuric acid solution. This is the standard EPA stack gas sampling train for mercury. The final mercury trap, after the impingers, was a filter packed with either glass wool or sulfur impregnated carbon. Figure A-3 shows the off-gas scrubbing system.

2.3 RTA TEST CONDITIONS

For all tests, treatment time (at temperature) was 30 minutes, the RTA was purged with 1.5 liters per minute of air and the initial soil weight was 600 to 650 grams. Due to seal leakage,

Figure A-1. Schematic of RTA Test Equipment

Figure A-2. General Flow and Monitoring Diagram for RTA Testing

STARTING DATE: 4/19/94	DATE LAST REV.:	DRAFT. CHCK. BY:	INITATOR: R. McBride	DWG. NO.: 4083138-S-01
DRAWN BY: M. MOWERY	DRAWN BY:	ENG. CHCK. BY:	PROJ MGR.:	PROJ NO.: 483138.008.01.008

Figure A-3. Modified Mercury Train for High Level Mercury Gas Stream

total gas flow ranged from 1.4 to 5.7 liters per minute, with most tests having a flow of 1.9 to 3.0 liters per minute.

2.4 RTA TEST PROCEDURES

A standard operating procedure for the RTA tests has been established and is included in Appendix B of the project report on thermal desorption demonstration of mercury from LEFPC soils. The main steps of the procedure are described below.

- The soil or waste for the test is mixed for homogeneity, debris is removed by hand, and 500 to 1000 grams of material is charged to the treatment cylinder, which is then bolted into the RTA.
- The off-gas sampling systems are connected to the RTA and the purge gas, which for the mercury speciation study was air, is set to the required rate of 1.5 liters per minute. The cylinder rotation is set at 5 rpm.
- The furnace is preheated to 200°C above the desired treatment temperature. It is then raised and clamped around the treatment cylinder.
- The temperature of the soil is monitored and the set point of the furnace is adjusted. The furnace is usually opened to avoid overshooting the desired soil temperature.
- After the soil treatment time is reached, the furnace is turned off and removed from the treatment cylinder, which is then cooled by a fan.
- Purge gas is shut down and the unit disassembled when soil reaches ambient conditions.

This procedure was followed for all tests and no problems were encountered.

2.5 SAMPLING AND ANALYSIS

Mercury was the only analyte of concern for this study. All mercury analyses were done by the IT Process Development Group Analytical Section at the ETDC facility. SW-846 cold vapor methods were used. For each test, the following samples were analyzed:

- Treated Soil
- RTA Quartz Tube Rinse
- Hot Filter Residue
- Impinger Scrubbing Solution
- Glass Wool or Sulfur Impregnated Carbon.

In addition, samples of the untreated LEFPC soil were taken from the feed batch for each of the five RTA tests, and also analyzed for mercury. In the experiments using the soil spiked with elemental mercury, beads of mercury were found on the surface of the frit of the bubbler in the first impinger. When the frit was allowed to sit in concentrated hydrochloric acid, the mercury bead passed through the frit and coalesced in the bottom of the receiver. These washes were analyzed separately from the impinger solutions to complete the mass balance calculations.

3.0 DATA SUMMARY AND RESULTS

The purpose of this study was to compare the desorption of elemental mercury, mercury sulfide and the existing mercury species (due to contamination) from soils from the floodplain of the LEFPC. The data from this study showed that, at temperatures between 100°C and 300°C, the desorption behavior of the mercury in contaminated soils from LEFPC more closely resembled mercury sulfide than elemental mercury, and supports the original conclusions on mercury speciation.

Table A-1 summarizes the results of the 11 RTA tests that were conducted for this study. The mercury desorption efficiency for the contaminated soil from LEFPC and the spiked soils at different temperatures is shown in Figure A-4, and Figure A-5 shows the residual mercury concentrations as a function of temperature.

The data showed that with a 30-minute treatment time at 100°C and 150°C, mercury concentrations in the contaminated LEFPC soils were unchanged, while 58 percent and 68 percent of the elemental mercury was removed from the spiked soil. At 200°C, 21 percent of the mercury was removed from the LEFPC soil while 74 percent of the elemental mercury was removed from the spiked soil, indicating that the elemental mercury is more volatile than the mercury species in the contaminated soil. The plot of residual mercury shows similar results.

For the soil spiked with mercury sulfide, removal at 200°C, 250°C, and 300°C was 50 percent, 50 percent, and 60 percent, respectively. This compares to 21 percent, 56 percent, and 94 percent mercury removal with the contaminated LEFPC soil. Except for the 200°C test, mercury sulfide was less volatile than the native mercury species.

During all tests, the off-gas from the RTA was analyzed so that a mercury balance could be developed. The off-gas from the RTA went through a scrubbing system consisting of a hot filter, three impingers filled with a dilute mixture of permanganate and sulfuric acid, and either a demister (a fiberglass pad) or a mercury adsorbent. The hot filter, impinger solution, demister, and demister rinse or adsorbent were all analyzed for total mercury. Based on total mercury recoveries (soil residual plus mercury collected in the scrubbing system) of 29 percent to 100 percent, the mercury removal efficiency from the off-gas was in the range of 24 percent to 82 percent. Although this efficiency was low, it is consistent with previous

TABLE A-1. DATA SUMMARY
MMBS - Lower East Fork Poplar Creek
RTA Test - Fate of Mercury

Run ID	Feed Soil					Treated Soil					Volume Off Gas Collected (m ³)	Feed Soil Mercury Total (mg)	Treated Soil Mercury Total (mg)	% Mercury in Off Gas	% Mercury in Treated Soil	Total % Mercury Recovered
	weight (kg)	Hg Conc. (mg/Kg)	Total Hg* (mg)	weight (kg)	Hg Conc. (mg/Kg)	Total Hg (mg)	Hg Conc. (mg/Kg)	Total Hg (mg)	Hg Conc. (mg/Kg)	weight (kg)						
100°C	0.6378	359.7	194.6	0.4966	510.8	253.7	0.0825	194.6	253.7	130	0.35	253.7	198.1	1	103	104
150°C	0.6297	316	192	0.4770	415.3	198.1	0.1618	192	198.1	79	8.5	152.5	192	1	103	104
200°C	0.6292	219	192	0.4743	321.5	152.5	0.1475	192	152.5	44	19	82.0	192	19	44	63
250°C	0.6124	291.8	186.9	0.4582	179	82.0	0.1420	186.9	82.0	6	<23	11	186.9	19	44	63
300°C	0.6234	339.4	190.2	0.4603	24	11	0.1417	190.2	11	<29		11	190.2	<23	6	<29
Unspiked Runs																
100°C	0.6333	479	312.9	0.5252	250.16	131.4	0.1429	313	131.4	42	21	131.4	131.4	21	42	63
150°C	0.6540	456	298.2	0.5237	181.7	95.2	0.1040	298	95.2	32	36	95.2	298	36	32	68
200°C	0.6519	468	305.0	0.5206	155.12	80.76	0.1275	305	80.76	<61		80.76	305	<61	26	<87
Hg Spiked Runs																
200°C	0.6546	286.3	187.4	0.5233	178.56	93.4	0.3128	187.4	93.4	50	2.4	93.4	187.4	2.4	50	52
250°C	0.6526	281.2	183.5	0.5179	176.22	91.3	0.1636	183.5	91.3	50	<38	91.3	183.5	<38	50	<88
300°C	0.6499	285.1	185.3	0.5148	145.4	74.9	0.0760	185.3	74.9	40	<16	74.9	185.3	<16	40	<56

* Unspiked feed totals based on average feed concentration of all runs.

Thermal Desorption of Mercury from Soil
LEFPC - Mercury (II) Sulfide - Elemental Mercury
Figure A-4

Thermal Desorption of Mercury from Soil
LEFPC - Mercury (II) Sulfide - Elemental Mercury
Figure A-5

studies and may be due to the difficulty of mechanically recovering minute mercury beads from the scrubber system.

Appendix A-1
RTA TEST DATA

Thermal Desorption of Mercury from LEFPC Soil

30 Minutes at Treatment Temperature 300°C

Thermal Desorption of Mercury from LEFPC Soil

30 Minutes at Treatment Temperature 250°C

Thermal Desorption of Mercury from LEFPC Soil

30 Minutes at Treatment Temperature 200°C

Thermal Desorption of Mercury from LEFPC Soil

30 Minutes at Treatment Temperature 150°C

Thermal Desorption of Mercury from LEFPC Soil

30 Minutes at Treatment Temperature 100°C

Thermal Desorption of Mercury from HgS Spiked Soil

30 Minutes at Treatment Temperature 300°C

Thermal Desorption of Mercury from HgS Spiked Soil

30 Minutes at Treatment Temperature 250°C

Thermal Desorption of Mercury from HgS Spiked Soil

30 Minutes at Treatment Temperature 200°C

Thermal Desorption of Mercury from Hg^o Spiked Soil

30 Minutes at Treatment Temperature 200°C

Thermal Desorption of Mercury from Hg^o Spiked Soil

30 Minutes at Treatment Temperature 150°C

Thermal Desorption of Mercury from Hg^o Spiked Soil

30 Minutes at Treatment Temperature 100°C

Appendix A-2

**ANALYTICAL DATA SUMMARY TABLES
AND CERTIFICATES OF ANALYSIS**

**MMES - Lower East Fork Poplar Creek
RTA Test - Fate of Mercury**

Run ID	Volume Off Gas Collected (m ³)	Feed Soil Total Mercury (mg)	Stem Rinse Total Mercury (mg)	Mercury Train Total Mercury (mg)	Wool / Carbon Total Mercury (mg)	Treated Soil Total Mercury (mg)	% Mercury in Impinger Train	% Mercury in Off Gas	% Mercury in Treated Soil	% Mercury Recovered
Unspiked Runs										
100°C	0.0825	194.6	0.07	0.61	0.00040	253.7	0.31	0.35	130	131
150°C	0.1618	192	0.10	1.9	0.0012	198.1	0.97	1.0	103	104
200°C	0.1475	192	0.10	41	0.11	39.5	21.4	21.5	21	42
250°C	0.1420	186.9	0.070	33	0.11	104.9	18	18	56	74
300°C	0.1417	190.2	0.449	24	< 0.13	179.2	13	< 13	94	< 107
HgS Spiked Runs										
200°C	0.3128	187.4	0.451	4.1	0.034	93.4	2.19	2.4	50	52
250°C	0.1636	183.5	0.49	75	< 0.1	92.2	40.87	< 41	50	< 91
300°C	0.0760	185.3	0.19	27	< 0.1	74.9	14.57	< 15	40	< 55
Hg Spiked Runs										
100°C	0.1429	313	0.22	36	0.265	181.6	11.50	12	58	70
150°C	0.1040	298	0.060	52	0.403	202.8	17.45	18	68	86
200°C	0.1275	305	0.077	82	< 0.3	224.30	26.89	< 27	74	< 101

MMES Lower East Fork Poplar Creek
RTA Test - Treated Soils
Mercury Results - Unspiked Runs

Run No.	Sample Number	Test Temperature (°C)	Analyte	Concentration (mg/Kg)	Test Weight (Kg)	Total Contaminant (mg)
1	IT-5335	100	mercury	510.8	0.4966	253.7
2	IT-5347	150	mercury	415.3	0.4770	198.1
3	IT-5355	200	mercury	321.5	0.4743	152.5
4	IT-5363	250	mercury	179	0.4582	82.0
5	IT-5371	300	mercury	24	0.4603	11

MMES Lower East Fork Poplar Creek
RTA Test - Feed Soils
Mercury Results - Unspiked Results

Run No.	Sample Number	Test Temperature (°C)	Analyte	Concentration (mg/Kg)	Test Weight (Kg)	Total Contaminant (mg)
1	IT-5334	100	mercury	359.7	0.6378	194.6
2	IT-5346	150	mercury	316	0.6297	192
3	IT-5354	200	mercury	219	0.6292	192
4	IT-5362	250	mercury	291.8	0.6124	186.9
5	IT-5370	300	mercury	339.4	0.6234	190.2

AVG. MERCURY CONCENTRATION (mg/Kg) 305

**MMES - Lower East Fork Poplar Creek
RTA Test - Treated Soils
Mercury Results - Spiked Runs**

Run ID Number	Run No. 6 - Mercury Sulfide Spiked Soil
Soil Temperature (°C)	200
Feed Soil Weight (Kg)	0.6546
Spiked Compound	HgS
Amount of Hg Spiked (mg)	187.4

Sample No.	Mercury Concentration (mg/Kg)	Soil Weight (Kg)	Total Mercury (mg)
IT5379	131.2	0.5233	68.66
IT5386	142.8	0.5233	74.73
IT5387	182.6	0.5233	95.55
IT5388	182.2	0.5233	95.35
IT5389	254	0.5233	133

RUN No. 6 AVG. TOTAL MERCURY (mg)

93.4

Run ID Number	Run No. 7 - Mercury Sulfide Spiked Soil
Soil Temperature (°C)	250
Feed Soil Weight (Kg)	0.6526
Spiked Compound	HgS
Amount of Hg Spike (mg)	183.5

Sample No.	Mercury Concentration (mg/Kg)	Soil Weight (Kg)	Total Mercury (mg)
IT5392	188.2	0.5179	97.47
IT5393	207	0.5179	107
IT5394	200.8	0.5179	104.0
IT5395	147.8	0.5179	76.55
IT5396	137.3	0.5179	71.11

RUN No. 7 AVG. TOTAL MERCURY (mg)

91.3

Run ID Number	Run No. 8 - Mercury Sulfide Spiked Soil
Soil Temperature (°C)	300
Feed Soil Weight (Kg)	0.6499
Spiked Compound	HgS
Amount of Spike (g)	185.3

Sample No.	Mercury Concentration (mg/Kg)	Soil Weight (Kg)	Total Mercury (mg)
IT5405	231.3	0.5148	119.1
IT5406	119	0.5148	61.3
IT5407	180.6	0.5148	92.97
IT5408	71.0	0.5148	36.6
IT5409	125.1	0.5148	64.40

RUN No. 8 AVG. TOTAL MERCURY (mg)

74.9

**MMES - Lower East Fork Poplar Creek
RTA Test - Treated Soils
Mercury Results - Spiked Runs**

Run ID Number	Run No. 9 - Metallic Mercury Spiked Soil		
Soil Temperature (°C)	100		
Feed Soil Weight (Kg)	0.6533		
Spiked Compound	Hg		
Amount of Hg Spiked (μl)	23.1		
Sample No.	Mercury Concentration (mg/Kg)	Soil Weight (Kg)	Total Mercury (mg)
IT5418	254.8	0.5252	133.8
IT5419	291.3	0.5252	153.0
IT5420	256.6	0.5252	134.8
IT5421	267.6	0.5252	140.5
IT5422	180.5	0.5252	94.80

RUN No. 9 AVG. TOTAL MERCURY (mg)

131.4

Run ID Number	Run No. 10 - Metallic Mercury Spiked Soil		
Soil Temperature (°C)	150		
Feed Soil Weight (Kg)	0.654		
Spiked Compound	Hg		
Amount of Hg Spiked (μl)	22.0		
Sample No.	Mercury Concentration (mg/Kg)	Soil Weight (Kg)	Total Mercury (mg)
IT5433	179.3	0.5237	93.90
IT5434	191.8	0.5237	100.4
IT5435	188.1	0.5237	98.51
IT5436	192	0.5237	101
IT5437	157.3	0.5237	82.38

RUN No. 10 AVG. TOTAL MERCURY (mg)

95.2

Run ID Number	Run No. 11 - Metallic Mercury Spiked Soil		
Soil Temperature (°C)	200		
Feed Soil Weight (Kg)	0.6519		
Spiked Compound	Hg		
Amount of Hg Spiked (μl)	22.5		
Sample No.	Mercury Concentration (mg/Kg)	Soil Weight (Kg)	Total Mercury (mg)
IT5447	156.4	0.5206	81.42
IT5448	158.2	0.5206	82.36
IT5449	155.9	0.5206	81.16
IT5450	146.1	0.5206	76.06
IT5451	159.0	0.5206	82.78

RUN No. 11 AVG. TOTAL MERCURY (mg)

80.76

MMES Lower East Fork Poplar Creek
RTA Test - Quartz Stem Rinses
Mercury Results - Unspiked Runs

Run No.	Sample Number	Test Temperature (°C)	Analyte	Concentration (mg/L)	Test Volume (L)	Total Contaminant (mg)
1	IT-5344	100	mercury	1.3	0.050	0.07
2	IT-5352	150	mercury	2.8	0.0343	0.10
3	IT-5360	200	mercury	2.2	0.0455	0.10
4	IT-5368	250	mercury	1.4	0.050	0.070
5	IT-5376	300	mercury	16.3	0.0276	0.449

MMES Lower East Fork Poplar Creek
RTA Test - Quartz Stem Rinses
Mercury Results - Spiked Runs

Run No.	Sample Number	Test Temperature (°C)	Analyte	Concentration (mg/L)	Test Volume (L)	Total Contaminant (mg)
6 ⁽¹⁾	IT-5384	200	mercury	11.7	0.0385	0.451
7 ⁽²⁾	IT-5403	250	mercury	9.7	0.050	0.49
8 ⁽³⁾	IT-5416	300	mercury	3.8	0.050	0.19
9 ⁽⁴⁾	IT-5429	100	mercury	4.4	0.050	0.22
10 ⁽⁵⁾	IT-5444	150	mercury	1.1	0.0549	0.060
11 ⁽⁶⁾	IT-5458	200	mercury	1.5	0.0511	0.077

- (1) The feed soil was spiked with 286.3 ppm of Hg.
- (2) The feed soil was spiked with 281.2 ppm of Hg.
- (3) The feed soil was spiked with 285.1 ppm of Hg.
- (4) The feed soil was spiked with 479.5 ppm of Hg.
- (5) The feed soil was spiked with 456.1 ppm of Hg.
- (6) The feed soil was spiked with 468.0 ppm of Hg.

MMES - Lower East Fork Poplar Creek
RTA Test - Method 101 Mercury Train
Mercury Results - Unspiked Runs

Run No.	Sample No. (2)	Particulate Filter			Back half - $\text{KMnO}_4/\text{H}_2\text{SO}_4/\text{HCl}$ (1)			TRAIN TOTAL
		Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	Concentration (mg/L)	Sample Volume (L)	TOTAL (mg)	
1 (3)	IT5336 / IT5337 / IT5338	47.7	0.00053	0.025	1.12	0.520	0.582	0.61
2 (4)	IT5348 / IT5349 / IT5350	138	0.00063	0.088	3.15	0.565	1.78	1.9
3 (5)	IT5356 / IT5357 / IT5358	47.	0.00153	0.0721	28.9	0.555	16.0	16.1
4 (6)	IT5364 / IT5365 / IT5366	102.6	0.00062	0.064	59.0	0.588	34.7	35
5 (7)	IT5372 (8) / IT5373 / IT5374	2.7	0.03186	0.086	74.5	0.581	43.3	43
QC Reagent Blank	IT5339 / IT5340 / IT5341	< 0.5	0.00046	< 0.0002	0.032	0.050	0.0016	< 0.002

(1) The back half consists of two samples compostied together - the impinger soltuion ($\text{KMnO}_4/\text{H}_2\text{SO}_4$) and the impinger rinsate (HCl).

(2) The sample numbers are given in the following order: particulate filter / impinger solution / impinger rinsate.

(3) The test temperature was 100°C.

(4) The test temperature was 150°C.

(5) The test temperature was 200°C.

(6) The test temperature was 250°C.

(7) The test temperature was 300°C.

(8) Due to error in loading the filter housing, the particulate filter sample was changed to a filter housing rinsate. The sample results are reported in mg/L.

**MMES - Lower East Fork Poplar Creek
RTA Test - Method 101 Mercury Train
Mercury Results - Spiked Runs**

Run No.	Sample No. ⁽²⁾	Particulate Filter			Back half - $\text{KMnO}_4/\text{H}_2\text{SO}_4/\text{HCl}$ ⁽¹⁾			TRAIN TOTAL (mg)
		Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	Concentration (mg/L)	Sample Volume (L)	TOTAL (mg)	
6 ⁽³⁾	IT5380 / IT5381 / IT5382	81.4	0.00055	0.045	8.7	0.464	4.0	4.1
7 ⁽⁴⁾	IT5397 / IT5398 / IT5399	535.4	0.00120	0.642	122.2	0.563	68.8	69.4
8 ⁽⁵⁾	IT5410 / IT5411 / IT5412	490.9	0.00056	0.27	65.5	0.444	29.1	29.4
9 ⁽⁶⁾	IT5423 / IT5424 / IT5425	67.0	0.00092	0.062	122.7	0.525	64.4	64.5

⁽¹⁾ The back half consists of two samples compostied together - the impinger soltuion ($\text{KMnO}_4/\text{H}_2\text{SO}_4$) and the impinger rinsate (HCl).

⁽²⁾ The sample numbers are given in the following order: particulate filter / impinger solution / impinger rinsate.

⁽³⁾ The test temperature was 200°C, and the feed soil was spiked with 286.3 ppm of Hg.

⁽⁴⁾ The test temperature was 250°C, and the feed soil was spiked with 281.2 ppm of Hg.

⁽⁵⁾ The test temperature was 300°C, and the feed soil was spiked with 285.1 ppm of Hg.

⁽⁶⁾ The test temperature was 100°C, and the feed soil was spiked with 479.5 ppm of Hg.

**MMES - Lower East Fork Poplar Creek
RTA Test - Method 101 Mercury Train
Mercury Results - Spiked Runs**

Run No.	Sample No. ⁽²⁾	Particulate Filter			Back half - $\text{KMNO}_4/\text{H}_2\text{SO}_4/\text{HCl}$ ⁽¹⁾			HCl Impinger Rinse			TRAIN TOTAL (mg)
		Concentration (mg/L)	Weight (Kg)	TOTAL (mg)	Concentration (mg/L)	Volume (L)	TOTAL (mg)	Concentration (mg/L)	Volume (L)	TOTAL (mg)	
10 ⁽³⁾	IT5438 / IT5439 / IT5440 / IT5461	54.0	0.00058	0.031	107.4	0.885	95.0	216.9	0.050	11	106
11 ⁽⁴⁾	IT5452 / IT5453 / IT5454 / IT5462	111.5	0.00087	0.097	204.4	0.777	159	519.7	0.050	26	185

(1) The back half consist of two samples composited together - the impinger solution ($\text{KMNO}_4/\text{H}_2\text{SO}_4$) and the impinger rinse (HCl).

(2) The sample numbers are given in the following order: particulate filter / impinger solution / impinger rinsate / impinger rinse.

(3) The test temperature was 150°C, and the feed soil was spiked with 456.1 ppm of Hg.

(4) The test temperature was 200°C, and the feed soil was spiked with 468.0 ppm of Hg.

MMES Lower East Fork Poplar Creek
RTA Test - Glass Wool Samples
Mercury Results - Unspiked Runs

Run No.	Sample Number	Test Temperature (°C)	Analyte	Concentration (mg/Kg)	Test Weight (Kg)	Total Contaminant (mg)
1	IT-5342	100	mercury	0.131	0.0030	0.00040
2	IT-5351	150	mercury	0.146	0.0080	0.0012
3	IT-5359	200	mercury	21.4	0.0051	0.11
4	IT-5367	250	mercury	29.2	0.0036	0.11

MMES - Lower East Fork Poplar Creek
RTA Test - Glass Wool and Sulfur Impregnated Carbon
Mercury Results - Unspiked Runs

Run No.	Sample No.	Glass Wool			Sulfur Impregnated Carbon			TRAIN TOTAL (mg)
		Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	
5	IT 5375 ⁽¹⁾	53.3	0.0023	0.12	< 0.5	0.024	< 0.012	< 0.13
QC Reagent Blank	IT 5343 / IT5460 ⁽²⁾	0.17	0.0038	0.00066	0.5	0.024	0.012	0.012

(1) The sample had a glass wool portion and a sulfur impregnated carbon portion

(2) The sample numbers are given in the following order: glass wool / sulfur impregnated carbon.

MMES - Lower East Fork Poplar Creek
RTA Test - Glass Wool and Sulfur Impregnated Carbon
Mercury Results - Spiked Runs

Run No.	Sample No. ⁽¹⁾	Pre-carbon Glass Wool			Sulfur Impregnated Carbon			Post-carbon Glass Wool			TRAIN TOTAL (mg)
		Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	Concentration (mg/Kg)	Sample Weight (Kg)	TOTAL (mg)	
6 ⁽²⁾	IT5390 / IT5383 / IT5391	19.6	0.00093	0.018	0.4	0.0229	0.009	4.8	0.00129	0.0062	0.034
7 ⁽³⁾	IT5400 / IT5401 / IT5402	79.2	0.00095	0.075	< 0.5	0.0255	< 0.01	3.3	0.00102	0.0034	< 0.1
8 ⁽⁴⁾	IT5413 / IT5414 / IT5415	58.5	0.00101	0.0591	< 0.5	0.0234	< 0.01	5.9	0.00114	0.0067	< 0.1
9 ⁽⁵⁾	IT5426 / IT5427 / IT5428	158.2	0.00127	0.201	0.6	0.0226	0.01	47.4	0.00107	0.0507	0.265
10 ⁽⁶⁾	IT5441 / IT5442 / IT5443	202.9	0.00136	0.276	4.3	0.0247	0.11	16.5	0.00126	0.0208	0.403
11 ⁽⁷⁾	IT5455 / IT5456 / IT5457	215.7	0.00132	0.285	< 0.5	0.0258	< 0.01	21.0	0.00110	0.0231	< 0.3

⁽¹⁾ The sample numbers are given in the following order: pre-carbon glass wool / sulfur impregnated carbon / post-carbon glass wool.

⁽²⁾ The test temperature was 200°C, and the feed soil was spiked with 286.3 ppm of Hg.

⁽³⁾ The test temperature was 250°C, and the feed soil was spiked with 281.2 ppm of Hg.

⁽⁴⁾ The test temperature was 300°C, and the feed soil was spiked with 285.1 ppm of Hg.

⁽⁵⁾ The test temperature was 100°C, and the feed soil was spiked with 479.5 ppm of Hg.

⁽⁶⁾ The test temperature was 150°C, and the feed soil was spiked with 456.1 ppm of Hg.

⁽⁷⁾ The test temperature was 200°C, and the feed soil was spiked with 468.0 ppm of Hg.

**MMES - Lower East Fork Poplar Creek
RTA Test - MS/MSD Results
Solid Samples**

Sample Number	Sample ID	Original Conc. (mg/Kg)	Spike Conc. (mg/Kg)	Observed Conc. (mg/Kg)	Percent Recovery ⁽¹⁾ (%)	RPD ⁽²⁾ (%)
IT-5335 MS	Run #2 Mercury Train	510.8	40.0	501.4	NC ⁽³⁾	4.7
IT-5335 MSD	Treated Soil		40.0	525.4	NC ⁽³⁾	
IT-5371 MS	Run #5 Mercury Train	22.3	111.1	130.6	97.5	10.1
IT-5371 MSD	Treated Soil		100.0	110.4	88.1	
IT-5405 MS	Run #8 Mercury Train	231.3	156.3	396.7	106	3.10
IT-5405 MSD	Treated Soil Sample A		151.5	409.2	117	
IT-5406 MS	Run #8 Mercury Train	57.2	151.6	170.7	74.9	15.8
IT-5406 MSD	Treated Soil Sample B		151.7	199.9	94.1	
IT-5434 MS	Run #10 Mercury Train	191.8	150	295.8	69.3	7.89
IT-5434 MSD	Treated Soil		150	320.1	85.5	

¹⁾ Percent Recovery:

$$\frac{\text{Observed Concentration} - \text{Original Concentration}}{\text{Spiked Concentration}} \times 100$$

⁽²⁾ Relative Percent Difference (RPD): Where: D₁ and D₂ are the matrix spike and the matrix spike duplicate result, respectively.

$$\text{RPD} = \frac{|D_1 - D_2|}{(D_1 + D_2) \div 2} \times 100$$

⁽³⁾ The percent recovery was not calculated due to the high levels of mercury present in the original sample.

**MMES - Lower East Fork Poplar Creek
RTA Test - Duplicate Results**

Sample ID	Sample Number	Measured Concentration (mg/Kg)	RPD ⁽¹⁾ (%)
Run #2 Mercury Train - Feed Soil	IT-5346	196.0	38.3
	IT-5346 D	288.9	
Run #3 Mercury Train - Feed Soil	IT-5354	207.9	15.1
	IT-5354 D	241.8	
Run #4 Mercury Train - Treated Soil	IT-5363	159.3	27.1
	IT-5363 D	121.3	
Run #5 Mercury Train - Treated Soil	IT-5371	24.1	13.5
	IT-5371 D	27.6	
Run #6 Mercury Train - Treated Soil	IT-5389	364.2	1.6
	IT-5389 D	370.0	

⁽¹⁾ Relative Percent Difference (%RPD): Where: D₁ and D₂ are the original and the duplicate result, respectively.

$$\% \text{ RPD} = \frac{|D_1 - D_2|}{(D_1 + D_2) \div 2} \times 100$$

**MMES - Lower East Fork Poplar Creek
RTA Test - MS/MSD Results
Liquid Samples**

Sample Number	Sample ID	Original Conc. (mg/L)	Spike Conc. (mg/L)	Observed Conc. (mg/L)	Percent Recovery ⁽¹⁾ (%)	RPD ⁽²⁾ (%)
IT-5353 MS	Run #2 Mercury Train	0.078	20.8	20.7	99	12
IT-5353 MSD	O ₂ Impinger		20.8	23.3	112	
IT-5381/IT-5382 MS	Run #6 Mercury Train	8.7	100	113	104	13
IT-5381/IT-5382 MSD	Impinger Composite		100	99.4	91	
IT-5439/IT-5440 MS	Run #10 Mercury Train	107.4	200	346.8	120	0.69
IT-5439/IT-5440 MSD	Impinger Composite		200	349.2	121	

⁽¹⁾ Percent Recovery:

$$\frac{\text{Observed Concentration} - \text{Original Concentration}}{\text{Spiked Concentration}} \times 100$$

⁽²⁾ Relative Percent Difference (RPD):

Where: D₁ and D₂ are the matrix spike and the matrix spike duplicate result, repective

$$\text{RPD} = \frac{|D_1 - D_2|}{(D_1 + D_2) \div 2} \times 100$$

Appendix C
TEST PROCEDURES

APPENDIX B

TEST PROCEDURES

Rotary Thermal Apparatus Procedure

- Define and record the planned experiment in the laboratory notebook (i.e., time, temperature, etc.). Set the temperature ranges and points on the multipoint recorder and prepare the data collection file in the computer by entering the appropriate responses to the Logger program.
- Set the furnace temperature controller to a least 150 degrees Celsius ($^{\circ}\text{C}$) above the desired test temperature and turn on the power. Set the chiller to the desired temperature and start the circulating pump. Turn on the heaters in the inlet and outlet sections of the Rotary Thermal Apparatus (RTA).
- Weigh an aliquot of the homogenized test matrix, usually 400 to 500 grams, into a large tared stainless steel or plastic beaker.
- Transfer the contents of the beaker into the prepared cylinder and reweigh the beaker to calculate the net transfer.
- Place the loaded cylinder into the test apparatus and complete the assembly of the system.
- Insert the thermocouples to measure the gas and the soil temperature in the cylinder and connect the oxygen monitor.
- Connect the quartz gas outlet tube to the scrubber system and set the purge gas flows to the inlet and outlet distribution boxes. Position the heater around the exposed portion of the outlet tube with heating tape and start the heating.
- Charge the scrubber recirculating system with one liter of 0.1 normal (N) NaOH and start the scrubbing pump and the system vacuum pump. Adjust the bypass on the vacuum pump to obtain the desired negative pressure at the inlet distribution box, usually -0.38 centimeter (cm) to -0.63 cm (-0.15 to -0.25 inch) water column.
- Start the cylinder drive and check the bearing alignment. Adjust the alignment if necessary. Start the computer data collection.
- Carefully place the preheated furnace around the rotating cylinder and allow the furnace controller to approach the preheat temperature. Start the temperature recorder as soon as the furnace has been closed around the cylinder.

- Lower the controller set point when the soil temperature is within 125 to 150°C of the desired operating temperature.
- Monitor the temperatures during the test and adjust the furnace as necessary to maintain the desired temperature profile by opening the lid of the oven and reclosing the lid as necessary.
- When the desired residence time at the test temperature has been reached, turn off the furnace temperature controller and lower the furnace away from the rotating cylinder. Allow the system to cool to ambient conditions. Additional cooling is provided by a fan directed at the top of the cylinder. Turn off the recorder and the computer data logging after a few minutes of cooling. Lower the power settings of the heater controls for the inlet and outlet.
- Turn off the purge gas, the vacuum pump, the scrubber pump, and the cylinder drive after the soil temperature has dropped below 100°C.
- Disassemble the cylinder and transfer the contents to a tared beaker and weigh. Transfer the treated residue to the appropriate containers for analysis and storage.
- If the scrubber contents analysis is required, disassemble the scrubber system and measure the volume of the scrubber solution. Transfer to an appropriate container for analysis.
- Clean the cylinder, the scrubber, and other system components according to the prescribed cleanup procedures.

Tray Test Procedure

- Define and record planned experiment in the data book (i.e. time, temperature, soil).
- Weigh the empty, clean tray.
- Transfer a representative aliquot of prepared soil from the jar to the tray using a stainless steel spatula.
- Weigh the soil and tray, and adjust the soil quantity to achieve a uniform layer in the bottom of the tray, usually 2 to 3 millimeters (mm) depth for a 50-gram aliquot of soil.
- Distribute and level the soil within the tray.
- Turn on the purge gas flow to the proper setting on the rotameter.

- Place the tray with the soil in the oven at ambient temperature and close the oven door.
- Set oven temperature controller set-point to the target test temperature and start the timer.
- Monitor and record the temperatures and time periodically throughout the test period and record any pertinent observations.
- When the prescribed residence time at the target temperature is reached, shut off the oven heater and open the oven door.
- Cautiously withdraw the hot tray and soil using the special tongs, place a cover on the tray, and place the covered tray in a laboratory hood for cooling. Allow the tray to cool one-half hour covered and then remove the cover and allow the tray to cool further.
- Weigh the tray (without cover) plus treated soil after 1 hour.
- Transfer an aliquot of the treated soil to a 250-milliliter (mL) (8-ounce) jar. Label the sample with the desired sample coding information and hold for analysis.
- Clean the tray, cover, and nondisposable implements using the following procedure:
 - Rinse with acetone and wipe clean.
 - Rinse with dilute nitric acid.
 - Rinse with methanol.
 - Scrub with detergent (Alconox) solution and rinse with hot tap water followed by distilled water.
 - Rinse with acetone.
 - Air dry and store.

Pilot Desorber Procedure

- Record the planned experimental operating conditions on the standard operating forms. Fill in the required information on each sheet.
- Charge the quench scrubber within the required amount of water and sodium hydroxide for the experiment, usually 56.8 and 0.57 kilogram (kg) (125 and 1.25 pounds), respectively for a 0.1 N solution.
- Start the chiller.
- Install clean filter bags and close the filter housings, taking care not to pinch the rubber O-rings in the lid closure.

- Replace and fasten the lid on the primary scrubber and check all scrubber system valves for correct positioning to start the scrubber pump.
- Turn on the wet electrostatic precipitator (WESP) per the manufacturers instructions.
- Turn on the desorber power systems at the main control panel. Start the purge and turn on the recorder to monitor the startup temperature profile in the desorber. Start the vacuum pump, the blower, and the quench scrubber at this time.
- Turn on the furnace fire control system, start the purge cycle, and light the burners.
- Start the soil feed system and load sufficient soil into the feed hopper to maintain the air seal over the feed portion of the desorber. Add soil as necessary to maintain the seal. Record the weight of soil added to the hopper on the sheets provided.
- Cycle the required number of burners on and off as necessary to obtain the desired soil temperature profile in the desorber.
- Adjust the vacuum bypass valve to obtain the desired slightly negative pressure in the desorber. The desorber is operated with a vacuum of 0.51- to 0.76-cm (0.2- to 0.3-inch) water column.
- Adjust flows as necessary for the quench scrubber to obtain the desired pressures and flows (typically 50 percent of the flowmeter setting on the primary scrubber at 1,561 mm mercury [Hg] [30 pounds per square inch {psi} and 2 to 4 gallons per minute [gpm] recirculation flow).
- Monitor the soil discharge rate to give the principal operator data for soil screw feed setting requirements to give the desired processing rate. Change soil discharge collection buckets as necessary and record the weights collected on the sheets provided.
- Monitor system parameters and record on the data sheets provided; make necessary changes for smooth operation at the proper test conditions. Inform the principal operator of changes and any deviation from routine conditions expected for the test so that the required corrections may be made. Evaluate the solids residence time and throughput before the formal test period begins. Make changes as necessary, recheck the residence time and throughput after any changes and re-evaluate.
- Collect samples as necessary as described in the Sampling and Analysis Plan (SAP) during and after the completion of the test.

- Ensure all data forms are filled in as appropriate throughout the test.
- Complete the required sampling forms and labeling of the samples and complete the chain-of-custody (COC) forms and request for analysis (RFA) forms.
- During the actual test portion of the procedure, monitor the appropriate system parameters utilizing a computer to collect data. Repeat the soil residence time measurement to verify the desired treatment conditions.
- At the completion of the test, turn off the desorber burners and discontinue feeding soil to the hopper. Allow the desorber to rotate and cool to a moderate temperature (usually less than 250°C) before shutting off the desorber power.
- Shut off the scrubber and purge systems and vacuum pump and do any necessary cleaning.

Liquid Residuals Treatment Procedure

- Adjust pH of scrubber liquid using concentrated sulfuric acid to pH of 3, while stirring vigorously.
- Allow to stand for 30 minutes at pH 3.
- If pH fluctuates, adjust with concentrated sulfuric.
- While stirring vigorously, add chelant as the neat solution to the reactor vessel. Stir for 2 hours and allow to stand overnight.
- Resume vigorous stirring and add iron (Fe^{3+}). Continue to stir for 30 minutes.
- An anionic polymer is added as a 0.25 percent solution, with vigorous stirring for 15 seconds and slow stirring for 10 minutes.
- Pump the clear supernatant liquid through a 25.4 cm (10-inch), yarn-wound, cartridge filter at 3.78 to 7.56 liters per minute (L/min) (1 to 2 gallon per minute) to a clean 50-gallon receiving vessel. The clear liquid must be pumped from the top down to avoid disturbing the bottom sludge blanket. A sample of the filtered liquid is collected and analyzed for mercury.
- The remaining sludge with a portion of the clear water is conditioned for thickening and filtration by addition of anionic polymer. The solution is stirred vigorously for 15 seconds, followed by 1 minute of slow stirring.
- The conditioned sludge is transferred to a 25.4 cm (10-inch) vacuum filter and filtered at 381 mm (15-inches) of mercury through a glass fiber filter. A sample

of the solids were extracted and analyzed by the Toxicity Characteristics Leaching Procedure (TCLP) for mercury.

Filter Bags and Glass Wool Treatment Procedure

- Place a 10-gallon Nalgene tray in the hood.
- Add 8 gallons of 5 percent nitric acid.
- Place each individual bag in the tray of nitric acid solution and vigorously agitate.
- After agitation, allow each bag to soak for 1 hour.
- Rinse the bag in a 5-gallon bucket of water.
- Allow to dry in laboratory hood.
- Repeat for the remainder of the bags.
- Collect nitric acid and rinse solutions for treatment.

Appendix D
CLEANLINESS TEST REPORT

Revised Report of Clean Certification Testing
IT Project No. 483138
May 13, 1994

1.0 Introduction

Per the requirements of Task 4 of the Lower East Fork Poplar Creek (LEFPC) project, a series of wipe samples were collected from the pilot thermal desorber system. The samples were collected for confirming that the system was clean and did not have any residual contaminants from past testing that might interfere with the LEFPC tests. These samples collected were analyzed for mercury by graphite furnace atomic adsorption (GFAA) and uranium by gross alpha/beta activity. Locations of the sample points inside the desorber were as follows: Sample point 1 - the rotary valve, Sample point 2 - inside the soil feed hopper, Sample point 3 - connector duct between the desorber and the off-gas cyclone, Sample point 4 - inside the scrubber tank, Sample point 5 - cooling section of the desorber tube, Sample point 6 - Brinks demister internal housing, Sample point 7 - inside the cyclone, and Sample point 8 - inside the scrubber housing.

2.0 Methods and Materials

All samples were collected and analyzed per the requirements of the project specific Work Plan (WP) dated December 6, 1993 and the project specific Sampling and Analysis Plan (SAP) dated December 6, 1993. Details of these methods will be included in the final project report.

Radiological Wipe Sample Collection

Because dilute acid is used to collect mercury wipe samples, it was necessary for radiological wipe samples to be collected first. A summary of the procedures used for collecting the samples is given below:

1. Mark off a 100 square centimeter area.
2. Using a paper smear, number side up, wipe the area in a back and forth manner.
3. Place the smears in a separate sample bottle or envelope, to prevent cross-contamination.

Radiological Analysis

The wipe samples were counted using a Ludlum 1000 with an alpha scintillation detector for alpha, and a Ludlum 1000 with a beta/gamma detector for beta counts per the requirements of IT standard operating procedure OR-HS-2312.

Mercury Wipe Sample Collection

The wipe samples were collected per the requirements of IT standard operating procedure FAS700. A summary of the collection procedure is given below:

1. Mark off a 100 square centimeter area
2. Saturate a 4-inch by 4-inch cotton gauze with 10 percent Nitric Acid
3. Wipe marked area in one direction only, i.e., up and down or left to right
4. Use a new gauze and wipe in the other direction
5. Place the two wipes in a wide mouth jar and close with a Teflon-lined lid
6. Label the jar with the sample number, sample location, and date
7. Repeat this procedure until all sample locations are wiped
8. Store collected samples in a freezer at 4°C until they are prepared for analysis.

Mercury Analysis

Analysis of the wipe samples was performed using cold vapor-graphite furnace atomic absorption. Details of the procedure can be found in the IT analytical report number 5846-79, which will be included in the final project report.

3.0 Results

Table 1 provides the summary of results from the wipe tests.

Table 1
Results of the Thermal Desorber Wipe Tests

Sample Location	Hg, $\mu\text{g}/100\text{ cm}^2$	α , dpm/100 cm^2	β , dpm/100 cm^2
Star Valve Blades	267	<20	<200
Feed Hopper	5.32	<20	<200
Connector	<1	<20	<200
Scrubber Tank	1080	<20	<200
Cooling Section	1160	<20	<200
Demister Housing	117	<20	<200
Cyclone	3.00	<20	<200
Scrubber Housing	169	<20	<200

All values were below the criteria established in the Work Plan except for two mercury results. The criteria were $660 \mu\text{g}/100 \text{ cm}^2$ for Hg, and less than 20 disintegrations per minute (dpm)/ 100 cm^2 alpha (α), and 200 dpm/ 100 cm^2 beta (β). The mercury wipe results for two locations exceeded the criteria by about 70 percent. These two locations are quite different in terms of their likelihood of having any residual mercury from past operations of this equipment.

The cooling section of the desorber tube is exposed to thermally treated soil, and would not be expected to collect any significant mercury residue from contact with the soil. The purge gas normally flows countercurrent to the soil flow, entering the desorber tube after the soil exits the cooling section. It is possible that during previous operation with high mercury-containing wastes some mercury vapor passed into the cooling section due to minor pressure variations in the purge/off-gas treatment system which might have led to brief reverse gas flow in the vicinity of the cooling section. The cool surface would tend to condense mercury vapors that might enter this section.

The scrubber tank collects liquid and solids from the off-gas, and would be expected to be exposed to mercury as well as any other chemicals that were desorbed. This tank is drained after each test and cleaned after each project or waste type. High levels of mercury in wastes previously treated in this system would be a source of residual surface contamination, since mercury tends to coat metal. Prior cleaning apparently did not absolutely remove all mercury from the scrubber tank.

The amount of mercury represented by this level of contamination is very low compared to the amount of mercury that was processed in the three pilot desorber tests. Based on a total contacted surface area of the scrubber tank and desorber cooling section and assuming all this area had residual mercury at the wipe values in Table 1, the total amount of mercury present in the equipment was about 0.15 g. The total mercury processed in the verification run (Run 2) was about 62 grams. Therefore, the potential contribution of any residual mercury present when the LEFPC soil was treated was insignificant (eg. less than 1 percent).

Appendix E
PILOT PROCESS DATA

**GENERAL FORM
MAIN SET-UP FORM**

CLIENT: ENERGY SYSTEMS

PROJECT NUMBER 483138/LEFPC

DATE: 3 / 10 1994

RUN No. 2

TIME: _____

MAIN TUBE TILT: _____ in/4 ft

INPUT (#/hr) 80

MAIN TUBE RPM: 5

% MOISTURE: 18

MAIN TUBE DAM SIZE: _____

OUTPUT (#/hr) ~65

LIVE BOTTOM BIN RPM: _____

TARGET TEMPERATURE (°C) 350

LIVE BOTTOM BIN SET PT.: _____

RETENTION TIME TOTAL (min.) 20

WEIGHT OF BRINKS: _____

RETENTION TIME AT TEMPERATURE (min.) 10

WEIGHT OF HEPA: _____

SCRUBBER STARTING CHARGE, # 1.25 / 125

WT. OF CARBON 1: 2800g

WESP START CHARGE (lbs or gal): 8 L

WT. OF CARBON 2: 2780g

PURGE GAS FLOW (CFM AIR): 2

SPECIAL TEMPERATURE PROFILE INSTRUCTIONS:

OUTLINE
THERMAL DESORBER SOIL INPUT TRACKING FORM
RC 3/10/94

Project: LOWER EAST FORK POPLAR CREEK

Project Number: 483138

Client Name: MMES

TEST NO. _____

DATE: 3/10/94

PAGE 1 OF 3

START TIME	END TIME	BUCKET NUMBER	GROSS WT. lbs.	BUCKET WT. lbs.	NET WT. lbs.	ALIQOT TAKEN / qty	BULK DENSITY, pcf	DATA BY
0900	0915	A1	19.2	4.4	14.8	N		R. Loh
0915	0930	A6	20.4	4.4	16.0	N		R. Loh
0930	0945	A1	20.4	4.4	16.0	YES AT 1045 COMPOSITE T104		R. Loh
0945	1000	A6	20.2	4.4	15.8	N		R. Loh
1000	1030	A1	33.8	4.4	29.4	N DESORBER STOPPED FOR 3 MINUTES		R. Loh
1030	1045	A6	19.6	4.4	15.2	N		R. Loh
1045	1100	A1	19.6	4.4	15.2	N		R. Loh
START TEST @ 1100			STOP TEST @ 1101			NO SAMPLES TAKEN		R. Loh
1100	1115	A6	18.6	4.4	14.2	Y ~ 200g (1/2 lb)		R. Loh
1115		A1		4.4				
1300	1315	A5	20.6	4.2	16.4			A. Green
1315	1340	A1	31.4	4.4	27.0	(26.7) - subtract ~ 1/3 lb for RT		A. Green
			Start test @ 13140					
1315	1400	A5	25.6	4.7	21.4	Y 3 scoops		" 4 we

THERMAL DESORBER SOIL INPUT TRACKING FORM

Project: LOWER EAST FORK POPLAR CREEK

Project Number: 483138

Client Name: MMES

TEST NO. _____

DATE: 3/10/94

PAGE 2 OF 3

START TIME	END TIME	BUCKET NUMBER	GROSS WT. lbs.	BUCKET WT. lbs.	NET WT. lbs.	ALIQOT TAKEN / qty	BULK DENSITY, pcf	DATA BY
1400	1420	A1	25.8	4.46	21.4	Y 4oz to lab + 3 scoops		A Groen
1420	1440	A5	25.2	4.46	20.8	Y 6 scoops		A Groen
1440	1500	A1	25.8	4.46	21.4	Y - 4oz @ 1450 6 scoops		A Groen
1500	1520	A5	26.4	4.4	22.0	Y + 4oz + 2oz 6 scoops		A Groen
1520	1540	A1	26.4	4.4	22.0	Y 6 scoops		A Groen
1540	1600	A5	26.8	4.4	22.4	Y - 4oz @ 1550 + 6 scoops		A Groen
1600	1620	A1	26.0	4.4	21.6	Y 4oz 16 scoops		A Groen
1620	1645 1642	A5	27.8	4.4	23.4	N - power off		A Groen
1645	1700	A3	20.4	4.4	16.0	N		A Groen
1700	1715	A4	20.6	4.4	16.2	N		A Groen
		RESTART @ 1715.						
1715	1745	A2	35.8 + 0.4	4.4	31.8	Y 10 sp. TEMP SP. @ 1735 (0.46) + GRAB		A Groen
1745	1815	A7	37.4	4.4	33.0	Y 10 sp. TEMP SP. @ 1805 0.46		A Groen
1815		A8	38.2	4.4	33.8	Y 10 sp. TEMP SP. @ 1835 + GRAB (0.46)		A Groen

Client Name: MMES

TEST NO. _____

DATE: 3/10/94

PAGE 3 OF 3

[illegible]

RECORDER # 1THERMAL DESORBER TEST DATA LOG
TEST OF 3/10/94

LEFPC - 483138

PT. #	WIRE #	DESCRIPTION OR LOCATION
1		#1 PROBE - GAS
2		#2 SOIL
3		#3 SOIL
4		#4 GAS
5		#5 SOIL
6		#6 SOIL
7		#7 SOIL
8		#8 GAS
9		#9 PROBE - SOIL
10		END PLENUM - GAS
11		CYCLONE - GAS
12		SHELL - SOIL FEED END
13		SHELL - NEXT
14		SHELL - NEXT
15		SHELL - SOIL DISCHARGE END
16		LIQUID OUT OF SCAUBBER
17		GAS OUT OF SCRUBBER TO WESP
18		SCRUBBER LIQUID INTO HEAT EXCHANGER
19		SCRUBBER LIQUID OUT OF HEAT EXCHANGER
20		COOLENT INTO HEAT EXCHANGER
21		COOLENT OUT OF HEAT EXCHANGER
22		GAS OUT OF WESP INTO CONDENSER
23		GAS OUT OF CONDENSER INTO DEMISTER
24		COOLENT INTO CONDENSER
25		COOLENT OUT OF CONDENSER
26		OUT FALL SOIL TEMPERATURE
27		AMBIENT - FEED PLATFORM
28		Oxygen - Per Cent
29		GAS OUT OF DEMISTER
30		ALTEK CALIBRATION SOURCE - 350°C

COMPLETED BY

Kenneth Ferguson

DATE

3/10/94

SOLID DATA SHEET

TEST NO. 2

DATE 03/10/94

2 1/2
PAGE 1 OF 1

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR: R. G. Bennett

TIME (24 hr) 1145

DRUM No. 22

INITIAL WT (lbs) 385.2

FINAL WT (lbs) _____

TOTAL NET WT USED (lbs) _____

WT SOIL ADDED (lbs)* _____

WT SOIL COLLETED (lbs)* _____

WT MISC MAT'L COLLETED (lbs)* _____

* Net weight, corrected for container tare.

SOLID DATA SHEET

TEST NO. 2

DATE 03/10/94

PAGE 1 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR: P. G. Bennett

TIME (24 hr) 0820

DRUM No. 18

INITIAL WT (lbs) 494.8

FINAL WT (lbs) 59.6

TOTAL NET WT USED (lbs) 435.2

WT SOIL ADDED (lbs)*

WT SOIL COLLETED (lbs)*

WT MISC MAT'L COLLETED (lbs)*

Remaining Dirt transferred
To Drum 22 at $\approx$ 11:45

* Net weight, corrected for container tare.

3/10/94

FIGURE 5-3. PILOT THERMAL DESORBER SYSTEM PROCESS FLOW DIAGRAM

SOLID DATA SHEET

TEST NO. 2

DATE 3/10/94

PAGE 3 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR: R. G. Bennett

TIME (24 hr)

DRUM No. 101

INITIAL WT (lbs) 242.0

FINAL WT (lbs)

TOTAL NET WT USED (lbs)

WT SOIL ADDED (lbs)*

WT SOIL COLLETED (lbs)*

WT MISC MAT'L COLLETED (lbs)*

* Net weight, corrected for container tare.

SOLID DATA SHEET

TEST NO. 2

DATE 03/10/94

PAGE 4 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR: R.G. Bennett

TIME (24 hr)

DRUM No. 26

INITIAL WT (lbs) 481.0

FINAL WT (lbs)

TOTAL NET WT USED (lbs)

WT SOIL ADDED (lbs)*

WT SOIL COLLETED (lbs)*

WT MISC MAT'L COLLETED (lbs)*

* Net weight, corrected for container tare.

THERMAL DESORBER TEST DATA LOG RETENTION TIME

TEST NO. _____

DATE 3, 10 /94

PAGE 1 OF 1

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

RT TEST NO.	TIME	START	TIME OUT MID	FINISH	AVG RT	DATA BY
1 *	1000	1018:30	1020		20 MIN.	R. Cole
2	1310	1329:50	1320:30	133155	20 1/2 MIN	A. Gue
3	1610	161910	162020	162130	21 min	A. Gue
4	1910	192950	1931	193230	21 1/2 min	A. Gue
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

* RAPID ~~STARTED~~ DESORBER AT 1019:30
GRAVEL APPEARED TO HAVE MAXIMUM FLOW
AT POINT OF STOPPAGE.

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 2DATA 3/10/94PAGE 4 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY MMH
Start

1. TIME (24 hr format)	12:45	13:00	13:15	13:30	13:40
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	76	76	78	78	78
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.6	0.6	0.5	0.5	0.5
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. _____	7248	7389	7556	7708	7805
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.6	0.8	0.8	0.6	0.8
7. FUEL GAS (dgm reading) note: start pt. _____	7867	7818	7826	7835	7840
8. FUEL GAS PRESSURE (oz)	7	7	7	7	7
9. PERCENT O ₂ METER (%)					
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	50	50	51	52	52
13. FILTER INLET PRES. (psig)	57	59	62	66	58
14. SCRUBBER LIQUID LEVEL	5.5	6	6.5	7	7
15. HEX CW TEMP. IN (°C) F 77	42	42	42	42	40
16. HEX CW TEMP. OUT (°C) F 31/10/94	42	42	42	42	40
17. SCRUBBER GAS TEMP. IN (°C)					
18. SCRUBBER LIQUID TEMP. OUT (°C)	12	14	14	14	15
19. SCRUBBER GAS TEMP. OUT (°C)	26	26	28	28	26
20. CH W COND. WATER TEMP. IN (°C) F 77	38	40	40	40	43
21. CH W COND. WATER TEMP. OUT (°C) F 31/10/94	40	40	40	40	42
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)					
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.4	0.4	0.4	0.4	0.4
24. PRESS. DROP ACROSS DEMISTER IN (psig)	1.0	1.0	1.0	1.0	1.0
25. TEMP. OF GAS EXIT WESP (°C)	26	26	26	26	26

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 2DATA 3 110 194PAGE 5 OF 4IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY MMH

AK

1. TIME (24 hr format)	14:00	14:15	14:30	14:45	15:00
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	56	70	38	40	40
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.6	0.5	0.5	0.5	0.5
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. _____	8030	8140	8286	8359	8436
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.4	0.8	0.5	0.5	0.6
7. FUEL GAS (dgm reading) note: start pt. _____	7952	7859	7869	7879	7888
8. FUEL GAS PRESSURE (oz)	7	7	6.5	6	6
9. PERCENT O ₂ METER (%)					
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	52	50	50	50	50
13. FILTER INLET PRES. (psig)	70	54	53	53	54
14. SCRUBBER LIQUID LEVEL	8	8	8.5	9	9.5
15. HEX CW TEMP. IN (°C) F <u>77</u>	42	42	41	42	42
16. HEX CW TEMP. OUT (°C) F <u>310/94</u>	42	42	44	44	44
17. SCRUBBER GAS TEMP. IN (°C)					
18. SCRUBBER LIQUID TEMP. OUT (°C)	14	14	14	14	13
19. SCRUBBER GAS TEMP. OUT (°C)	26	28	27	28	27
20. CH W COND. WATER TEMP. IN (°C) F <u>77</u>	38	38	38	36	37
21. CH W COND. WATER TEMP. OUT (°C) F <u>310/94</u>	38	38	40	40	40
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)					
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.2	0.4	0.4	0.4	0.4
24. PRESS. DROP ACROSS DEMISTER IN (psig)	1.0	1.0	0.8	0.6	0.6
25. TEMP. OF GAS EXIT WESP (°C)	26	26	27	27	27

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 2DATA 31/10/94PAGE 5 OF 6 ^{AK3-10-94}IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY AK

1. TIME (24 hr format)	15:15	15:30	15:45	16:00	16:15
2. AIR MAKEUP (cfm)	2	2	2	2 ^{AK}	2
3. GAS FLOW (rotameter %)	40	40	48	44 ^{AK}	48
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.5	0.5	0.5	0.5	0.6
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. _____	8516	8610	8696	8786	8915
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.5	0.5	0.5	0.5	0.5
7. FUEL GAS (dgm reading) note: start pt. _____	7898	7909	7919	7929	7938
8. FUEL GAS PRESSURE (oz)	6	6	6	6	6
9. PERCENT O ₂ METER (%)					
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	50	50	50	55	58
13. FILTER INLET PRES. (psig)	54	55	57	59	61
14. SCRUBBER LIQUID LEVEL	10	10.5	11	11.5	12
15. HEX CW TEMP. IN (°F) ^{*AK 3-10-94}	41	40	40	40	40
16. HEX CW TEMP. OUT (°F) *	44	44	44	43	42
17. SCRUBBER GAS TEMP. IN (°C)					
18. SCRUBBER LIQUID TEMP. OUT (°C)	13	12	12	12	12
19. SCRUBBER GAS TEMP. OUT (°C)	27	27	27	27	27
20. CH W COND. WATER TEMP. IN (°F) *	37	38	38	39	39
21. CH W COND. WATER TEMP. OUT (°F) *	40	40	40	40	40
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)					
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.4	0.4	0.4	0.6 ^{AK}	0.4
4. PRESS. DROP ACROSS DEMISTER IN (psig)	0.6	0.6	0.6	1.2	1.0
25. TEMP. OF GAS EXIT WESP (°C)	27	27	27	27	27

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 2DATA 3 / 10 / 94PAGE 7 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY AK

1. TIME (24 hr format)	16:30	16:45	17:00	17:15	17:30
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	60	48	48	48	58
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.5	0.5	0.5	0.5	0.6
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. _____	9038	9112	9206	9307	9420
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.5	0.6	0.6	0.5	0.7
7. FUEL GAS (dgm reading) note: start pt. _____	7947	7952	7966	7978	7986
8. FUEL GAS PRESSURE (oz)	6	6	6	6	6
9. PERCENT O ₂ METER (%)					
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	60	60	63	52	52
13. FILTER INLET PRES. (psig)	63	67	69	57	57
14. SCRUBBER LIQUID LEVEL	12.3	12.4	12.8	12.8	13
15. HEX CW TEMP. IN (°F) * <u>AK 3-10-94</u>	40	40	40	40	40
16. HEX CW TEMP. OUT (°F) *	42	42	42	42	42
17. SCRUBBER GAS TEMP. IN (°C)					
18. SCRUBBER LIQUID TEMP. OUT (°C)	12	12	12	11	12
19. SCRUBBER GAS TEMP. OUT (°C)	27	27	27	27	27
20. CH W COND. WATER TEMP. IN (°F) *	40	40	39	40	40
21. CH W COND. WATER TEMP. OUT (°F) *	41	41	41	41	41
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)					
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.3	0.3	0.3	0.3	0.4
24. PRESS. DROP ACROSS DEMISTER IN (psig)	0.7	0.7	0.7	0.9	0.0
25. TEMP. OF GAS EXIT WESP (°C)	27	27	27	27	

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 2DATA 3 / 10 / 94PAGE 8 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY AK

1. TIME (24 hr format)	18:00	18:15	18:30	18:45	19:00
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	58	58	86	76	78
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.6	0.6	0.6	0.5	0.4
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. _____	9647	9769	9900	0067	0223
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.6	0.7	¹¹⁵¹ ₃₋₁₁₋₉₄ 0.6	0.6	0.7
7. FUEL GAS (dgm reading) note: start pt. _____	8006	8015	8025	8034	8042
8. FUEL GAS PRESSURE (oz)	6	6	6	6	6
9. PERCENT O ₂ METER (%)					
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	52	54	55	60	60
13. FILTER INLET PRES. (psig)	60	60	61	62	64
14. SCRUBBER LIQUID LEVEL	13.8	14	14	15	15.5
15. HEX CW TEMP. IN (°F) * ^{HL} ₃₋₁₀₋₉₄	40	40	40	40	40
16. HEX CW TEMP. OUT (°F) *	42	42	42	42	42
17. SCRUBBER GAS TEMP. IN (°C)					
18. SCRUBBER LIQUID TEMP. OUT (°C)	12	12	12	13	12
19. SCRUBBER GAS TEMP. OUT (°C)	27	27	27	27	27
20. CH W COND. WATER TEMP. IN (°F) *	38	37	37	36	36
21. CH W COND. WATER TEMP. OUT (°F) *	40	40	38	38	38
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)					
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.4	0.4	0.4	0.4	0.4
24. PRESS. DROP ACROSS DEMISTER IN (psig)	0.9	1.0	0.9	0.7	0.7
25. TEMP. OF GAS EXIT WESP (°C)	27	27	27	27	27

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 2DATA 3 / 10 / 94PAGE 9 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY AK

1. TIME (24 hr format)	19:15	19:35			
2. AIR MAKEUP (cfm)	2	2			
3. GAS FLOW (rotameter %)	76	76			
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.5	0.4			
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. _____	0381	0564			
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.9	0.9			
7. FUEL GAS (dgm reading) note: start pt. _____	8052	8063			
8. FUEL GAS PRESSURE (oz)	6	6			
9. PERCENT O ₂ METER (%)					
10. SCRUBBER SPRAY FLOW (%)	6	6			
11. SCRUBBER SPRAY PRES. (psig)	38	38			
12. PUMP DISCHARGE PRES. (psig)	62	65			
13. FILTER INLET PRES. (psig)	70	71			
14. SCRUBBER LIQUID LEVEL	16	16.5			
15. HEX CW TEMP. IN (°F) * ^{AL} 3-10-94	40	40			
16. HEX CW TEMP. OUT (°F) *	42	42			
17. SCRUBBER GAS TEMP. IN (°C)					
18. SCRUBBER LIQUID TEMP. OUT (°C)	12	12			
19. SCRUBBER GAS TEMP. OUT (°C)	27	27			
20. CH W COND. WATER TEMP. IN (°F) *	36	37			
21. CH W COND. WATER TEMP. OUT (°F) *	38	40			
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)					
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.6	0.6			
24. PRESS. DROP ACROSS DEMISTER IN (psig)	1.1	1.1			
25. TEMP. OF GAS EXIT WESP (°C)	27	27			

THERMAL DESORBER SOIL INPUT TRACKING FORM

26.49
3.42
23.07

TEST NO. 2

DATE 03 10 194

PAGE 1 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

TIME	BUCKET NO.	NET WT.	SAMPLE ALIQUOT Y/N	BULK DEN	DATA BY
0827	1	21.3			DH
0833	2	^{DH 3-10-94} 23.913			DH
0842	3	26.13			DH
0905	4	21.83			DH
0920	5	22.88			RGB
0935	6	25.07			DH
0956	7	23.74			DH
1010	8	26.27			DH
1028	9	22.59			RGB
1051	10	25.73			RGB
1109	11	22.65			
	12	22.34	148 3/10/94		
	13	23.07	148 3/10/94		
1241	12	15.78			JX1
1246	13	17.71			DAH
1257	14	18.34			DAH
1318	15	18.64			DAH
1327	16	18.08			DAH
1328	17	16.148			DAH
1400(t)	18	15.44			PM
1409	19	19.507			PM
1420	20	15.424			PM
1445	21	19.213			

Test Conducted
11/25/94
start

~~1430(t) 22 18.55~~
CB 1-10-94 435.622

THERMAL DESORBER SOIL INPUT TRACKING FORM

TEST NO. 2

DATE 03 / 10 / 94

PAGE 2 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

TIME	BUCKET NO.	NET WT.	SAMPLE ALIQUOT Y/N	BULK DEN	DATA BY
1430(T)	22	18.557			PM
1500(T)	23	^{15.741} 15.741			CB
1515	24	23.119			CB
1530	25	18.42 22.618			CB
1544	26	18.38			PH
1600(T)	27	14.463			CB
1606	28	18.321			PM
1630	29	^{15.741} 20.117 11.806			CB
1623	30	14.860			CB
1653	31	20.008			CB
17:23	32	22.017			DAH
17:15(T)	33	22.054			CB
¹⁸ 17:30(T)	34	^{17.434} 17.434 14.434			CB
17:45(T)	35	^{15.741} 15.741 14.753			CB
17:57	36	20.491			CB
18:15	37	15.526			PM
18:24	38	17.690			P.M.
18:45	39	^{17.724} 17.724 17.724			DAH
^{19:00} 18:45	40	18.64			DAH
19:15	41	14.126			PM

760.784

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 2

DATE 3/10/94

PAGE 3 OF

IT PROJECT No. 483138/LEFPC

CLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY ----- st. state set pt. _____	<u>MM</u>	<u>MM</u>	<u>MM</u>	<u>MM</u>	<u>MM</u>	<u>MM</u>	<u>AK</u>	<u>AK</u>
TIME (24 HR FORMAT) ----- st. state set pt. _____	<u>13:02</u>	<u>13:20</u>	<u>13:34</u>	<u>13:44</u>	<u>14:05</u>	<u>14:20</u>	<u>14:36</u>	<u>14:50</u>
ZONE 1 (BELLOWS) ----- st. state set pt. <u>400</u>	<u>406</u>	<u>402</u>	<u>400</u>	<u>407</u>	<u>403</u>	<u>403</u>	<u>403</u>	<u>398</u>
ZONE 2 (PLENUM) ----- st. state set pt. <u>400</u>	<u>405</u>	<u>394</u>	<u>404</u>	<u>407</u>	<u>405</u>	<u>404</u>	<u>398</u>	<u>405</u>
ZONE 3 (DUCT TOP) ----- st. state set pt. <u>400</u>	<u>401</u>	<u>401</u>	<u>399</u>	<u>402</u>	<u>401</u>	<u>402</u>	<u>402</u>	<u>403</u>
ZONE 4 (DUCT BOTTOM) ----- st. state set pt. <u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>
ZONE 5 (CYCLONE TOP) ----- st. state set pt. <u>400</u>	<u>401</u>	<u>402</u>	<u>401</u>	<u>400</u>	<u>399</u>	<u>399</u>	<u>399</u>	<u>398</u>
ZONE 6 (CYCLONE BOTTOM) ----- st. state set pt. <u>400</u>	<u>401</u>	<u>401</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>
ZONE 7 (BOTTOM FLANGE) ----- st. state set pt. <u>400</u>	<u>353</u>	<u>357</u>	<u>372</u>	<u>371</u>	<u>358</u>	<u>362</u>	<u>355</u>	<u>359</u>
ZONE 8 (TOP FLANGE) ----- st. state set pt. <u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>
ZONE 9 (MANIFOLD) ----- st. state set pt. <u>400</u>	<u>400</u>	<u>400</u>	<u>399</u>	<u>399</u>	<u>399</u>	<u>400</u>	<u>400</u>	<u>398</u>
ZONE 10 (CROSSOVER) ----- st. state set pt. <u>400</u>	<u>400</u>	<u>400</u>	<u>407</u>	<u>411</u>	<u>403</u>	<u>407</u>	<u>401</u>	<u>401</u>

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 2

DATE 3 1 / 10 / 94

PAGE 4 OF

IT PROJECT No. 483138/LEFPC

CLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY ----- st. state set pt. _____	AK	AK	AK	AK	AK	AK	AK	AK
TIME (24 HR FORMAT)----- st. state set pt. _____	15:04	15:18	15:34	15:49	16:05	16:18	16:34	16:48
ZONE 1 (BELLOWS)----- st. state set pt. <u>400</u>	407	396	398	403	398	399	396	411
ZONE 2 (PLENUM)----- st. state set pt. <u>400</u>	409	401	404	395	407	407	399	405
ZONE 3 (DUCT TOP)----- st. state set pt. <u>400</u>	400	399	398	399	398	400	402	404
ZONE 4 (DUCT BOTTOM)----- st. state set pt. <u>400</u>	400	400	400	400	400	400	400	402
ZONE 5 (CYCLONE TOP)----- st. state set pt. <u>400</u>	400	403	399	404	401	398	401	417
ZONE 6 (CYCLONE BOTTOM)----- st. state set pt. <u>400</u>	400	401	400	401	400	400	400	408
ZONE 7 (BOTTOM FLANGE)----- st. state set pt. <u>400</u>	363	350	350	348	352	342	348	319
ZONE 8 (TOP FLANGE)----- st. state set pt. <u>400</u>	400	400	400	400	400	400	400	405
ZONE 9 (MANIFOLD)----- st. state set pt. <u>400</u>	400	399	400	400	400	400	400	404
ZONE 10 (CROSSOVER)----- st. state set pt. <u>400</u>	410	401	402	402	410	404	410	407

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 2

DATE 3 / 10 / 94

PAGE 5 OF

IT PROJECT No. 483138/LEFPC

CLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY ----- st. state set pt. _____	AK	AK	AK	AK	AK	AK	AK	AK
TIME (24 HR FORMAT) ----- st. state set pt. _____	17:03	17:19	17:34	18:04	18:20	18:35	18:48	AK 39 17:03
ZONE 1 (BELLOWS) ----- st. state set pt. <u>400</u>	409	401	404	398	401	398	402	405
ZONE 2 (PLENUM) ----- st. state set pt. <u>400</u>	397	407	401	406	394	405	398	394
ZONE 3 (DUCT TOP) ----- st. state set pt. <u>400</u>	397	401	399	399	403	398	398	399
ZONE 4 (DUCT BOTTOM) ----- st. state set pt. <u>400</u>	400	400	400	400	400	400	400	400
ZONE 5 (CYCLONE TOP) ----- st. state set pt. <u>400</u>	399	398	401	400	400	400	401	402
ZONE 6 (CYCLONE BOTTOM) ----- st. state set pt. <u>400</u>	399	400	400	400	400	400	400	400
ZONE 7 (BOTTOM FLANGE) ----- st. state set pt. <u>400</u>	337	347	346	348	355	355	360	368
ZONE 8 (TOP FLANGE) ----- st. state set pt. <u>400</u>	400	400	400	400	400	400	399	400
ZONE 9 (MANIFOLD) ----- st. state set pt. <u>400</u>	399	400	399	400	400	400	399	400
ZONE 10 (CROSSOVER) ----- st. state set pt. <u>400</u>	408	405	411	AK 39 405	405	402	407	408

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 2

DATE 3 / 10 / 94

PAGE 6 OF

IT PROJECT No. 483138/LEFPC

CLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY ----- st. state set pt. _____	AK	AK							
TIME (24 HR FORMAT) ----- st. state set pt. _____	19:19	19:36							
ZONE 1 (BELLOWS) ----- st. state set pt. <u>400</u>	408	398							
ZONE 2 (PLENUM) ----- st. state set pt. <u>400</u>	407	405							
ZONE 3 (DUCT TOP) ----- st. state set pt. <u>400</u>	399	399							
ZONE 4 (DUCT BOTTOM) ----- st. state set pt. <u>400</u>	400	400							
ZONE 5 (CYCLONE TOP) ----- st. state set pt. <u>400</u>	399	398							
ZONE 6 (CYCLONE BOTTOM) ----- st. state set pt. <u>400</u>	400	400							
ZONE 7 (BOTTOM FLANGE) ----- st. state set pt. <u>400</u>	367	376							
ZONE 8 (TOP FLANGE) ----- st. state set pt. <u>400</u>	399	400							
ZONE 9 (MANIFOLD) ----- st. state set pt. <u>400</u>	400	400							
ZONE 10 (CROSSOVER) ----- st. state set pt. <u>400</u>	412	412

By KHF Date 3/8/94 Subject T.C. PROBE Sheet No. of

Chkd. By Date Proj. No.

	TC SERIAL NO.	length
point # 1 - air -	605-04-	168"
point # 2 - soil -	605-01-	168"
point # 3 - soil -	603-02	156"
point # 4 - air -	604-04	144"
point # 5 - soil -	604-01	144"
point # 6 - soil -	599-01	120"
point # 7 - soil -	601-02	108"
point # 8 - air -	601-01	108"
point # 9 - soil -	598-02	90"

**OPERATING LOG COMMENTS (FOR THERMAL DESOBER SYSTEMS)
FOR FIRE CONTROL, ONSITE SUPERVISOR**

TEST NO. 2

DATE 31/10/94

PAGE 1 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR*	TIME	COMMENT	DATA BY
RA	0730	Level in Scrubber Tank - 3.0	RA
	0820	System start-up - Cylinder set 1.5	
	0820	DIM - 0237	
	0820	Fuel - 7621	
	0830	Jerome Breathing area Soil feed 0.012	
	0845		
	0910	Soil Discharge Jerome 0.016	
	0911	Soil Discharge Hobd Jerome 0.033	
	0912	Desorber Jerome Transition Dist 0.010	
	0913	Bottom of Steps 0.013	
	0915	Outfall rate of 59 lbs/hr	
	0930	Cyclone outfall from start 4.974 - .390 =	
	1000	Reduction time test begins 20 min	
	1020	Back Rapper jammed Removed - Restart	
	1045	System had restabilized	
—	1100	Test begins	
	1100	Cyclone solids wt .441 - .378 =	
	1105	Stop test overheat	
	1147	Change filter A - New Bag #3 (1338)	
	1315	Cyclones during Warm-up 2nd time 5.526 - .379 =	
—	1340	Start test	
	1404	Change filter B - New Bag #4 (1389)	
	1425	Liquid in air trains	
TB	1550	All running smoothly TAKING	

TEMPERATURE SAMPLES

**OPERATING LOG COMMENTS (FOR THERMAL DESOBER SYSTEMS)
FOR FIRE CONTROL, ONSITE SUPERVISOR**

TEST NO. _____

DATE 1 / 194

PAGE 2 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR*	TIME	COMMENT	DATA BY
CS KS	1605	RT TEST START	TG
KS	1621	RT 21 MIN	TG
	1620	OUTFALL 65 #/HR	TG
	1635	POWER FAILURE	↓
	1642	POWER BACK ON	↓
	1705	CHANGED FILTER BAG PUT IN #16 (146)	
	1715	START TAKING TEMPORAL SAMPLES AGAIN	TG
	1715	60.8 lb/hr	↓
	1910	RT TEST START	↓
	1932	RT = 21.5 MIN	↓
	1935	STOP TEST 73.8 lb/hr	✓
	2000	WT of Condensate 1268 - 144.58	TG
	2010	Cydrone Catch Gross 269 Tare 46 gr	TG
	2020	Remove 100g Condensate sample from Catch	
	2020	All cyclone solids consolidate into 1 sample	
	2025	Removed 4533 g of Water from WESP - 113g WESP	
	2045	3595 g Water used to Flush WESP	
	2046	1128.04 - 431g = 697.04 1% HNO ₃ to Flush WESP	
	2050	6467 - 994 = 5,473 FINAL Mass Removed from WESP	
	2055	Final Level in Scrubber 18.5	
	2055	Changed filter to A #19 (1555) IN 'B	
	2130	WT of filter bags 7687 - 1096g = 6,591g	
	2155	Changed filter bag WT 10661 - 1096g = 5,565g	
	2200	934 g Scrubber Solids Collected	

**OPERATING LOG COMMENTS (FOR THERMAL DESOBER SYSTEMS)
FOR FIRE CONTROL, ONSITE SUPERVISOR**

TEST NO. 2

DATE 31/10/94

PAGE 3 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

[illegible]

100.0
100.0

CHART

CHART NO. 89538RM

YOKOGAWA

100-

GENERAL FORM
MAIN SET-UP FORM

CLIENT: ENERGY SYSTEMS

PROJECT NUMBER 483138/LEFPC

DATE: 3 / 23 /94

RUN No. 3

TIME: 800

MAIN TUBE TILT: _____ in/4 ft

INPUT (#/hr) _____

MAIN TUBE RPM: _____

% MOISTURE: 15-17

MAIN TUBE DAM SIZE: 1 1/2

OUTPUT (#/hr) 260

LIVE BOTTOM BIN RPM: _____

TARGET TEMPERATURE (°C) 600

LIVE BOTTOM BIN SET PT.: 50

RETENTION TIME TOTAL (min.) 20

WEIGHT OF BRINKS: _____

RETENTION TIME AT TEMPERATURE (min.) 10

WEIGHT OF HEPA: _____

SCRUBBER STARTING CHARGE, # _____

WT. OF CARBON 1: _____

WESP START CHARGE (lbs or gal): _____

WT. OF CARBON 2: _____

PURGE GAS FLOW (CFM AIR): 2 CFM

SPECIAL TEMPERATURE PROFILE INSTRUCTIONS:

THERMAL DESORBER SOIL OUTFALL TRACKING FORM

Project: LOWER EAST FORK POPLAR CREEK

Project Number: 483138

Client Name: MMES

TEST NO. 3

DATE: 3/23/94

PAGE 1 OF 1

START TIME	END TIME	BUCKET NUMBER	GROSS WT. lbs.	BUCKET WT. lbs.	NET WT. lbs.	ALIQOT TAKEN / qty	BULK DENSITY, pcf	DATA BY
0837	0852		19.4	4.4	15.0	N		Re
0852	0900		12.4	4.4	8.0	N		Re
START TEST NO. 3 @ 0900								
0900	0915	R3-1	19.0	4.4	14.6	N. (COMPOSITE ONLY)		Re
0915	0940	R3-2	28.8	4.4	24.4	Y ONE 4 OZ. JAR & COMP.		Re
0940	1010	R3-3	33.0	4.4	28.6	Y ↓		Re
1010	1030	R3-4 R3-4 3:27:10	23.8	4.4	19.4	Y ↓		Re
1030	1130	R3-5	70.2	4.4	65.8	Y TWO 4 OZ. JARS & COMPOSITE		Re
1130	1215	R3-6	56.6	4.4	52.2	Y ONE 4 OZ. JAR + COMP.		Re
1215	1300	R3-7	56.0	4.4	51.6	Y TWO 4 OZ. JARS + COMPOSITE		Re
1300	1345	R3-8	57.6	4.4	53.2	Y ONE 4 OZ. JAR + COMPOS		Re
1345	1421	R3-9	47.2	4.4	42.8	Y TWO 4 OZ. JARS + COMPOSITE		Re

THERMAL DESORBER SOIL INPUT TRACKING FORM

TEST NO. _____

 DATE 3 123 194

 PAGE 1 OF _____

 IT PROJECT NO. 483138/LEFPC

 CLIENT NAME ENERGY SYSTEMS

TIME	BUCKET NO.	NET WT.	SAMPLE ALIQUOT Y/N	BULK DEN	DATA BY
07:56	1	14.48 lbs	N		CB
07:57	2	15.15 lbs	N		CB
08:02	3	10.44 lbs	N		DH
08:12	4	13.64 lbs	N		CB
Scales	changed	to grams	beginning with	bucket	# 5
08:19	5	8955	N		CB
08:56	6	1072 5732	N		CB
09:01	7	7763	N		DH
09:15	8	8114	N		CB
09:30	9	1267 7129	Y		DH
09:45	10	6496	N		DH
10:00	11	6062 5911	Y		CB
10:01	12	4420	N		DH
10:13	13	7591	N		CB
10:36	14	7014	Y		DH
10:37	15	6437	N		DH
10:44	16	11246	N		CB
11:00	17	8771	DH Y		DH
11:13	18	10105	N		CB
11:30	19	10872	Y		DH
11:48	20	9256	N		DH
12:00	21	9496 9052	Y		DH
12:12	22	8328	N		DH

1167162.04,

THERMAL DESORBER SOIL INPUT TRACKING FORM

TEST NO. 3

DATE 3/23/94

PAGE 2 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

[illegible]

7056 246.061.04

546.021 1/2

YOKOGAWA THERMAL DESORBER TEST DATA LOG
 KBF 3/22/94 L&N 2500 CHART RECORDER TEST OF 3/23/94 LEFPC - 483108

PT. #	RANGE	DESCRIPTION OR LOCATION
1	0-1000°C	#1 - PROBE - GAS TEMPERATURE
2	0-1000°C	#2 - PROBE - SOIL TEMPERATURE
3	550-650°C	#3 - PROBE - SOIL TEMPERATURE
4	0-1000°C	#4 - PROBE - GAS TEMPERATURE
5	550-650°C	#5 - PROBE - SOIL TEMPERATURE
6	550-650°C	#6 - PROBE - SOIL TEMPERATURE
7	550-650°C	#7 - PROBE - SOIL TEMPERATURE
8	0-1000°C	#8 - PROBE - GAS TEMPERATURE
9	0-1000°C	#9 - PROBE - SOIL TEMPERATURE
10	0-1000°C	END PLENUM - GAS TEMPERATURE
11	0-1000°C	CYCLONE EXIT - GAS TEMPERATURE
12	0-1000°C	SHELL - SOIL FEED END - COMBUSTION EXHAUST GAS
13	0-1000°C	SHELL - NEXT THERMOCOUPLE - COMBUSTION EXHAUST GAS
14	0-1000°C	SHELL - NEXT THERMOCOUPLE - COMBUSTION EXHAUST GAS
15	0-1000°C	SHELL - SOIL DISCHARGE END - COMBUSTION EXHAUST GAS
16	0-100°C	SCRUBBER EXIT TO TANK - SCRUBBER LIQUID TEMPERATURE
17	0-100°C	SCRUBBER EXIT TO WESP INLET - GAS TEMPERATURE
18	0-100°C	TEMPERATURE OF SCRUBBER LIQUID INTO HEAT EXCHANGER
19	0-100°C	TEMPERATURE OF SCRUBBER LIQUID OUT OF HEAT EXCHANGER
20	0-100°C	TEMPERATURE OF COOLANT INTO HEAT EXCHANGER
21	0-100°C	TEMPERATURE OF COOLANT OUT OF HEAT EXCHANGER
22	0-100°C	WESP EXIT TO CONDENSER INLET - GAS TEMPERATURE
23	0-100°C	CONDENSER EXIT TO DEMISTER INLET - GAS TEMPERATURE
24	0-100°C	TEMPERATURE OF COOLANT INTO CONDENSER
25	0-100°C	TEMPERATURE OF COOLANT OUT OF CONDENSER
26	0-100°C	DEMISTER EXIT - GAS TEMPERATURE
27	0-1000°C	SOIL IN OUTFALL COLLECTION BUCKET - SOIL TEMPERATURE
28	0-100%	PERCENT OXYGEN - BETWEEN HEPA AND CARBON FILTERS
29	0-100°C	AMBIENT TEMPERATURE AT FEED PLATFORM
30	550-650°C	ALTEK THERMOCOUPLE CALIBRATION SOURCE - SET ON 600°C

COMPLETED BY Kenneth Ferguson DATE 3/22/94

**OPERATING LOG COMMENTS (FOR THERMAL DESOBER SYSTEMS)
FOR FIRE CONTROL, ONSITE SUPERVISOR**

TEST NO. 3

DATE 3/23/94

PAGE 1 OF

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

OPERATOR*	TIME	COMMENT	DATA BY
KP/TG	0825	ALMOST @ TEMP RUNNING OK NOW	TG
..	0930	START TEMPORARY SAMPLES	TG
--	1015	INCR SF SP TO S2	TG
..	1035	AIR PUMP BKR TRIPPED - BACK ON	TG
...	1145	CHANGED FILTER @ 72 lbs Δ	TG
...	1330	RUNNING V. WELL	TG
...	1335	RT IN	TG
—	1505	Sample team in	
	1505	Composite soil sample wt in bucket $728g - 2.2lb = 784g$	
	1515	BONKS WT 6282g	
	1535	Cyclone solids 1596 - 688g = 910g	
	1600	6295 - 997 WT of WESP Liquid	
	1600	1156 - 404g = acid 120 b flush WESP	
	1601	9848 - 997 WT of WESP Liquid & Rinse	
	1605	1315 - 146.38g = RA Condensate	
	1605	Final Scrubber level @ 12.5	
	1606	Organic phase on scrubber	
	1610	Organic phase 618 - 46g =	
	1615	Changed to Bag A filter	
	1625	HEPA WT 1706g	
	1630	Primary Carbon - 2898 - 170g =	
	1635	Secondary Carbon 2657 - 170g	
	1640	pH Scrubber 8.5	

**OPERATING LOG COMMENTS (FOR THERMAL DESOBER SYSTEMS)
FOR FIRE CONTROL, ONSITE SUPERVISOR**

TEST NO. 3

DATE 3/23 /94

PAGE 2 OF 2

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

[illegible]

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 3DATA 3/23/94PAGE 1 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY MHStart Test

1. TIME (24 hr format)	9:00	09:15	09:30	09:45	10:00
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	80	42	42	42	42
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.2	0.2	0.4	0.2	0.2
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. <u>7139</u>	7200	7341	07418	07505	07589
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	1.0	0.6	0.6	0.6	0.8
7. FUEL GAS (dgm reading) note: start pt. <u>08193</u>	08200	08211	08223	08236	08248
8. FUEL GAS PRESSURE (oz)	7	7	7	7	7
9. PERCENT O ₂ METER (%)	X	X	X	X	X
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	55	60	60	60	60
13. FILTER INLET PRES. (psig)	60	62	64	65	66
14. SCRUBBER LIQUID LEVEL	3	3	4	4	4.5
15. HEX CW TEMP. IN (°F) <u>7th</u>	42	46	42	44	42
16. HEX CW TEMP. OUT (°F) <u>3/23/94</u>	45	48	48	46	44
17. SCRUBBER GAS TEMP. IN (°C)	X	X	X	X	X
18. SCRUBBER LIQUID TEMP. OUT (°C)	16	15	15	15	15
19. SCRUBBER GAS TEMP. OUT (°C)	34	34	34	34	34
20. CH W COND. WATER TEMP. IN (°F) <u>3/23/94</u>	40	40	40	40	40
21. CH W COND. WATER TEMP. OUT (°F) <u>3/23/94</u>	40	40	40	40	40
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)	X	X	X	X	X
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.6	0.2	0.2	0.2	0.2
4. PRESS. DROP ACROSS DEMISTER IN (psig)	1.0	0.6	0.6	0.6	0.6
25. TEMP. OF GAS EXIT WESP (°C)	25	25	25	25	25

X = Data recorded on recorder

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 3DATA 03/23/94PAGE 2 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY MA

1. TIME (24 hr format)	1015	1030	1045	1100	1115
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	42	42	42	42	42
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.2	0.2	0.2	0.2	0.2
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. <u>see page 1</u>	07675	07747	07842	07928	08015
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	0.6	0.6	0.6	0.8	0.8
7. FUEL GAS (dgm reading) note: start pt. <u>see page 1</u>	08263	08275	08292	08307	08321
8. FUEL GAS PRESSURE (oz)	7	7	7	7	7
9. PERCENT O ₂ METER (%)	X	X	X	X	X
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	62	62	62	65	65
13. FILTER INLET PRES. (psig)	68	70	68	68	70
14. SCRUBBER LIQUID LEVEL	5.5	6	6.5	7	7.5
15. HEX CW TEMP. IN (°F) <i>7 m 3/23/94</i>	42	42	43	44	48
16. HEX CW TEMP. OUT (°F) <i>3/23/94</i>	44	44	45	50	50
17. SCRUBBER GAS TEMP. IN (°C)	X	X	X	X	X
18. SCRUBBER LIQUID TEMP. OUT (°C)	16	17	17	18	18.5
19. SCRUBBER GAS TEMP. OUT (°C)	34	34	34	34	34
20. CH W COND. WATER TEMP. IN (°F) <i>7 m 3/23/94</i>	40	40	38	38	38
21. CH W COND. WATER TEMP. OUT (°F) <i>3/23/94</i>	40	40	40	40	38
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)	X	X	X	X	X
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.2	0.2	0.2	0.2	0.2
24. PRESS. DROP ACROSS DEMISTER IN (psig)	0.6	0.4	0.6	0.6	0.6
25. TEMP. OF GAS EXIT WESP (°C)	25	25	30	30	30

X = Data recorded on recorder.

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 3DATA 3/23/94PAGE 3 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY MMH

1. TIME (24 hr format)	11:30	11:45	12:00	12:15	12:30
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %) <i>was 42</i>	68	68	68	88	76
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.2	0.4	0.4	0.4	0.4
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. <u>see page 1</u>	08116	08258	08399	08557	08708
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	1.2	1.2	1.2	1.2	1.4
7. FUEL GAS (dgm reading) note: start pt. <u>see page 1</u>	08336	08354	08370	08385	08400
8. FUEL GAS PRESSURE (oz)	7	7	7	7	7
9. PERCENT O ₂ METER (%)	X	X	X	X	X
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	40
12. PUMP DISCHARGE PRES. (psig)	65	50	50	50	50
13. FILTER INLET PRES. (psig)	72	<i>switched</i> 58	58	60	62
14. SCRUBBER LIQUID LEVEL	<i>5.5</i> 5.5	8.5	7.5	8	8.5
15. HEX CW TEMP. IN (°F) <i>77W</i>	50	50	54	52	56
16. HEX CW TEMP. OUT (°F) <i>3/23/94</i>	50	56	56	58	60
17. SCRUBBER GAS TEMP. IN (°C)	X	X	X	X	X
18. SCRUBBER LIQUID TEMP. OUT (°C)	20	21	22	23	23
19. SCRUBBER GAS TEMP. OUT (°C)	34	34	34	34	34
20. CH W COND. WATER TEMP. IN (°F) <i>77W</i>	38	38	40	40	40
21. CH W COND. WATER TEMP. OUT (°F) <i>363W</i>	40	40	40	40	38
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)	X	X	X	X	X
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.2	0.2	0.2	0.4	0.4
4. PRESS. DROP ACROSS DEMISTER IN (psig)	1.0	0.8	1.0	1.0	1.0
25. TEMP. OF GAS EXIT WESP (°C)	20	30	30	30	30

X = Data recorded on recorder

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 3DATA 3/23/94PAGE 4 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY MMH

1. TIME (24 hr format)	12:45	13:00	13:15	13:30	13:45
2. AIR MAKEUP (cfm)	2	2	2	2	2
3. GAS FLOW (rotameter %)	78	74	74	74	74
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	0.4	0.4	0.4	0.4	0.4
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. <u>see page 1</u>	08865	09031	09182	09321	09479
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	1.4	1.2	1.2	1.2	1.2
7. FUEL GAS (dgm reading) note: start pt. <u>see page 1</u>	08415	08432	08449	08464	08483
8. FUEL GAS PRESSURE (oz)	7	7	7	7	7
9. PERCENT O ₂ METER (%)	X	X	X	X	X
10. SCRUBBER SPRAY FLOW (%)	6	6	6	6	6
11. SCRUBBER SPRAY PRES. (psig)	38	38	38	38	38
12. PUMP DISCHARGE PRES. (psig)	54	56	60	60	60
13. FILTER INLET PRES. (psig)	62	64	64	67	69
14. SCRUBBER LIQUID LEVEL	9	9.5	10	10.5	11
15. HEX CW TEMP. IN (°C) <u>7mm</u>	56	56	58	58	60
16. HEX CW TEMP. OUT (°C) <u>364/44</u>	60	60	60	61	61
17. SCRUBBER GAS TEMP. IN (°C)	X	X	X	X	X
18. SCRUBBER LIQUID TEMP. OUT (°C)	23	23	24	24	25
19. SCRUBBER GAS TEMP. OUT (°C)	34	34	34	34	34
20. CH W COND. WATER TEMP. IN (°C) <u>7mm</u>	40	40	40	40	38
21. CH W COND. WATER TEMP. OUT (°C) <u>364/44</u>	40	40	40	40	40
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C) <u>3.30 + 8.00</u>	X	X	X	X	X
23. PRESS. DROP ACROSS CONDENSER IN (psig) <u>3/24/94</u>	0.2	0.2	0.2	0.2	0.2
4. PRESS. DROP ACROSS DEMISTER IN (psig)	1.0	1.0	1.0	1.0	1.0
25. TEMP. OF GAS EXIT WESP (°C)	30	30	30	30	30

X = Data recorded on recorder.

THERMAL SEPARATION DATA LOG (Scrubber System)

TEST No. 3DATA 3/23/94PAGE 5 OF IT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMSDATA BY

END OF RUN

1. TIME (24 hr format)	14:00	14:20			
2. AIR MAKEUP (cfm)	2	2			
3. GAS FLOW (rotameter %)	⁸⁸ 7m 09652	72			
4. GAS VACUUM OF TS UNIT (in. H ₂ O)	³¹²³ 0.4	0.4			
5. TOTAL PROCESS GAS FLOW (dgm reading) note: start pt. <u>see page 1</u>	09652	09864			
6. GAS PRESSURE DROP ACROSS SCRUBBER (in. H ₂ O)	1.4	1.5			
7. FUEL GAS (dgm reading) note: start pt. <u>see page 1</u>	08503	08521			
8. FUEL GAS PRESSURE (oz)	6	6			
9. PERCENT O ₂ METER (%)	X	X			
10. SCRUBBER SPRAY FLOW (%)	6	6			
11. SCRUBBER SPRAY PRES. (psig)	40	40			
12. PUMP DISCHARGE PRES. (psig)	60	60			
13. FILTER INLET PRES. (psig)	70	72			
14. SCRUBBER LIQUID LEVEL	11	12			
15. HEX CW TEMP. IN (°C)	^{3123/93} 14	16			
16. HEX CW TEMP. OUT (°C)	^{3123/94} 18	18			
17. SCRUBBER GAS TEMP. IN (°C)	^{3123/94} X	X			
18. SCRUBBER LIQUID TEMP. OUT (°C)	25	20			
19. SCRUBBER GAS TEMP. OUT (°C)	34	34			
20. CH W COND. WATER TEMP. IN (°C)	^{3123/94} 4	4			
21. CH W COND. WATER TEMP. OUT (°C)	^{3123/94} 6	4			
22. GAS TEMP. OUT OF CHILLED WATER COND. (°C)	X	X			
23. PRESS. DROP ACROSS CONDENSER IN (psig)	0.2	0.2			
4. PRESS. DROP ACROSS DEMISTER IN (psig)	1	0.7			
25. TEMP. OF GAS EXIT WESP (°C)	30	30			

X Data recorded on recorder

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 3DATE 3/24/94PAGE 1 OF IT PROJECT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY <u>MMH</u> st. state set pt. <u> </u>	<u>MMH</u>	<u>MMH</u>	<u>MMH</u>	<u>MMH</u>	<u>MMH</u>	<u>MMH</u>	<u>MMH</u>	<u>MMH</u>
TIME (24 HR FORMAT) <u> </u> st. state set pt. <u>0904</u>	<u>0904</u>	<u>0918</u>	<u>0932</u>	<u>0947</u>	<u>1002</u>	<u>1017</u>	<u>1031</u>	<u>1047</u>
ZONE 1 (BELLOWS) <u> </u> st. state set pt. <u>700</u>	<u>638</u>	<u>640</u>	<u>641</u>	<u>645</u>	<u>642</u>	<u>644</u>	<u>648</u>	<u>646</u>
ZONE 2 (PLENUM) <u> </u> st. state set pt. <u>700</u>	<u>659</u>	<u>673</u>	<u>678</u>	<u>676</u>	<u>677</u>	<u>678</u>	<u>677</u>	<u>676</u>
ZONE 3 (DUCT TOP) <u> </u> st. state set pt. <u>700</u>	<u>706</u>	<u>708</u>	<u>699</u>	<u>690</u>	<u>701</u>	<u>705</u>	<u>658</u>	<u>699</u>
ZONE 4 (DUCT BOTTOM) <u> </u> st. state set pt. <u>700</u>	<u>700</u>	<u>699</u>	<u>701</u>	<u>700</u>	<u>701</u>	<u>699</u>	<u>698</u>	<u>700</u>
ZONE 5 (CYCLONE TOP) <u> </u> st. state set pt. <u>700</u>	<u>697</u>	<u>707</u>	<u>705</u>	<u>704</u>	<u>700</u>	<u>702</u>	<u>702</u>	<u>698</u>
ZONE 6 (CYCLONE BOTTOM) <u> </u> st. state set pt. <u>700</u>	<u>699</u>	<u>703</u>	<u>701</u>	<u>696</u>	<u>703</u>	<u>700</u>	<u>699</u>	<u>701</u>
ZONE 7 (BOTTOM FLANGE) <u> </u> st. state set pt. <u>700</u>	<u>362</u>	<u>360</u>	<u>359</u>	<u>375</u>	<u>377</u>	<u>376</u>	<u>379</u>	<u>376</u>
ZONE 8 (TOP FLANGE) <u> </u> st. state set pt. <u>700</u>	<u>625</u>	<u>644</u>	<u>654</u>	<u>673</u>	<u>682</u>	<u>689</u>	<u>693</u>	<u>697</u>
ZONE 9 (MANIFOLD) <u> </u> st. state set pt. <u>700</u>	<u>690</u>	<u>708</u>	<u>701</u>	<u>699</u>	<u>700</u>	<u>699</u>	<u>694</u>	<u>699</u>
ZONE 10 (CROSSOVER) <u> </u> st. state set pt. <u>700</u>	<u>700</u>	<u>700</u>	<u>700</u>	<u>700</u>	<u>700</u>	<u>700</u>	<u>699</u>	<u>700</u>

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 3DATE 3/24/94PAGE 2 OF 2IT PROJECT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY ----- st. state set pt. _____	MA	MA	MA	MA	MA	MA	MA	MA
TIME (24 HR FORMAT) ----- st. state set pt. _____	1102	1118	1132	1149	1202	1218	1232	1247
ZONE 1 (BELLOWS) ----- st. state set pt. <u>700</u>	648	646	645	645	646	644	643	643
ZONE 2 (PLENUM) ----- st. state set pt. <u>700</u>	676	676	666	663	666	660	660	661
ZONE 3 (DUCT TOP) ----- st. state set pt. <u>700</u>	706	706	701	695	696	705	709	695
ZONE 4 (DUCT BOTTOM) ----- st. state set pt. <u>700</u>	700	700	701	698	699	700	701	699
ZONE 5 (CYCLONE TOP) ----- st. state set pt. <u>700</u>	700	698	703	701	697	697	700	699
ZONE 6 (CYCLONE BOTTOM) ----- st. state set pt. <u>700</u>	700	699	696	700	699	701	700	701
ZONE 7 (BOTTOM FLANGE) ----- st. state set pt. <u>700</u>	375	372	388	397	396	392	388	385
ZONE 8 (TOP FLANGE) ----- st. state set pt. <u>700</u>	699	701	701	702	700	699	700	700
ZONE 9 (MANIFOLD) ----- st. state set pt. <u>700</u>	700	699	700	699	700	698	701	700
ZONE 10 (CROSSOVER) ----- st. state set pt. <u>700</u>	700	699	700	699	700	699	700	700

THERMAL DESORBER TEST DATA LOG DESORBER TEMPERATURE (°C)

TEST No. 3DATE 3/23/94PAGE 3 OF IT PROJECT No. 483138/LEFPCCLIENT NAME: ENERGY SYSTEMS

DATA TAKEN BY ----- st. state set pt. _____	MM	MM	MM	MM	MM	MM		
TIME (24 HR FORMAT) ----- st. state set pt. _____	1302	1317	1331	1346	1409	1425		
ZONE 1 (BELLOWS) ----- st. state set pt. <u>700</u>	643	642	642	642	642	642		
ZONE 2 (PLENUM) ----- st. state set pt. <u>700</u>	658	658	658	657	656	653		
ZONE 3 (DUCT TOP) ----- st. state set pt. <u>700</u>	667	674 ^{5m} 674	654 ³⁶⁴ 654	702	653	715		
ZONE 4 (DUCT BOTTOM) ----- st. state set pt. <u>700</u>	700	700	699	701	701	721		
ZONE 5 (CYCLONE TOP) ----- st. state set pt. <u>700</u>	700	701	700	697	701	705		
ZONE 6 (CYCLONE BOTTOM) ----- st. state set pt. <u>700</u>	700	700	698	700	703	700		
ZONE 7 (BOTTOM FLANGE) ----- st. state set pt. <u>700</u>	392	386	387	390	397	393		
ZONE 8 (TOP FLANGE) ----- st. state set pt. <u>700</u>	699	700	700	700	700	700		
ZONE 9 (MANIFOLD) ----- st. state set pt. <u>700</u>	699	699	700	699	700	706		
ZONE 10 (CROSSOVER) ----- st. state set pt. <u>700</u>	700	700	700	699	700	702		

THERMAL DESORBER TEST DATA LOG RETENTION TIME

TEST NO. 3

DATE 3 / 23 / 94

PAGE 1 Of

IT PROJECT NO. 483138/LEFPC

CLIENT NAME ENERGY SYSTEMS

[illegible]

Run 3

Jan 11
09:00-

19.00

1000.0

11:04

Mar. 23. 94

01 44 500
02 36 1000
03 59 1800
04 51 2600
05 30 3400
06 02 4200
07 50 5000

08

577.500
312.100
335.200
671.900
791.200
655.400
584.100

15

613.400
18.300
27.100
17.700
15.900
9.800
12.300
30.500

23

3.600
0.200
0.500
20.700
74.800
17.000
33.500
53.500

1000.0

11:00

Mar. 23. 94

01 43 900
02 34 1800
03 55 2600
04 50 3400
05 01 4200
06 05 5000
07 51 5800

08

579.500
314.800
334.300
682.800
783.600
685.400
605.300

15

611.100
18.300
27.100
17.700
15.900
9.800
12.300
28.800

23

3.600
0.200
0.500
20.700
75.700
16.500
33.600
599.200

50

60

70

80

90

1000.0

10:48

Mar. 23. 94

01 44 900
02 55 1800
03 58 2600
04 50 3400
05 59 4200
06 03 5000
07 50 5800

08

585.900
312.100
330.900
682.800
783.600
692.600
590.100

15

616.000
17.500
26.600
16.800
15.100
8.900
11.500
28.500

23

3.700
0.400
0.600
19.600
85.600
16.300
32.900
599.000

YOKOGAWA

W. KOKUSAI CHART

CHART

YOKOGAWA

Time	Lat	Long	Temp	Wind	Clouds	Pressure	Humidity	Sea	Remarks
01	23.94	148.30	48.3	9.0	0	1000.0	100.0	0	0-125
02	23.94	148.30	50.4	9.0	0	1000.0	100.0	0	0-125
03	23.94	148.30	55.9	5.0	0	1000.0	100.0	0	0-125
04	23.94	148.30	61.5	3.0	0	1000.0	100.0	0	0-125
05	23.94	148.30	60.4	3.0	0	1000.0	100.0	0	0-125
06	23.94	148.30	59.5	2.0	0	1000.0	100.0	0	0-125
07	23.94	148.30	60.8	3.0	0	1000.0	100.0	0	0-125
08	23.94	148.30	58.8	6.0	0	1000.0	100.0	0	0-125
09	23.94	148.30	33.6	1.0	0	1000.0	100.0	0	0-125
10	23.94	148.30	30.8	2.0	0	1000.0	100.0	0	0-125
11	23.94	148.30	67.6	7.0	0	1000.0	100.0	0	0-125
12	23.94	148.30	80.5	1.0	0	1000.0	100.0	0	0-125
13	23.94	148.30	74.5	5.0	0	1000.0	100.0	0	0-125
14	23.94	148.30	57.2	1.0	0	1000.0	100.0	0	0-125
15	23.94	148.30	58.8	6.0	0	1000.0	100.0	0	0-125
16	23.94	148.30	33.6	1.0	0	1000.0	100.0	0	0-125
17	23.94	148.30	30.8	2.0	0	1000.0	100.0	0	0-125
18	23.94	148.30	67.6	7.0	0	1000.0	100.0	0	0-125
19	23.94	148.30	80.5	1.0	0	1000.0	100.0	0	0-125
20	23.94	148.30	74.5	5.0	0	1000.0	100.0	0	0-125
21	23.94	148.30	57.2	1.0	0	1000.0	100.0	0	0-125
22	23.94	148.30	58.8	6.0	0	1000.0	100.0	0	0-125
23	23.94	148.30	33.6	1.0	0	1000.0	100.0	0	0-125
24	23.94	148.30	30.8	2.0	0	1000.0	100.0	0	0-125
25	23.94	148.30	67.6	7.0	0	1000.0	100.0	0	0-125
26	23.94	148.30	80.5	1.0	0	1000.0	100.0	0	0-125
27	23.94	148.30	74.5	5.0	0	1000.0	100.0	0	0-125
28	23.94	148.30	57.2	1.0	0	1000.0	100.0	0	0-125
29	23.94	148.30	58.8	6.0	0	1000.0	100.0	0	0-125
30	23.94	148.30	33.6	1.0	0	1000.0	100.0	0	0-125

22	Type K	100.0°C	0.0	100.0 x 02	0-125
23	Type K	100.0°C	0.0		0-125
24	Type K	100.0°C	0.0		0-125
25	Type K	100.0°C	0.0		0-125
26	Type K	100.0°C	0.0		0-125
27	Type K	100.0°C	0.0		0-125
28	200µV	64.50mV	0.0		0-250
29	Type K	100.0°C	0.0		0-125
30	Type K	650.0°C	0.0		125-250

0	10	20	30	40	50	60	70	80	90	100
11	Type K	100.0°C	0.0	100.0 x 02	0-125					
12	Type K	100.0°C	0.0							
13	Type K	100.0°C	0.0							
14	Type K	100.0°C	0.0							
15	Type K	100.0°C	0.0							
16	Type K	100.0°C	0.0							
17	Type K	100.0°C	0.0							
18	Type K	100.0°C	0.0							
19	Type K	100.0°C	0.0							
20	Type K	100.0°C	0.0							
21	Type K	100.0°C	0.0							
22	Type K	100.0°C	0.0							
23	Type K	100.0°C	0.0							
24	Type K	100.0°C	0.0							
25	Type K	100.0°C	0.0							
26	Type K	100.0°C	0.0							
27	Type K	100.0°C	0.0							
28	200µV	64.50mV	0.0							
29	Type K	100.0°C	0.0							
30	Type K	650.0°C	0.0							

3.5°C

Appendix F
GAS SAMPLING AND ANALYSIS REPORT

***Off-gas Sampling and Analysis Report
Thermal Desorption Demonstration Project -
Lower East Fork Poplar Creek***

IT Project 483138

Prepared for:
**Martin Marietta Energy Systems
Oak Ridge, Tennessee**

Prepared by:
**IT Corporation
Knoxville, Tennessee**

June 1994

RESPONSIVE TO THE NEEDS OF ENVIRONMENTAL MANAGEMENT

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1.0 Introduction

IT Corporation was contracted by Martin Marietta Energy Systems (MMES) to conduct a pilot-scale thermal desorption treatability test on the mercury contaminated soil from the Lower East Fork Poplar Creek (LEFPC) floodplain in Oak Ridge, Tennessee. The samples collected in support of this testing effort were analyzed at the IT Analytical Services (ITAS) St. Louis Laboratory, ITAS Special Analysis Laboratory (SAL), IT's Environmental Technology Development Center (EDTC), and Southwest Research Institute (SRI). The objective of the test was to quantify the efficiency of the desorber unit in treating the soil and to establish the gas concentrations of select target contaminants before and after treatment by the gas cleaning system. This report focuses on the characterization of the pre-treated gas (off-gas) and treated gas (vent gas) resulting from the verification test performed in the pilot-scale system on March 10, 1994.

1.1 Project Objective

The project objective was to demonstrate in a pilot-scale thermal desorption system and off-gas cleaning system the removal of mercury from the LEFPC soil to a level of 10 part-per-million (ppm) or less. The pilot-scale system simulated the various components of a full scale system. The pilot-scale system consisted of an indirect natural gas fired thermal desorber unit, hot cyclone, spray scrubber, wet electrostatic precipitator (WESP), chilled condenser, Brinks demister, HEPA filter, and activated carbon bed system. This system was tested for its ability to effectively desorb mercury from the LEFPC soil to the desired concentration and remove contaminants from the desorber off-gas.

1.2 Sampling Objectives

The sampling objective of this thermal desorption treatability test was to collect samples both during and at the conclusion of the test from the pilot-scale system that would provide the analytical data necessary to:

- Demonstrate that the treatment conditions (residence time and temperature) used in the pilot-scale test effectively removed mercury from the soil to a level of 10 ppm.

- Characterize the off-gas and vent gas from the desorber unit to demonstrate that the off-gas cleaning system was effective in the removal of mercury as well as other pollutants.

The gas sampling program was designed to meet the later objective through the collection and analysis of representative samples from various points in the off-gas treatment system. The gas samples were subjected to a variety of analytical procedures to obtain the data necessary to evaluate the pilot-scale system. These analyses included particulate, metals (specifically mercury, arsenic, cadmium, and uranium), target compound list (TCL) volatiles, TCL semivolatiles, acid gases (anions: F⁻, Cl⁻, Br⁻, I⁻), ammonia, oxygen (O₂), carbon dioxide (CO₂), and carbon monoxide (CO).

1.3 Intended Use of Data

The analytical data obtained from gas samples is being used to assist in the conceptual design and evaluation of the effectiveness, feasibility, and cost of a full scale thermal desorber as a potential treatment technology for the remediation of mercury contaminated LEFPC floodplain soils.

1.4 Samples Collected

During the second test run on March 10, 1994, the verification test, the thermal desorber unit was operated at a treatment temperature of 350°C. The desorber off-gas and system vent gas emissions were simultaneously sampled. Four different types of sampling trains were connected at various locations in these gas streams to collect samples. The sampling trains were set up, connected, and operated in two locations: immediately after the hot cyclone (off-gas) and at the end of the off-gas treatment system (vent gas). The following gas samples were collected during the test:

- U.S. EPA Volatile Organic Sampling Train (VOST)
Tenax[®] and Tenax/charcoal resin tube pairs
Condensate
- U.S. EPA Modified Method 5 (MM5) Semivolatile Train
Front half - particulate filter, acetone/hexane rinse
Back half - impinger #1-#3 contents: DI water and condensate

- U.S. EPA Method 5 Multi-metals Train (MMT)
 - Front half - particulate filter, nitric acid (HNO_3) rinse (all target metals)
 - Back half - impingers #1-#3: $\text{HNO}_3/\text{H}_2\text{O}_2$ (all target metals)
 - Back half - impingers #4-#5: $\text{KMnO}_4/\text{H}_2\text{SO}_4$ (mercury)
- U.S. EPA Method 0050 Acid gas/Ammonia Train (AGT)
 - Front half - particulate filter, acetone rinse
 - Back half - impingers #1-#2: H_2SO_4
 - Back half - impinger #3-#4: NaOH
- U.S. EPA Method 3 - Orsat Gas Samples

2.0 Sampling Plan and Procedures

The test was conducted using the pilot-scale thermal desorber unit and off-gas treatment system shown in Figure 2-1. The desorber unit was heated to the targeted soil temperature of 350°C while being purged with an air sweep gas at a rate of 2 actual cubic feet per minute (acfm). The contaminated soil was introduced to the unit and processed at a feed rate of 70-78 lbs/hr. Once steady state of unit operation was attained, four hours of gas sampling began by activating the sample train control boxes.

The sampling trains used at both locations collected their samples from a representative slip stream of the total gas stream available. Standard stack sampling trains and associated methods approved by the U.S. EPA were used to collect these samples.

The desorber off-gas and vent gas sample collection for volatiles was accomplished through the use of a VOST. This sampling train, assembled and operated as shown in Figure 2-2, pulls from a slip stream a representative gas sample first through a Tenax resin tube, then a condensate trap, and finally a Tenax/charcoal resin tube. The Tenax and Tenax/charcoal resin matrices have been demonstrated to be effective in trapping the target volatile components present in the gas stream.

The desorber off-gas and vent gas sample collection for semivolatiles was accomplished through the use of a MM5 Train. This sampling train, assembled and operated as shown in Figure 2-3, pulls from a slip stream a representative gas sample first through a particulate filter and an XAD-2 resin tube before entering impingers filled with DI water. The various collection media used in this train have been demonstrated to be effective in trapping the target semivolatile components present in the gas stream.

The desorber off-gas and vent gas sample collection for metals was accomplished through the use of a Method 5 (M5) MMT. This sampling train, assembled and operated as shown in Figure 2-4, pulls from a slip stream a representative gas sample first through a particulate filter then three impingers filled with nitric acid/peroxide ($\text{HNO}_3/\text{H}_2\text{O}_2$) solution, and then finally through two

FIGURE 2-1. SAMPLING POINTS FOR PILOT SCALE THERMAL DESORBER VERIFICATION TESTS

STARTING DATE: 5/30/91	DATE LAST REV.:	DRAFT. CHCK. BY:	INATOR:	DWG. NO.: 305702-S-02
DRAWN BY: M. MOWERY	DRAWN BY:	ENG. CHCK. BY:	PROJ. MGR.:	PROJ. NO.: 305702

Figure 2-2.

VOST Train Schematic

STARTING DATE: 5/20/91	DATE LAST REV.:	DRAFT. CHK. BY:	INATOR:	DWG. NO.: 305702-S-01
DRAWN BY: M. MOHRY	DRAWN BY:	ENG. CHK. BY:	PROJ. MGR.:	PROJ. NO.: 305702

Figure 2-3.

Modified Method 5 Semivolatiles Train Schematic

INTERNATIONAL
CORPORATION

STARTING DATE: 5/20/91	DATE LAST REV.:	DRAFT. CHK. BY:	INATOR: P. OSTERGAARD	DWG. NO.: 305702-04
DRAWN BY: M. MOHREY	DRAWN BY:	ENG. CHK. BY:	PROJ. MGR.: P. OSTERGAARD	PROJ. NO.: 305702

Figure 2-4.

Method 5 Multi-metals Train Schematic

impingers filled with a potassium permanganate/sulfuric acid ($\text{KMnO}_4/\text{H}_2\text{SO}_4$) solution. The various collection media used in this train have been demonstrated to be effective in trapping the target metallic components present in the gas stream.

The desorber off-gas and vent gas sample collection for acid gas was accomplished through the use of a Method 0050 AGT. This sampling train, assembled and operated as shown in Figure 2-5, pulls from a slip stream a representative gas sample first through a particulate filter, then two impingers filled with an H_2SO_4 solution, followed by two impingers filled with a sodium hydroxide (NaOH) solution. The various collection media used in this train have been demonstrated to be effective in trapping the target anion and ammonia components present in the gas stream. This train was also used to collect particulate for characterization. Because isokinetic conditions were not attempted for this sampling activity, the particulate mass loadings determined from the sampling train are not considered sufficiently accurate for use in mass balance evaluations of the desorber system.

Because H_2SO_4 was used in the first impingers, it was not possible to quantify SO_2 in the gas samples. The amount of SO_2 which could have been generated from oxidation of sulfides in the LEFPC soil during desorption was very small compared to the concentration of H_2SO_4 . The SO_2 values reported in Section 4.0 represent the H_2SO_4 impinger solution.

The desorber off-gas and vent gas VOST were operated at a sampling rate of 0.5 L/min (0.02 cfm) for 20 minutes per pair. The remaining sampling trains for the desorber off-gas were operated at an approximately sampling rate of 0.02 cfm. The trains connected at the vent gas location were all operated at a sampling rate of 0.3 cfm. These low desorber off-gas volumes were necessary to prevent the total gas volume passing through the off-gas treatment system from becoming substantially depleted. The low volume of gas collected was considered sufficient because of the expected high concentrations of constituents in the off-gas.

Representative composite samples of the vent gas were collected during the test run to measure CO_2 , O_2 , and CO by the Orsat method. The Orsat procedure used is described in 40 CFR 60, Appendix A, Method 3.

40724816 03/04/92 10:09am STC

STARTING DATE: 03/03/92	DATE LAST REV.:	DRAFT. CHCK. BY: J. HUBBARD	INITIATOR: J. DISHNER	DRAWING NO.: 407248-A-16
DRAWN BY: S. CARDWELL	DRAWN BY:	ENGR. CHCK BY: J. DISHNER	PROJ. MGR.: P. OSTERGAARD	PROJ. NO.: 407248

Figure 2-5.
Method 0050 HCl/Ammonia Train Schematic

In addition to the samples collected directly from the sampling trains, several quality control (QC) reagent blank samples were also collected and analyzed. These QC samples included reagent blank particulate filters, distilled, deionized water, impinger solutions, VOST tubes, and XAD-2 resin. All QC samples were analyzed to determine any contribution of contaminants native to the reagents used in the various systems.

At the conclusion of the test, the sampling trains were individually disassembled and the various sample components recovered. For the MM5 Trains, the particulate filter housings were allowed to cool before removing the particulate filters. To collect any residual semivolatiles, the filter housing and the associated upstream train glassware were rinsed with acetone and hexane solvents as described in the method and this rinse sample was recovered for analysis. The XAD-2 resin tubes were recovered, sealed and secured. The back half impinger samples were gravimetrically and volumetrically measured before being placed into a sample container.

For the MMT, the particulate filter housings were allowed to cool before removing the particulate filters. To collect any residual metals, the filter housing and the associated upstream train glassware were rinsed with nitric acid as described in the method and this rinse sample was recovered for analysis. The three $\text{HNO}_3/\text{H}_2\text{O}_2$ impingers were gravimetrically and volumetrically measured before being combined into one sample container, and the associated HNO_3 impinger rinses were measured and combined with the sample. The two $\text{KMnO}_4/\text{H}_2\text{SO}_4$ impingers were gravimetrically and volumetrically measured before being combined into one sample container. The method procedure next calls for the rinsing of these impingers with an 8N HCl solution to remove any oxidized KMnO_4 remaining on the impinger walls. Because HCl and KMnO_4 react to produce chlorine gas (Cl_2) when combined, the method recommends to collect these samples individually in the field and combine them in the controlled conditions of the laboratory for safety. A variance from this procedure occurred when the associated 8N HCl rinse solution for the desorber off-gas train was added to the KMnO_4 impinger sample in the field. No impact on the quality of the data is anticipated from this condition and the sample was sent for analysis.

The particulate filter housings of the M0050 AGT were allowed to cool before removing the particulate filters. To collect any residual particulate, the filter housing and the associated

upstream train glassware were rinsed with acetone as described in the method and this rinse sample was recovered for analysis. The two H_2SO_4 impingers were gravimetrically and volumetrically measured before being combined into one sample container, and the associated H_2SO_4 rinse was measured and combined with the sample. The two NaOH impingers were gravimetrically and volumetrically measured before being combined into one sample container, and the associated NaOH rinse was measured and combined with the sample.

3.0 Analytical Plan and Procedures

The collected gas samples were analyzed for the listed parameters by the following laboratories:

- ITAS St. Louis/ITAS-SAL/IT-ETDC - metals, acid gases, and ammonia
- IT Corporation Field Analytical Services (FAS) - particulate
- IT Corporation Air Quality Services (AQS) - oxygen, carbon dioxide, and carbon monoxide by Orsat Analyzer
- SRI - VOST train and MM5 semivolatile train samples

The samples shipped off-site to SRI or ITAS were subjected to standard SW-846 and American Society for Testing and Materials (ASTM) analytical methods in accordance with the project Request for Analysis/Chain-of-Custody Form which accompanied each sample shipment.

Metals Analysis - Mercury (Methods 7470 and 7471)

The liquid samples collected from the MMT were prepared and analyzed for mercury by Method 7470 using cold vapor atomic absorption spectrophotometry (CVAA) by the ITAS St. Louis Laboratory. These samples included: the digestate from the MMT particulate filters and HNO₃ rinses (i.e., desorber off-gas, vent gas, and QC), MMT impingers #1-#3: HNO₃/H₂O₂ (i.e., desorber off-gas, vent gas, and QC), and MMT impingers #4-#5: KMnO₄/H₂SO₄ (i.e., desorber off-gas, vent gas, and QC). The feed soil and other solid matrix samples collected for the test were prepared and analyzed for mercury by Method 7471.

Metals Analysis - Arsenic (Method 7060) and Cadmium (Method 7131)

The samples collected from the metals gas sampling trains for arsenic analysis were prepared by Method 3050, acid digestion, to convert organic forms of arsenic to inorganic forms, to minimize organic interferences, and to convert the sample to a suitable solution for analysis. After preparation, all samples were analyzed by graphite furnace atomic absorption (GFAA) according Method 7060 and 7131. The samples prepared and analyzed for As and Cd analysis at ITAS St. Louis Laboratory included the digestate from the MMT particulate filters and HNO₃ rinses (i.e., desorber off-gas, vent gas, and QC), MMT impingers #1-#3: HNO₃/H₂O₂ (i.e., desorber off-gas, vent gas, and QC).

Metals Analysis - Total Uranium (ASTM Method D-5174)

The samples collected from the MMT for total uranium analysis were prepared and analyzed by ASTM D-5174. The samples prepared and analyzed for total uranium analysis by kinetic phosphorescence analysis (KPA) at ITAS St. Louis Laboratory included the MMT particulate filters and HNO₃ rinses (i.e., desorber off-gas, vent gas, and QC), MMT impingers #1-#3: HNO₃/H₂O₂ (i.e., desorber off-gas, vent gas, and QC).

VOST Train Analysis (Methods 5040 and 8240)

The analysis that was planned for the Tenax and Tenax-charcoal resin tube samples collected from the VOST was for them to be prepared by Method 5040 and analyzed by Method 8240. However, due to the high concentrations of volatile analytes found on the first pair of Tenax and Tenax/charcoal tubes analyzed (Pair #4), Pair #1, #2, and #3 of the desorber off-gas VOST were prepared by an approved alternate method. In this method, each tube of the pair was desorbed into methanol using a stainless steel impinger cooled with methanol and dry ice. The resulting methanol extract was then analyzed by Method 8240 using gas chromatography/mass spectrometry (GC/MS) and the data was compensated by a preparation dilution factor. This method of sample preparation also resulted in elevated detection limits for all analytes. The methanol preparation method was only used for Pair #1, #2, and #3 of the desorber off-gas VOST while Pair #4, all the tubes from the vent gas VOST, the field blank pair, and the trip blank pair were all prepared using the standard Method 5040. To perform Method 5040, the contents of each tube were thermally desorbed for 10 minutes at 180°C with organic-free nitrogen, bubbled through 5 mL of organic-free water, and trapped on an analytical adsorbent trap. The contents of the adsorbent traps were analyzed by Method 8240 using GC/MS. The VOST condensate sample and the DI water trip blank were also analyzed by Method 8240. All of these analyses were performed at SRI. In addition to quantifying TCL volatiles, SRI quantified and reported tentatively identified compounds (TICs) for each sample processed.

MM5 Semivolatiles Train (Methods 3510 and 3540 and SOW OLM 01.8)

The collected components of the MM5 Trains were combined in the laboratory to form two samples - a front half composite and a back half composite. The front half consisted of the XAD-2 tube, particulate filter, and the acetone/hexane rinse samples, and was formed by

combining the extracts generated from a Soxhlet extraction lasting for 18 hours using methylene chloride by Method 3540. The back half consisted of the condensate and the DI water impinger catch, which was composited during collection. The back half was prepared by liquid/liquid extraction using methylene chloride by Method 3510. Both the front half and the back half extracts were analyzed by Method SOW OLM01.8 using GC/MS at SRI. In addition to quantifying TCL semivolatiles, SRI quantified and reported TICs for each sample processed.

M0050 Acid Gas/Ammonia Train - Ion Chromatography (Method 9056)

The samples collected from the M0050 AGT for ion chromatography analysis were prepared and analyzed according to Method 9056. The samples analyzed at the ITAS St. Louis Laboratory were the impingers #1-#2: H₂SO₄ (i.e., desorber gas, vent gas, and QC) and impingers #3-#4: NaOH (i.e., desorber gas, vent gas, and QC).

M0050 Acid Gas/Ammonia Train - Ammonia (Method 350.2)

The samples collected from the M0050 AGT for ammonia analysis were prepared and analyzed according to Method 350.2. The samples analyzed at the ITAS St. Louis Laboratory by Method 350.2 included impingers #1-#2: H₂SO₄ (e.g., desorber gas, vent gas, and QC) and impingers #3-#4: NaOH (i.e., desorber gas, vent gas, and QC).

M0050 Acid Gas/Ammonia Train - Particulate

The samples collected from the M0050 AGT for particulate analysis were the particulate filters and acetone rinses. The filters used for this train had been tare weighed and recorded. After the test, the particulate filters were oven dried for at least 12 hours and then desiccated for 6 additional hours. The filters were re-weighed, their weight was recorded, and were placed in desiccation for a minimum of 2 additional hours between each weighing. This process was repeated until a final weight was obtained with the desired precision (± 0.05 g). The total amount of particulate collected was then determined by subtracting the tare weight from the final weight. The acetone rinse samples were placed in beakers which had their tare weights recorded. The acetone was slowly evaporated from the beaker by oven heating, and then was desiccated for 2 hours. The beakers were re-weighed, their weight was recorded and then placed in desiccation for 2 hours between each weighing, until a final weight was obtained with the desired precision

($\pm$ 0.05 g). The amount of particulate for the acetone rinse sample was then determined by subtracting the tare weight from the final weight. The samples that were analyzed by IT-FAS personnel for particulate included the particulate filter (i.e., desorber gas, vent gas, and QC) and the acetone rinse samples (i.e., desorber gas, vent gas, and QC).

Orsat Gas Sample Analysis

the composite bag samples of the desorber off-gas was analyzed on-site following the execution of the test by IT-AQS personnel for O₂, CO₂ and CO. To verify the complete adsorption of the analyte, the analysis of each bag sample was repeated several times until a constant reading was observed between two measurements. The field analytical procedure, analyzer schematic, and the analytical values observed are presented in Attachment I.

4.0 Analytical Data Summaries

This section contains several summary tables that show the concentration of the gas samples collected and how these concentrations were then used to calculate the concentration of the analytes in the off-gas and vent gas streams. The tables summarize the particulate, metals, volatiles, semivolatiles, acid gases and ammonia concentrations. All train totals are calculated in terms of total mass (i.e., total μg , mg , or g) and the concentration in the off-gas or vent gas is shown in mass per unit volume units of $\mu\text{g}/\text{m}^3$, mg/m^3 , or g/m^3 .

In cases where the laboratory did not report a value above the limit of detection for a gas sample, the limit of detection was used to calculate the train totals and a less than symbol ($<$) was used to flag the total. Using the limit of detection in this manner, assumes the "worst case" for the train totals.

**Table 4-1. MMES - Lower East Fork Poplar Creek
Desorber Test Off-gas Correction Factors**

Train ID	Volume Collected Through Sampling Train ⁽¹⁾		Total Volume of Off-gas/ Vent Gas ⁽²⁾		Gas Volume Correction Factor ⁽³⁾
	(ft ³)	(m ³)	(ft ³)	(m ³)	
Desorber Off Gas VOST - Pair #1-#3	2.03	0.06	1,920	54.4	946
Desorber Off Gas VOST - Pair #4 ⁽⁴⁾	0.38	0.01	1,920	54.4	5,053
Desorber Off Gas MM5 Semivolatiles	4.60	0.13	1,920	54.4	417
Desorber Off Gas Multi-metals	4.32	0.12	1,920	54.4	444
Desorber Off Gas Acid Gas	4.15	0.12	1,920	54.4	463
Vent Gas VOST	3.68	0.10	1,920	54.4	522
Vent Gas MM5 Semivolatiles	70.57	2.00	1,920	54.4	27.2
Vent Gas Multi-metals	69.80	1.98	1,920	54.4	27.5
Vent Gas Acid Gas	69.49	1.97	1,920	54.4	27.6

(1) These volumes have been corrected to standard temperature and pressure and are reported on a dry gas basis.

(2) The total volume of vent gas for the four hour sampling period is equal to the volume measured by the dry gas meter (1,691 ft³) plus the sum of the volumes collected by all sample trains (229 ft³). It is assumed that the desorber off-gas volume is the same as the vent gas volume.

(3) The gas volume correction factor is calculated by the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Volume of Off-gas or Vent Gas During Sampling (ft}^3\text{)}}{\text{Volume Pulled Through Sampling Train (ft}^3\text{)}}$$

(4) Due to the two different analytical approaches taken to analyzing Pair #4 versus Pair #1-#3, two correction factors were computed to use with the two analytical data sets.

**Table 4-2. MMES - Lower East Fork Poplar Creek
Particulate Determination**

Desorber Off-gas Train Summary:

Sample	Total Particulate (g)
Particulate Filter(s)	0.155
Acetone Probe Wash	0.504

Train Total:	0.659
Gas Volume Correction Factor:	x 463

Desorber Off-gas Total:	305.1 g
Total Off-gas Volume:	÷ 54.4 m ³

Desorber Off-gas Concentration:	5.608 g/m³
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Vent Gas Train Summary:

Sample	Total Particulate (g)
Particulate Filter(s)	< 0.001
Acetone Probe Wash	< 0.001

Train Total:	< 0.002
Gas Volume Correction Factor:	x 27.6

Vent Gas Total:	< 0.055 g
Total Vent gas Volume:	÷ 54.4 m ³

Vent Gas Concentration:	< 0.001 g/m³
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QC Blank - Particulate Summary:

Sample	Total Particulate (g)
Particulate Filter(s)	< 0.001
Acetone Probe Wash	< 0.001

QC Blank Total:	< 0.002
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**Table 4-3. MMES-Lower East Fork Poplar Creek
Multi-Metals Train Metals Analysis - Off-gas and Vent Gas**

	Particulate Filter	Front half - HNO ₃ /H ₂ O ₂			Back half - KMnO ₄ /H ₂ SO ₄ + HCl ⁽¹⁾			TRAIN TOTAL (mg)
Analyte	TOTAL (mg)	Concentration (mg/L)	Sample Volume (L)	TOTAL (mg)	Concentration (mg/L)	Sample Volume (L)	TOTAL (mg)	
Desorber Off Gas:								
arsenic	0.0015	0.035	0.719	0.025				0.026
cadmium	0.0016	0.041	0.719	0.029				0.031
mercury	0.103	25.3	0.719	18.2	40.8	0.238	9.71	28.0
uranium	0.260	0.335	0.719	0.241				0.501
Vent Gas:								
arsenic	< 0.0003	< 0.003	0.495	< 0.001				< 0.0018
cadmium	< 0.00003	< 0.0003	0.495	< 0.0001				< 0.0002
mercury	< 0.00004	< 0.0002	0.495	< 0.0001	0.001	0.220	0.0002	< 0.0004
uranium	0.00368	0.0011	0.495	0.00054				0.0042
QC Blank Train:								
arsenic	< 0.0003	< 0.003	0.300	< 0.001				< 0.001
cadmium	< 0.00003	< 0.0003	0.300	< 0.0001				< 0.0001
mercury	< 0.00004	< 0.02	0.300	< 0.01	0.002	0.200	0.0004	< 0.01
uranium	0.0015	0.0021	0.300	0.00064				0.0022

⁽¹⁾ The back half consist of two impingers of a KMnO₄/H₂SO₄ and an 8N HCl rinse.

Table 4-4. MMES - Lower East Fork Poplar Creek
MMT Contaminant Gas Totals and Concentration - Off-gas and Vent Gas

Analyte	Train Total ⁽¹⁾ (mg)	Gas Volume Correction Factor ⁽²⁾	Gas Total ⁽³⁾ (mg)	Total Gas Volume ⁽⁴⁾ (m ³)	Gas Concentration ⁽⁵⁾ (mg/m ³)
Desorber Off Gas:					
Metals:					
arsenic	0.026	444	11.7	54.4	0.22
cadmium	0.031		13.6		0.25
mercury	28.0		12,434		228.6
uranium	0.501		222		4.1
Vent Gas:					
Metals:					
arsenic	< 0.0018	27.5	< 0.049	54.4	< 0.00090
cadmium	< 0.0002		< 0.004		< 0.00009
mercury	< 0.0004		< 0.009		< 0.00018
uranium	0.0042		0.12		0.0021

⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included in the calculation. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

⁽²⁾ The gas volume correction factor is based on the percentage of the total gas volume sampled by the MMT for the desorber off-gas stream and the MMT for the vent gas stream. These factors are based on the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Total Off-gas or Vent Gas during Sampling (ft}^3\text{)}}{\text{Total Gas Sampled by the MMT (ft}^3\text{)}}$$

⁽³⁾ The gas total represents the total mass of contaminant in the entire desorber off-gas or vent gas stream during the sampling period and is calculated by the following relationship:

$$\text{Off Gas Total (mg)} = \text{Train Total (mg)} \times \text{Gas Volume Correction Factor}$$

⁽⁴⁾ The total gas volume is the total non-condensable volume (m³) that passed through the the off-gas treatment system and vent during the test run.

⁽⁵⁾ The gas concentration is calculated by the following relationship:

$$\text{Gas Concentration (mg/m}^3\text{)} = \frac{\text{Gas Total (mg)}}{\text{Total Gas Volume (m}^3\text{)}}$$

**Table 4-5A. MMES - Lower East Fork Poplar Creek
VOST Train Volatiles Analysis - Off-gas**

Compound	Pair #1	Pair #2	Pair #3	Condensate			TRAIN TOTAL ⁽¹⁾ (μg)
	TOTAL (μg)	TOTAL (μg)	TOTAL (μg)	Concentration (μg/L)	Sample Volume (L)	TOTAL (μg)	
Desorber Off Gas							
acetone	340	140	26	84	0.052	4.36	510
2-butanone	150	52	16	8.4	0.052	0.43	218
benzene	500	230	35	< 3.3	0.052	< 0.17	< 765
toluene	590	120	8.2	< 3.3	0.052	< 0.17	< 718
ethylbenzene	86	< 10	< 2	< 3.3	0.052	< 0.17	< 98.2
xylene (total)	220	27	6.8	< 3.3	0.052	< 0.17	< 254
styrene	230	26	9.2	< 3.3	0.052	< 0.17	< 265
TICS: ⁽²⁾							
furan	510	700	71	ND	NA	NA	1,281 ⁽²⁾
2-methyl-furan	690	620	100	ND	NA	NA	1,410 ⁽²⁾
1-methyl-1H-pyrrole	41	ND	5.2	ND	NA	NA	46.2 ⁽²⁾
methane	ND	69	ND	ND	NA	NA	69 ⁽²⁾
2-methyl-butene	ND	46	ND	ND	NA	NA	46 ⁽²⁾
hexane	ND	340	5.8	ND	NA	NA	346 ⁽²⁾
2-methyl-propanal	ND	ND	14	ND	NA	NA	14 ⁽²⁾
2,3-dimethyl-2-butene	ND	ND	7.7	ND	NA	NA	7.7 ⁽²⁾
acetaldehyde	ND	ND	ND	0.03	0.052	0.002	0.002 ⁽²⁾

Notes:

ND - Not Detected and a limit of quantitation was not given.

NA - Not Applicable.

⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included in the calculation. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

⁽²⁾ TICs - Tentatively Identified Compound. The concentration reported is an estimated value.

**Table 4-5B. MMES - Lower East Fork Poplar Creek
VOST Train Volatiles Analysis - Off-gas**

Compound	Pair #4	Condensate				TRAIN TOTAL ⁽¹⁾ (μ g)		
	TOTAL (μ g)	Concentration (μ g/L)	Sample Volume (L)	TOTAL (μ g)				
Desorber Off Gas								
chloromethane	14.4 ⁽²⁾	<	6.7	0.052	<	0.35	<	14.7 ⁽²⁾
bromomethane	1.6 ⁽²⁾	<	6.7	0.052	<	0.35	<	1.9 ⁽²⁾
acetone	30 ⁽²⁾		84	0.052		4.4		34.4 ⁽²⁾
carbon disulfide	17.2 ⁽²⁾	<	3.3	0.052	<	0.17	<	17.4 ⁽²⁾
2-butanone	33 ⁽²⁾		8.4	0.052		0.44		33.4 ⁽²⁾
benzene	8 ⁽²⁾	<	3.3	0.052	<	0.17	<	8.2 ⁽²⁾
4-methyl-2-pentanone	1.5 ⁽²⁾	<	33	0.052	<	1.7	<	3.2 ⁽²⁾
toluene	1.5 ⁽²⁾	<	3.3	0.052	<	0.17	<	1.7 ⁽²⁾
TICS: ⁽³⁾								
1,3-pentadiene	1.3		ND	NA		NA		1.3 ⁽³⁾
1,5-hexadiyne	2.4		ND	NA		NA		2.4 ⁽³⁾
acetaldehyde	ND		0.033	0.052		0.0017		0.0017 ⁽³⁾

Notes:

ND - Not Detected and a limit of quantitation was not given.

NA - Not Applicable.

- ⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included in the calculation. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.
- ⁽²⁾ The compound concentration exceeded the calibration range of the GC/MS instrument for that specific analysis. The reported concentration is an estimated value.
- ⁽³⁾ TICs - Tentatively Identified Compound. The concentration reported is an estimated value.

**Table 4-6. MMES - Lower East Fork Poplar Creek
VOST Train Volatiles Analysis - Vent Gas**

	Pair #1	Pair #2	Pair #3	Pair #4	Condensate			TRAIN TOTAL ⁽¹⁾ (μg)
Compound	TOTAL (μg)	TOTAL (μg)	TOTAL (μg)	TOTAL (μg)	Concentration (μg/L)	Sample Volume (L)	TOTAL (μg)	
Vent Gas								
chloromethane	9.4 ⁽²⁾	24.9 ⁽²⁾	32 ⁽²⁾	42 ^{(2),(3)}	NC	NA	NA	108
toluene	0.119	< 0.05	< 0.05	< 0.05	NC	NA	NA	< 0.27
TICs: ⁽⁴⁾								
2-methyl-butane	0.048	ND	ND	ND	NC	NA	NA	0.05 ⁽⁴⁾
3-methyl-hexane	0.036	ND	ND	ND	NC	NA	NA	0.04 ⁽⁴⁾
3-methyl-hexane	0.14	ND	0.17	ND	NC	NA	NA	0.31 ⁽⁴⁾
2,4-dimethyl-pentane	0.089	ND	0.11	ND	NC	NA	NA	0.20 ⁽⁴⁾
trichlorofluoromethane	ND	ND	ND	0.053	NC	NA	NA	0.05 ⁽⁴⁾
2-butenal	ND	ND	ND	0.112	NC	NA	NA	0.11 ⁽⁴⁾

Notes:

NC - Not Collected.

NA - Not Applicable.

ND - Not Detected and a limit of quantitation was not given.

- (1) The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.
- (2) The individual Tenax and Tenax-charcoal results indicate breakthrough may have occurred for this analyte. The reported result may be biased low due to breakthrough.
- (3) The compound concentration exceeded the calibration range of the GC/MS instrument for that specific analysis. The reported concentration is an estimated value.
- (4) TICs - Tentatively Identified Compound. The concentration reported is an estimated value.

**Table 4-7A. MMES - Lower East Fork Poplar Creek
VOST Train Contaminant Totals and Concentration - Off-gas**

Train ID	Contaminant	Train Total ⁽¹⁾ (μg)	Gas Volume Correction Factor ⁽²⁾	Off Gas Total ⁽³⁾ (μg)	Total Off Gas Volume ⁽⁴⁾ (m ³)	Off Gas Concentration ⁽⁵⁾ (μg/m ³)
Desorber Off Gas (Pair #1 - #3):						
Volatiles:						
	acetone	510	946	482,808	54.4	8,875
	2-butanone	218		206,641		3,799
	benzene	< 765		< 723,852		< 13,306
	toluene	< 718		< 679,580		< 12,492
	ethylbenzene	< 98.2		< 92,870		< 1,707
	xylene (total)	< 254		< 240,257		< 4,416
	styrene	< 265		< 251,042		< 4,615
TICs: ⁽⁶⁾						
	furan	1,281		1,211,826		22,276 ⁽⁶⁾
	2-methyl-furan	1,410		1,333,860		24,519 ⁽⁶⁾
	1-methyl-1H-pyrrole	46.2		43,705		803 ⁽⁶⁾
	methane	69		65,274		1,200 ⁽⁶⁾
	2-methyl-butene	46		43,516		800 ⁽⁶⁾
	hexane	346		327,127		6,013 ⁽⁶⁾
	2-methyl-propanal	14		13,244		243 ⁽⁶⁾
	2,3-dimethyl-2-butene	7.7		7,284		134 ⁽⁶⁾
	1,5-hexadiyne	0.002		1.623		0.03 ⁽⁶⁾
	acetaldehyde	0.0017		1.623		0.03 ⁽⁶⁾

(1) The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

(2) The gas volume correction factor is based on the percentage of the total gas volume sampled by the VOST for Pair #1-#3 for the desorber off-gas stream. This is based on the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Total Off-gas during Sampling (ft}^3\text{)}}{\text{Total Gas Sampled by VOST Pair \#1-\#3 (ft}^3\text{)}}$$

(3) The off gas total represents the total mass of contaminant in the entire desorber gas stream during the sampling period and is calculated by the following relationship:

$$\text{Off Gas Total } (\mu\text{g}) = \text{Train Total } (\mu\text{g}) \times \text{Gas Volume Correction Factor}$$

(4) The total off-gas volume is the total non-condensable volume (m^3) that passed through the the off-gas treatment system and vent during the test run.

(5) The off-gas concentration is calculated by the following relationship:

$$\text{Off-gas Concentration } (\mu\text{g}/\text{m}^3) = \frac{\text{Off-gas Total } (\mu\text{g})}{\text{Total Off-gas Volume (m}^3\text{)}}$$

⁶⁾ TICs - Tentatively Identified Compound. The concentration is an estimated value.

**Table 4-7B. MMES - Lower East Fork Poplar Creek
VOST Train Contaminant Totals and Concentration - Off-gas**

Train ID	Contaminant	Train Total ⁽¹⁾ (μg)	Gas Volume Correction Factor ⁽²⁾	Off Gas Total ⁽³⁾ (μg)	Total Off Gas Volume ⁽⁴⁾ (m^3)	Off Gas Concentration ⁽⁵⁾ ($\mu\text{g}/\text{m}^3$)
Desorber Off Gas (Pair #4 Only):						
Volatiles:						
	chloromethane	< 14.7 ⁽⁶⁾	5,053	< 74,524 ⁽⁶⁾	54.4	< 1,370 ⁽⁶⁾
	bromomethane	< 1.9 ⁽⁶⁾		< 9,845 ⁽⁶⁾		< 181 ⁽⁶⁾
	acetone	34.4 ⁽⁶⁾		173,662 ⁽⁶⁾		3,192 ⁽⁶⁾
	carbon disulfide	< 17.4 ⁽⁶⁾		< 87,779 ⁽⁶⁾		< 1,614 ⁽⁶⁾
	2-butanone	33.4 ⁽⁶⁾		168,956 ⁽⁶⁾		3,106 ⁽⁶⁾
	benzene	< 8.2 ⁽⁶⁾		< 41,291 ⁽⁶⁾		< 759 ⁽⁶⁾
	4-methyl-2-pentanone	< 3.2 ⁽⁶⁾		< 16,250 ⁽⁶⁾		< 299 ⁽⁶⁾
	toluene	< 1.7 ⁽⁶⁾		< 8,447 ⁽⁶⁾		< 155 ⁽⁶⁾
TICs: ⁽⁷⁾						
	furan	1.3		6,569		121 ⁽⁷⁾
	2-methyl-furan	2.4		12,127		223 ⁽⁷⁾
	acetaldehyde	0.001		8,671		0.159 ⁽⁷⁾

⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included in the calculation. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

⁽²⁾ The gas volume correction factor is based on the percentage of the total gas volume sampled by the VOST for Pair #4 for the desorber off-gas stream. This is based on the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Total Off-gas during Sampling (ft}^3\text{)}}{\text{Total Gas Sampled by VOST Pair \#4 (ft}^3\text{)}}$$

⁽³⁾ The off gas total represents the total mass of contaminant in the entire desorber gas stream during the sampling period and is calculated by the following relationship:

$$\text{Off Gas Total } (\mu\text{g}) = \text{Train Total } (\mu\text{g}) \times \text{Gas Volume Correction Factor}$$

⁽⁴⁾ The total off-gas volume is the total non-condensable volume (m^3) that passed through the the off-gas treatment system and vent during the test run.

⁽⁵⁾ The off-gas concentration is calculated by the following relationship:

$$\text{Off-gas Concentration } (\mu\text{g}/\text{m}^3) = \frac{\text{Off-gas Total } (\mu\text{g})}{\text{Total Off-gas Volume } (\text{m}^3)}$$

⁽⁶⁾ The compound concentration exceeded the calibration range of the GC/MS instrument for that specific analysis. The reported concentration is an estimated value.

⁽⁷⁾ TICs - Tentatively Identified Compound. The concentration is an estimated value.

**Table 4-8. MMES - Lower East Fork Poplar Creek
VOST Train Contaminant Totals and Concentration - Vent Gas**

Train ID	Contaminant	Train Total ⁽¹⁾ (μg)	Gas Volume Correction Factor ⁽²⁾	Vent Gas Total ⁽³⁾ (μg)	Total Vent Gas Volume ⁽⁴⁾ (m ³)	Vent Gas Concentration ⁽⁵⁾ (μg/m ³)
Vent Gas (Pair #1 - #4):						
Volatiles:						
	chloromethane	108	522	56,533	54.4	1,039
	vinyl chloride	< 0.39		< 205		< 3.8
	bromomethane	< 2.9		< 1,493		< 27.4
	carbon disulfide	< 0.23		< 120		< 2.2
	toluene	< 0.27		< 140		< 2.6
TICs: ⁽⁶⁾						
	2-methyl-butane	0.05		25.1		0.5 ⁽⁶⁾
	3-methyl-hexane	0.04		18.8		0.3 ⁽⁶⁾
	3-methyl-hexane	0.31		162		3.0 ⁽⁶⁾
	2,4-dimethyl-pentane	0.20		104		1.9 ⁽⁶⁾
	trichlorofluoromethane	0.05		27.7		0.5 ⁽⁶⁾
	2-butenal	0.11		58		1.1 ⁽⁶⁾

⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

⁽²⁾ The gas volume correction factor is based on the percentage of the total gas volume sampled by the VOST for the vent gas stream. This is based on the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Total Vent Gas during Sampling (ft}^3\text{)}}{\text{Total Gas Sampled by VOST (ft}^3\text{)}}$$

⁽³⁾ The vent gas total represents the total mass of contaminant in the entire desorber gas stream during the sampling period and is calculated by the following relationship:

$$\text{Vent Gas Total } (\mu\text{g}) = \text{Train Total } (\mu\text{g}) \times \text{Gas Volume Correction Factor}$$

⁽⁴⁾ The total vent gas volume is the total non-condensable volume (m^3) that passed through the the off-gas treatment system and vent during the test run.

⁽⁵⁾ The vent gas concentration is calculated by the following relationship:

$$\text{Vent Gas Concentration } (\mu\text{g}/\text{m}^3) = \frac{\text{Vent Gas Total } (\mu\text{g})}{\text{Total Vent Gas Volume } (\text{m}^3)}$$

⁽⁶⁾ TICs - Tentatively Identified Compound. The concentration is an estimated value.

**Table 4-9. MMES - Lower East Fork Poplar Creek
MM5 Train Semivolatiles Analysis - Off-gas and Vent Gas**

Compound	XAD/Particulate Filter Concentration (Total µg)	Back Half Concentration (Total µg)	TRAIN TOTAL ⁽¹⁾ (µg)
Desorber Off Gas			
phenol	1,500 ⁽²⁾	1,800 ⁽²⁾	3,300 ⁽²⁾
2-methyl-phenol	250	47	300
4-methyl-phenol	470	200 ⁽²⁾	670 ⁽²⁾
naphthalene	620	< 10	< 630
2-methyl-naphthalene	260	< 10	< 270
acenaphthylene	39 ⁽³⁾	< 10	< 49 ⁽³⁾
acenaphthene	17 ⁽³⁾	< 10	< 27 ⁽³⁾
dibenzofuran	63 ⁽³⁾	< 10	< 73 ⁽³⁾
diethylphthalate	< 100	0.6 ⁽³⁾	< 100 ⁽³⁾
fluorene	18 ⁽³⁾	< 10	< 28 ⁽³⁾
phenanthrene	140	0.6 ⁽³⁾	140 ⁽³⁾
anthracene	27 ⁽³⁾	< 10	< 37 ⁽³⁾
di-n-butylphthalate	10 ⁽³⁾	0.5 ⁽³⁾	10 ⁽³⁾
fluoranthene	87 ⁽³⁾	0.7 ⁽³⁾	90 ⁽³⁾
pyrene	44 ⁽³⁾	< 10	< 54 ⁽³⁾
benzo(a)anthracene	8 ⁽³⁾	< 10	< 20 ⁽³⁾
chrysene	18 ⁽³⁾	< 10	< 28 ⁽³⁾
bis(2-ethylhexyl)phthalate	< 100	2 ⁽³⁾	< 100 ⁽³⁾
benzo(b)fluoranthene	15 ⁽³⁾	< 10	< 25 ⁽³⁾
benzo(a)pyrene	5 ⁽³⁾	< 10	< 20 ⁽³⁾
TICs:			
5-methyl-2-furancarboxaldehyde	1,900 ^{(2), (3)}	420 ^{(2), (3)}	2,300 ^{(2), (3)}
dimethylnaphthalene	52 ⁽³⁾	ND	52 ⁽³⁾
benzaldehyde	1,400 ^{(2), (3)}	ND	1,400 ^{(2), (3)}
pentylcyclohexane	360 ^{(2), (3)}	ND	360 ^{(2), (3)}
1-methyl-2,5-pyrrolidinedione	ND	10 ⁽³⁾	10 ⁽³⁾
2,3-dihydro-1H-inden-1-one	ND	3 ⁽³⁾	3 ⁽³⁾
1(3H)-isobenzofuranone	ND	5 ⁽³⁾	5 ⁽³⁾
2H-1-benzopyran-2-one	ND	4 ⁽³⁾	4 ⁽³⁾
1H-pyrrole-2-carboxaldehyde	ND	210 ^{(2), (3)}	210 ^{(2), (3)}

**Table 4-9. (Continued) MMES - Lower East Fork Poplar Creek
MM5 Train Semivolatiles Analysis - Off-gas and Vent Gas**

Compound	XAD/Particulate Filter Concentration (Total µg)	Back Half Concentration (Total µg)	TRAIN TOTAL ⁽¹⁾ (µg)
Vent Gas			
phenol	18	< 10	< 28
naphthalene	100 ⁽²⁾	< 10	< 110 ⁽²⁾
2-methylnaphthalene	23	< 10	< 33
diethylphthalate	7 ⁽³⁾	< 10	< 20 ⁽³⁾
phenanthrene	1 ⁽³⁾	< 10	< 10 ⁽³⁾
di-n-butylphthalate	2 ⁽³⁾	< 10	< 10 ⁽³⁾
bis(2-ethylhexyl)phthalate	4 ⁽³⁾	1 ⁽³⁾	5 ⁽³⁾
TICs:			
dimethyl-benzene	48 ^{(2), (3)}	ND	48 ^{(2), (3)}

Notes:

TICs: Tentatively Identified Compounds

ND - Not Detected. No quantitation limit was given.

- ⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included in the calculation. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.
- ⁽²⁾ The compound concentration was reported from a dilution analyzed on this sample. The dilution was performed to obtain data that fell within the instrument calibration range of the method.
- ⁽³⁾ This compound concentration is an estimated value.

**Table 4-10. MMES - Lower East Fork Poplar Creek
MM5 Train Contaminant Off Gas Totals and Concentration - Off-gas and Vent Gases**

Contaminant	Train Total ⁽¹⁾ (μg)	Gas Volume Correction Factor ⁽²⁾	Gas Total ⁽³⁾ (μg)	Total Gas Volume ⁽⁴⁾ (m ³)	Gas Concentration ⁽⁵⁾ (μg/m ³)
Desorber Off Gas:					
Semivolatiles:					
phenol	3,300 ⁽⁶⁾	417	1,376,100 ⁽⁶⁾	54.4	25,296 ⁽⁶⁾
2-methyl-phenol	300		125,100		2,300
4-methyl-phenol	670 ⁽⁶⁾		279,390 ⁽⁶⁾		5,136 ⁽⁶⁾
naphthalene	< 630		< 262,710		< 4,829
2-methyl-naphthalene	< 270		< 112,590		< 2,070
acenaphthylene	< 49 ⁽⁷⁾		< 20,433 ⁽⁷⁾		< 376 ⁽⁷⁾
acenaphthene	< 27 ⁽⁷⁾		< 11,259 ⁽⁷⁾		< 207 ⁽⁷⁾
dibenzofuran	< 73 ⁽⁷⁾		< 30,441 ⁽⁷⁾		< 560 ⁽⁷⁾
diethylphthalate	< 100 ⁽⁷⁾		< 41,700 ⁽⁷⁾		< 767 ⁽⁷⁾
fluorene	< 28 ⁽⁷⁾		< 11,676 ⁽⁷⁾		< 215 ⁽⁷⁾
phenanthrene	140 ⁽⁷⁾		58,380 ⁽⁷⁾		1,073 ⁽⁷⁾
anthracene	< 37 ⁽⁷⁾		< 15,429 ⁽⁷⁾		< 284 ⁽⁷⁾
di-n-butylphthalate	10 ⁽⁷⁾		4,170 ⁽⁷⁾		77 ⁽⁷⁾
fluoranthene	90 ⁽⁷⁾		37,530 ⁽⁷⁾		690 ⁽⁷⁾
pyrene	< 54 ⁽⁷⁾		< 22,518 ⁽⁷⁾		< 414 ⁽⁷⁾
benzo(a)anthracene	< 20 ⁽⁷⁾		< 8,340 ⁽⁷⁾		< 153 ⁽⁷⁾
chrysene	< 28 ⁽⁷⁾		< 11,676 ⁽⁷⁾		< 215 ⁽⁷⁾
bis(2-ethylhexyl)phthalate	< 100 ⁽⁷⁾		< 41,700 ⁽⁷⁾		< 767 ⁽⁷⁾
benzo(b)fluoranthene	< 25 ⁽⁷⁾		< 10,425 ⁽⁷⁾		< 192 ⁽⁷⁾
benzo(a)pyrene	< 20 ⁽⁷⁾		< 8,340 ⁽⁷⁾		< 153 ⁽⁷⁾
TICs: ⁽⁶⁾					
5-methyl-2-furancarboxaldehyde	2,300 ⁽⁷⁾		959,100 ⁽⁷⁾		17,631 ^{(6), (7)}
dimethylnaphthalene	52		21,684		399 ⁽⁶⁾
benzaldehyde	1,400 ⁽⁷⁾		583,800 ⁽⁷⁾		10,732 ^{(6), (7)}
pentylcyclohexane	360 ⁽⁷⁾		150,120 ⁽⁷⁾		2,760 ^{(6), (7)}
1-methyl-2,5-pyrrolidinedione	10		4,170		77 ⁽⁶⁾
2,3-dihydro-1H-inden-1-one	3		1,251		23 ⁽⁶⁾
1(3H)-isobenzofuranone	5		2,085		38 ⁽⁶⁾
2H-1-benzopyran-2-one	4		1,668		31 ⁽⁶⁾
1H-pyrrole-2-carboxaldehyde	210 ⁽⁷⁾		87,570 ⁽⁷⁾		1,610 ^{(6), (7)}

**Table 4-10. (Continued) MMES - Lower East Fork Poplar Creek
MM5 Train Contaminant Off Gas Totals and Concentration - Off-gas and Vent Gas**

Contaminant	Train Total ⁽¹⁾ (μg)	Gas Volume Correction Factor ⁽²⁾	Gas Total ⁽³⁾ (μg)	Total Gas Volume ⁽⁴⁾ (m^3)	Gas Concentration ⁽⁵⁾ ($\mu\text{g}/\text{m}^3$)
Vent Gas:					
Semivolatiles:					
phenol	< 28	27.2	< 762	54.4	< 14
naphthalene	< 110 ⁽⁶⁾		< 2,992 ⁽⁶⁾		< 55 ⁽⁶⁾
2-methylnaphthalene	< 33		< 898		< 17
diethylphthalate	< 20 ⁽⁷⁾		< 544 ⁽⁷⁾		< 10 ⁽⁷⁾
phenanthrene	< 10 ⁽⁷⁾		< 272 ⁽⁷⁾		< 5 ⁽⁷⁾
di-n-butylphthalate	< 10 ⁽⁷⁾		< 272 ⁽⁷⁾		< 5 ⁽⁷⁾
bis(2-ethylhexyl)phthalate	5 ⁽⁷⁾		136 ⁽⁷⁾		3 ⁽⁷⁾
TICs: ⁽⁶⁾					
dimethyl-benzene	48 ⁽⁷⁾		1,306 ⁽⁷⁾		24.0 ^{(6), (7)}

⁽¹⁾ The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

⁽²⁾ The gas volume correction factor is based on the percentage of the total gas volume sampled by the MM5 Train for the desorber off-gas stream and the MM5 Train for the vent gas stream. These factors are based on the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Total Off-gas or Vent Gas during Sampling (ft}^3\text{)}}{\text{Total Gas Sampled by the MM5 Train (ft}^3\text{)}}$$

⁽³⁾ The gas total represents the total mass of contaminant in the entire desorber off-gas or vent gas stream during the sampling period and is calculated by the following relationship:

$$\text{Gas Total } (\mu\text{g}) = \text{Train Total } (\mu\text{g}) \times \text{Gas Volume Correction Factor}$$

⁽⁴⁾ The total gas volume is the total non-condensable volume (m^3) that passed through the the off-gas treatment system and vent during the test run.

⁽⁵⁾ The gas concentration is calculated by the following relationship:

$$\text{Gas Concentration } (\mu\text{g}/\text{m}^3) = \frac{\text{Gas Total } (\mu\text{g})}{\text{Total Gas Volume } (\text{m}^3)}$$

⁽⁶⁾ Concentration was reported as an estimated value. TICs - Tentatively Identified Compound. The concentration of a TIC is an estimated value by definition.

⁽⁷⁾ Value was reported from a dilution of the original sample.

**Table 4-11. MMES - Lower East Fork Poplar Creek
Acid Gas Train Anion and Ammonia Analysis - Off-gas and Vent Gas**

Analyte	Imp. #1/#2: H ₂ SO ₄			Imp. #3/#4: NaOH			TRAIN TOTAL ⁽¹⁾ (mg)
	Concentration (mg/L)	Volume (L)	Total (mg)	Concentration (mg/L)	Volume (L)	Total (mg)	
Desorber Off Gas							
fluoride	5.05	0.450	2.27	< 0.10	0.218	< 0.022	< 2.3
chloride	5.18	0.450	2.33	< 0.25	0.218	< 0.055	< 2.4
bromide	< 0.25	0.450	< 0.11	< 0.25	0.218	< 0.055	< 0.17
nitrate	1.36	0.450	0.612	0.187	0.218	0.0408	0.653
sulfate	1,790	0.450	806	< 1.0	0.218	< 0.218	< 806
ammonia	206	0.450	92.7	< 0.03	0.218	< 0.0065	< 92.7
Vent Gas							
fluoride	< 0.10	0.254	< 0.025	< 0.10	0.210	< 0.021	< 0.046
chloride	4.58	0.254	1.16	< 0.25	0.210	< 0.053	< 1.2
bromide	< 0.25	0.254	< 0.064	< 0.25	0.210	< 0.053	< 0.12
nitrate	0.054	0.254	0.014	< 0.02	0.210	< 0.004	< 0.02
sulfate	3250	0.254	826	< 1.0	0.210	< 0.21	< 830
ammonia	< 0.03	0.254	< 0.01	< 0.15	0.210	< 0.0315	< 0.039
QC Blank Train							
fluoride	< 0.10	0.200	< 0.020	< 0.10	0.200	< 0.020	< 0.040
chloride	< 1.25	0.200	< 0.250	< 0.25	0.200	< 0.050	< 0.300
bromide	< 0.25	0.200	< 0.050	< 0.25	0.200	< 0.050	< 0.10
nitrate	< 0.02	0.200	< 0.004	< 0.02	0.200	< 0.004	< 0.008
sulfate	4200	0.200	840	< 1.0	0.200	< 0.20	< 840
ammonia	< 0.03	0.200	< 0.01	< 0.03	0.200	< 0.01	< 0.012

⁽¹⁾ The train totals have been calculated as the sum of each train component and reported in the correct number of significant figures. The less than symbol (<) was used in the total when a value less than the quantitation limit was included in the calculation. The train total calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

**Table 4-12. MMES - Lower East Fork Poplar Creek
Acid Gas Train Contaminant Gas Totals and Concentration - Off-gas and Vent Gas**

Analyte	Train Total ⁽¹⁾ . (mg)	Gas Volume Correction Factor ⁽²⁾	Gas Total ⁽³⁾ (mg)	Total Gas Volume ⁽⁴⁾ (m ³)	Gas Concentration ⁽⁵⁾ (mg·m ³)
Desorber Off Gas:					
Anions:					
fluoride	< 2.3	463	< 1,062	54.4	< 19.5
chloride	< 2.4		< 1,104		< 20
bromide	< 0.17		< 77		< 1.4
nitrate	0.653		302		5.6
sulfate	< 806		< 373,047		< 6,857
ammonia	< 92.7		< 42,920		< 789
Vent Gas:					
Anions:					
Fluoride	< 0.046	27.6	< 1.28	54.4	< 0.024
chloride	< 1.2		< 33.6		< 0.62
bromide	< 0.116		< 3.20		< 0.059
nitrate	< 0.018		< 0.49		< 0.0091
sulfate	< 826		< 22,790		< 419
ammonia	< 0.039		< 1.08		< 0.02

(1) The train totals have been calculated as the sum of each train component and reported. The less than symbol (<) was used when a value less than the quantitation limit was included in the calculation. The train total, calculated in this manner, represents the maximum train concentration with respect to the limit of quantitation.

(2) The gas volume correction factor is based on the percentage of the total gas volume sampled by the Acid Gas Train for the desorber off-gas stream and the Acid Gas Train for the vent gas stream. These factors are based on the following relationship:

$$\text{Gas Volume Correction Factor} = \frac{\text{Total Off-gas or Vent Gas during Sampling (ft}^3\text{)}}{\text{Total Gas Sampled by the Acid Gas Train (ft}^3\text{)}}$$

(3) The gas total represents the total mass of contaminant in the entire desorber off-gas or vent gas stream during the sampling period and is calculated by the following relationship:

$$\text{Off Gas Total (mg)} = \text{Train Total (mg)} \times \text{Gas Volume Correction Factor}$$

(4) The total gas volume is the total non-condensable volume (m³) that passed through the the off-gas treatment system and vent during the test run.

(5) The gas concentration is calculated by the following relationship:

$$\text{Gas Concentration (mg/m}^3\text{)} = \frac{\text{Gas Total (mg)}}{\text{Total Gas Volume (m}^3\text{)}}$$

Attachment I. Orsat Procedures and Data

ORSAT ANALYZER LEAK CHECK PROCEDURE

Moving an ORSAT analyzer frequently may cause it to leak. Therefore, an ORSAT analyzer must be thoroughly leak checked on site before the flue gas sample is introduced into it. The procedure for leak checking an ORSAT analyzer is:

- Bring the liquid level in each pipette up to the reference mark on the capillary tubing and then close the pipette stopcock.
- Raise the leveling bulb sufficiently to bring the confining liquid meniscus onto the graduated portion of the burette and then close the manifold stopcock.
- Record the meniscus position.
- Observe the meniscus in the burette and the liquid level in the pipette for movement over the next 4 minutes.
- For the ORSAT analyzer to pass the leak check, two conditions must be met:
 1. The liquid level in each pipette must not fall below the bottom of the capillary tubing during this 4 minute interval.
 2. The meniscus in the burette must not change by more than 0.2 ml during this 4 minute interval.

If the analyzer fails the leak check procedure, all rubber connections and stopcocks should be checked until the cause of the leak is identified. Leaking stopcocks must be disassembled, cleaned, and regreased. Leaking rubber connections must be replaced. After the analyzer is reassembled, the leak check procedure must be repeated.

ORSAT Gas Sample Analysis

To insure the complete adsorption of the CO_2 and O_2 , repeated passes must be made through each adsorbing solution until two consecutive readings are equal. Several passes (three to four) should be made between readings. If constant readings cannot be obtained after three consecutive passes, the adsorbing solution must be replaced.

Repeat the analysis until the following criteria are met:

- For percent CO_2 , repeat the analytical procedure until the results of any three analyses differ by no more than: a) 0.3% by volume when CO_2 is greater than 4 percent, or b) 0.2% by volume when CO_2 is less than or equal to 4 percent. Average the three acceptable values of percent CO_2 and report the results to the nearest 0.1 percent.
- For percent O_2 , repeat the analytical procedure until the results of any three analyses differ by no more than: a) 0.3% by volume when O_2 is less than 15

percent, or b) 0.2% by volume when O₂ is greater than or equal to 15 percent.
Average the three acceptable values of percent O₂ and report the results to the nearest 0.1 percent.

The gas samples can be captured in clean, leak-free Tedlar® sample bags or aluminized Mylar sample bags. These types of sample bags may also be used in the calibration of the Orsat analyzer. The calibration of the ORSAT analyzer is performed using the analysis steps outlined above, using either certified master gas mixtures or EPA Protocol 1 gas mixtures. Sample bags are leak checked by positive pressure and submersion techniques. If the sample bags are determined to have leaks, the sample bag is destroyed and discarded.

STARTING DATE: 2/22/94	DATE LAST REV.: 2/1/91	DRAFT. CHK. BY:	INITIATOR: R. BRYSON	DWG. NO.:
DRAWN BY: R. BRYSON	DRAWN BY: R. BRYSON	ENG. CHK. BY: M. MOWERY	PROJ. MGR.: R. HEISEL	PROJ. NO.:

ORSAT Analyzer (not to scale)

STACK GAS ANALYSIS FORM

PROJECT NAME LEFPC
 PROJECT NO. 483/38
 DATE 3/10/94
 PROCESS Thermal Desorber
 ANALYTICAL METHOD ORSAT
 ANALYZED BY R. Bryson

COMMENTS:

All trains
(outlet)

350°C Verification Test

TEST NO.	BAG NO.	CO ₂ %	O ₂ %	CO ppmv	N ₂ %	DRY MOLECULAR WEIGHT g/g-mole	EXCESS AIR %
1 ^{RUN} 1	a	3.8	17.2	703			
	b	2.5	18.0	700			
	c	2.5	17.5	697			
Avg.		2.9	17.6	700 (dry)			

$$\text{DRY MOLECULAR WEIGHT} = 0.440(\% \text{CO}_2) + 0.320(\% \text{O}_2) + 0.280(\% \text{N}_2 + \% \text{CO})$$

$$\% \text{N}_2 = (\% \text{CO}_2 + \% \text{O}_2 + \% \text{CO}) - 100\%$$

$$\text{PERCENT EXCESS AIR} = \frac{\% \text{O}_2 - 0.5\% \text{CO}}{0.264\% \text{O}_2 (\% \text{O}_2 - 0.5\% \text{CO})} \times 100$$

By M. Mowery Date 3/23/94 Subject MM / Poplar Creek Soil Test Sheet No. 1 of 1
Chkd. By Date Orsat analysis of off-gas Proj. No. 483138-005.01
600°C Verification Test

<u>Time</u>	<u>O₂ %</u>	<u>CO₂ %</u>	<u>Method</u>
8:00	19.5	—	fyrte (on line process analyzer)
8:15	19.0	—	fyrte
8:30	18.3	2.2	orsat
8:45	17.0	—	fyrte
9:00	18.5	1.8	orsat
9:15	17.0	—	fyrte
9:30	17.3	3.0	orsat
9:45	16.5	—	fyrte
10:00	16.2	3.8	orsat
10:15	17.3	3.2	orsat
10:30	17.3	3.5	orsat
10:45	17.5	—	fyrte
11:45	16.5	—	fyrte
12:15	18.3	2.5	orsat
12:45	17.5	—	fyrte
13:15	18.3	2.5	orsat
13:45	17.0	—	fyrte
14:00	17.5	3.0	orsat

Appendix G
ANALYTICAL DATA

Appendix G
Martin Marietta Energy Systems
Lower East Fork Poplar Creek
Analytical Data

**Martin Marietta Energy Systems
Lower East Fork Poplar Creek
Sample Request for Analysis List**

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LEFPC Request for Analysis

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
Characterization					
	1124000805	Feed Soil	100 g	Total U, Isotopic U	KPA, Alpha Spectroscopy
	1124000806	Feed Soil	100 g	Total U, Isotopic U	KPA, Alpha Spectroscopy
	3010930	Feed Soil	125 g	Gross alpha/beta	Gross alpha/beta
	112400801	Feed Soil	100 g	Metals	6010
	112400802	Feed Soil	100 g	Metals	6010
	112400803	Feed Soil	25 g	VOA	8260 (GC/MS)
	112400804	Feed Soil	25 g	VOA	8260 (GC/MS)
	112400801	Feed Soil	200 g	SVOA	8270 (GC/MS)
	112400802	Feed Soil	200 g	SVOA	8270 (GC/MS)
	112400801	Feed Soil	200 g	PCB	8080 (GC/ECD)
	112400802	Feed Soil	200 g	PCB	8080(GC/ECD)
	112400801	Feed Soil	100 g	TOC	9060
	112400802	Feed Soil	100 g	TOC	9060
Trial Run					
IT 5091	1042300BC	Scrubber Water	120 ml	VOA	8260 (GC/MS)
IT 5092	1042300D	Scrubber Sludge	100 g	VOA	8260 (GC/MS)
IT 5093	1041607RB	QC Reagent Blank	120 ml	VOA	8260 (GC/MS)
IT 5094	1041600TB	QC Trip Blank	40 ml	VOA	8260 (GC/MS)
350 °C Thermal Run					
IT-5119	2011400	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5120	2021420	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5121	2011430	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5122	2021450	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5123	2011500	Feed Soil	4 oz	Hg	7471(CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5124	2021520	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5125	2011530	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5126	2021550	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5127	2011600	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5128	2021620	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5129	2011715	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5130	2021735	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5131	2011745	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5132	2021805	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5133	2011815	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5134	2021835	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5135	2011845	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5136	2021905	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5137	2011915	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5138	2021935	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5139	2022030	Treated Soil Composite	500 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471(CVAA)
IT-5140	2022030	Treated Soil Composite	500 mL	PCB	3550
					8080 (GC/ECD)
IT-5141	2022030	Treated Soil Composite	500 mL	SVOA	3550
					8270 (GC/MS)
IT-5142	2022030	Treated Soil Composite	2 x 500 mL	full TCLP	1311
			2 x 4 oz		As - 7060 (GFAA)
					Cd - 7131 (GFAA)
					Pb - 7421(GFAA)
					Se - 7740 (GFAA)
					Hg - 7471 (CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
					Metals - 6010/7470
					SVOA - 8270
					PEST - 8080
					HERB - 8150
					EXT VOA - 1311
					Leachates - 8240
IT-5143	2022030	Treated Soil Composite	1 oz	Total U	KPA
IT-5145	2032030	Cyclone Solids Comp.	500 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471 (CVAA)
				PCB	3550
					8080 (GC/ECD)
				SVOA	3550
					8270 (GC/MS)
				Total U	KPA
IT-5149	2042030	Scrubber Water	2 x 4 oz	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)
IT-5149DUP	2042030	Scrubber Water	2 x 4 oz	TOC	SW-846
				Sulfate	SW-846
IT-5150	2042030	Scrubber Water		PCB	3510
					8080 (GC/ECD)
IT-5151	2042030	Scrubber Water		SVOA	3510
					8270 (GC/MS)
IT-5152	2042030	Scrubber Water		Cancelled VOA	8260 (GC/MS)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5153	2042030	Scrubber Water		Total U	KPA
IT-5154	2042030D	Scrubber Sludge		As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471 (CVAA)
IT-5155	2042030D	Scrubber Sludge		PCB	3550
					8080 (GC/ECD)
IT-5156	2042030D	Scrubber Sludge		SVOA	3550
					8270 (GC/MS)
IT-5157	2042030D	Scrubber Sludge		Cancelled VOA	8260 (GC/MS)
IT-5158	2042030D	Scrubber Sludge		Total U	KPA
IT-5159	2052030	HEPA Filter	2 x 500 mL	Metals - TAL	3050
					TAL - 6010
IT-5160	2052030	HEPA Filter	2 x 500 mL	Hg	7471 (CVAA)
			2 x 4 oz		
IT-5161	2052030	HEPA Filter	2 x 500 mL	Total U	KPA
IT-5165	2062030	Carbon Bed		Hg	7471 (CVAA)
IT-5166	2062030	Carbon Bed		SVOA	3550
					8270 (GC/MS)
Reagent Blk	2062030RB	Carbon Bed	1 x 500 mL	SVOA	3550
					8270 (GC/MS)
IT-5181	2062030	Carbon Bed	1 x 500 mL	VOA	8260 (GC/MS)
IT-5182	2062030RB	QC Reagent Blk /Carbon Bed	1 x 120 mL	VOA	8260 (GC/MS)
IT-5183	Filter	Multi-Metals Train		As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
				Total U	KPA
IT-5185	Impingers 1,2,3: HNO3/H2O2	Multi-Metals Train		Total U	KPA
				As	7060 (GFAA)
				Cd	7131 (GFAA)
IT-5186	Impingers 1,2,3: HNO3/H2O2	Multi-Metals Train		Hg	7470 (CVAA)
IT-5187	Impingers 4,5: KMnO4/H2SO4 (Incl. 8N HCl Rinse)	Multi-Metals Train		Hg	7470 (CVAA)
IT-5189	Filter	Multi-Metals Train		As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)
				Total U	KPA
IT-5191	Impingers 1,2,3: HNO3/H2O2	Multi-Metals Train		Total U	KPA
				As	7060 (GFAA)
				Cd	7131 (GFAA)
IT-5192	Impingers 1,2,3: HNO3/H2O2	Multi-Metals Train		Hg	7470 (CVAA)
IT-5193	Impingers 4,5: KMnO4/H2SO4	Multi-Metals Train		Hg	7470 (CVAA)
IT-5194	8 N HCl Impingers Rinsate	Multi-Metals Train		Hg	7470 (CVAA)
IT-5195	Filter Blank	QC Reagent Blk/ Multi-Metals Train		Total U	KPA
				As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5196	Rinse Blank Nitric	QC Reagent Blk/ Multi-Metals Train		Total U	KPA
				As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)
IT-5197	Impingers 1,2,3: HNO3/H2O2	QC Reagent Blk/ Multi-Metals Train		Total U	KPA
				As	7060 (GFAA)
				Cd	7131 (GFAA)
IT-5198	Impingers 1,2,3: HNO3/H2O2	QC Reagent Blk/ Multi-Metals Train		Hg	7470 (CVAA)
IT-5199	Impingers 4,5: KMnO4/H2SO4	QC Reagent Blk/ Multi-Metals Train		Hg	7470 (CVAA)
IT-5200	8 N HCl Impingers Rinsate	QC Reagent Blk/ Multi-Metals Train		Hg	7470 (CVAA)
IT-5201	Impingers 1,2: H2SO4	HCl/Ammonia Train		Anions	9056
IT-5202	Impingers 1,2: H2SO4	HCl/Ammonia Train		Ammonia	350.2
IT-5203	Impingers 3,4: NaOH	HCl/Ammonia Train		Anions	9056
IT-5204	Impingers 3,4: NaOH	HCl/Ammonia Train		Ammonia	350.2
IT-5205	Impingers 1,2: H2SO4	HCl/Ammonia Train		Anions	9056
IT-5206	Impingers 1,2: H2SO4	HCl/Ammonia Train		Ammonia	350.2
IT-5207	Impingers 3,4: NaOH	HCl/Ammonia Train		Anions	9056

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5208	Impingers 3,4: NaOH	HCl/Ammonia Train		Ammonia	350.2
IT-5209	Impingers 1,2: H2SO4	QC Reagent Blk/HCl Ammonia Train		Anions	9056
IT-5210	Impingers 1,2: H2SO4	QC Reagent Blk/HCl Ammonia Train		Ammonia	350.2
IT-5211	Impingers 3,4: NaOH	QC Reagent Blk/HCl Ammonia Train		Anions	9056
IT-5212	Impingers 3,4: NaOH	QC Reagent Blk/HCl Ammonia Train		Ammonia	350.2
IT-5213	QC Blank	QC Trip Blank		VOA	8260 (GC/MS)
IT-5256	2042300RB	QC Reagent Blk/Scrubber Water		SVOA	3510
					8270 (GC/MS)
IT-5257	2042300RB	QC Reagent Blk/Scrubber Water		Cancelled VOA	8260 (GC/MS)
600 °C Thermal Run					
IT-5267	3010930	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5268	3020950	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5269	3011000	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5270	3021020	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5271	3011030	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5272	3021050	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5273	3011100	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5274	3021120	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5275	3011130	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5276	3021150	Treated Soil	4 oz	Hg	7471(CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5277	3011200	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5278	3021220	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5279	3011230	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5280	3021250	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5281	3011300	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5282	3021320	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5283	3011330	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5284	3021350	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5285	3011400	Feed Soil	4 oz	Hg	7471(CVAA)
IT-5286	3021420	Treated Soil	4 oz	Hg	7471(CVAA)
IT-5287	3021530	Treated Soil Composite	500 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471(CVAA)
				Total U	KPA
IT-5288	3021530	Treated Soil Composite	500 mL	PCB	3550
					8080 (GC/ECD)
IT-5289	3021530	Treated Soil Composite	500 mL	SVOA	3550
					8270 (GC/MS)
IT-5290	3021530	Treated Soil Composite	2 x 500 mL	full TCLP	1311
			2 x 2 oz		As - 7060 (GFAA)
					Cd - 7131 (GFAA)
					Pb - 7421(GFAA)
					Se - 7740 (GFAA)
					Hg - 7470 (CVAA)
					Other Metals - 6010 (ICP)
					SVOA - 8270
					PEST - 8080
					HERB - 8150

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
					EXT VOA - 1311
					Leachates - 8240
IT-5291	3031530	Cyclone Solids Comp.	500 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471(CVAA)
				PCB	3550
					8080 (GC/ECD)
				SVOA	3550
					8270 (GC/MS)
				Total U	KPA
IT-5292	3041530	Scrubber Water	2 x 500 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)
				Total U	KPA
IT-5293	3041530	Scrubber Water	2 x 4.5 L	PCB	3510
					8080 (GC/ECD)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5294	3041530	Scrubber Water	1 x 500 mL	SVOA	3510
					8270 (GC/MS)
IT-5295	3041530	Scrubber Water	8 x 40 mL	VOA	8260 (GC/MS)
IT-5296	3041530	Scrubber Water	125 mL	TOC	9060
IT-5297	3041530	Scrubber Water	125 mL	Sulfate	9056
IT-5298	3041530RB	QC Reagent Blk /Scrubber Water	1 L	SVOA	3510
					8270 (GC/MS)
IT-5299	3041530RB	QC Reagent Blk /Scrubber Water	2 x 40 mL	VOA	8260 (GC/MS)
IT-5300	3041530D	Scrubber Sludge	125 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471 (CVAA)
				Total U	KPA
IT-5301	3041530D	Scrubber Sludge	125 mL	PCB	3550
					8080 (GC/ECD)
IT-5302	3041530D	Scrubber Sludge	125 mL	SVOA	3550
					8270 (GC/MS)
IT-5303	3041530D	Scrubber Sludge	8 x 20 mL	VOA	8260
IT-5304	3051530	HEPA Filter	500 mL	Metals - TAL	3050
					TAL - 6010
IT-5305	3051530	HEPA Filter	4 oz	Hg	7471 (CVAA)
IT-5306	3051530	HEPA Filter	500 mL	Total U	KPA
IT-5307	3061530P	Primary Carbon Bed	125 mL	Hg	7471 (CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5308	3061530P	Primary Carbon Bed	125 mL	SVOA	3550
					8270 (GC/MS)
IT-5309	3061530P	Primary Carbon Bed	2 x 40 mL	VOA	8260 (GC/MS)
IT-5310	3061530S	Secondary Carbon Bed	125 mL	Hg	7471 (CVAA)
IT-5311	3061530S	Secondary Carbon Bed	2 x 40 mL	VOA	8260 (GC/MS)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
IT-5312	3061530RB	QC Reagent Blk/ Carbon Bed	125 mL	SVOA	3550
					8270 (GC/MS)
IT-5313	3061530RB	QC Reagent Blk/ Carbon Bed	2 x 40 mL	VOA	8260 (GC/MS)
IT-5314	BLK	QC Blk	2 x 40 mL	VOA	8260 (GC/MS)
IT-5315	3041530RB	QC Reagent Blk	1 L	Sulfate	9056
IT-5316	3041530RB	QC Reagent Blk	2 x 250 mL	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7470 (CVAA)
				Total U	KPA
IT-5333	3041530f	Scrubber Float	4 oz	As	7060 (GFAA)
				Cd	7131 (GFAA)
				Hg	7471(CVAA)
				PCB	3550
					8080 (GC/ECD)
				SVOA	3550
					8270 (GC/MS)
				Total U	KPA
Residuals					
	112404307	Fenton's Reagent Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112405910	Fenton's Reagent Treated Run #3 pH 3 Scrubber Soln	1 L	Pyridine	GC/FID

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
	112406001	Fenton's Reagent Treated Run #3 pH 7.5 Scrubber Soln	1 L	Pyridine	GC/FID
	112406005	Carbon Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112406006	Carbon Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112406007	Carbon Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112406008	Carbon Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112406101	Carbon Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112406102	Carbon Treated Run #3 Scrubber Soln	1 L	Pyridine	GC/FID
	112406202	Treated Decon Water Run #1	1 L	Pyridine	GC/FID
	112406203	Treated Decon Water Run #2	1 L	Pyridine	GC/FID
	112406204	Treated Decon Water Run #3	1 L	Pyridine	GC/FID
	112406201	Metals Precip. Decon/Misc Water	1 L	Pyridine	GC/FID
	112406501	Scrubber Water	1 L	Pyridine	GC/FID

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
	112406502	Scrubber Water	1 L	Pyridine	GC/FID
	112406503	Scrubber Water	1 L	Pyridine	GC/FID
	112404305	Treated Scrubber Soln, Run #1	100 ml	Hg	7471 (CVAA)
	112404306	Treated Scrubber Soln, Run #2	100 ml	Hg	7471 (CVAA)
	112404307	Treated Scrubber Soln, Run #3	100 ml	Hg	7471 (CVAA)
	112404308	Trt. Decon Water Composite, Runs #1,2,3	100 ml	Hg	7471 (CVAA)
	112404301	Scrubber Water Trt. Solids, Run #1	100 g	Hg	7471 (CVAA)
	112404302	Scrubber Water Trt. Solids, Run #2	100 g	Hg	7471 (CVAA)
	112404303	Scrubber Water Trt. Solids, Run #3	100 g	Hg	7471 (CVAA)
	112404304	Scrubber Rinse Trt. Solids, Runs #1,2,3	100 g	Hg	7471 (CVAA)
	112404410	MTCLP Ext. of Filter Solids, Composit	100 ml	Hg	7471 (CVAA)
	1125131RB	Treated Filter Solids, Composite	100 g	Hg	7471 (CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
	GG5993 MTCLP	MTCLP Ext. of Filter Solids, Composite	100 ml	Hg	7471 (CVAA)
	112405904	Treated Residual Decon/Misc. Water	100 ml	Hg	7471 (CVAA)
	112405901	MTCLP Ext. of Scrubber Solids, Runs #1,2,3	100 ml	Hg	7471 (CVAA)
	11250151RB	Treated Scrubber Solids, Runs #1,2,3	100 g	Hg	7471 (CVAA)
	GG5994 MTCLP	MTCLP Ext. of Scrubber Solids, Runs #1,2,3	100 ml	Hg	7471 (CVAA)
	112405903	MTCLP Ext. of Amalg./Stab. Hg	100 ml	Hg	7471 (CVAA)
	112404602	Washed Scrubber Filter Bags, Runs #1,2,3	100 ml	Hg	7471 (CVAA)
	112404701	MTCLP Ext. of Washed Bags, Acid Washed, Runs #1,2,3	100 ml	Hg	7471 (CVAA)
	112404901	Brinks Demister Pads, MTCLP Extract of Washed Pads, Acid Washed, Runs #1,2,3	100 ml	Hg	7471 (CVAA)
	112406011	MTCLP of Acid Washed HEPA	100 ml	Hg	7471 (CVAA)

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Sample No.	PCE Sample No.	Description	Volume	Requested Analysis	Requested Method
	112405902	Metals Precip. Resid. Decon/Misc Water	100 ml	Hg	7471 (CVAA)
	112405703	TCLP Spent Carbon, Primary and Secondary Comp., Run #3	100 ml	Hg	7471 (CVAA)
	112405701	Treated Spent Carbon to TMT Complexing Agent, Runs #1,2	100 ml	Hg	7471 (CVAA)
	112406205	Treated Residual Decon/Misc Water	100 ml	Metals	ICP (6010)
	112406011	HEPA Filters/Acid Washed	100 ml	Metals	ICP (6010)
	112406011RE	HEPA Filters/Acid Washed	100 ml	Metals	ICP (6010)
	112406206	Metals Prec. Decon/Misc Water	100 ml	Metals	ICP (6010)
	112405702	TCLP Spent Carbon, Run #3	80 ml	VOA	8260 (GC/MS)
	112405704	TCLP of Treated Carbon, Runs #1,2	80 ml	VOA	8260 (GC/MS)

**Martin Marietta Energy Systems
Lower East Fork Poplar Creek
Characterization Data**

APPENDIX G - CHARACTERIZATION

MMES LEFPC - TOTAL URANIUM									
Characterization Results									
			Total			2-Sigma	Receipt	Prep.	Analysis
Sample No.	Description	Parameter	Uranium	Units	% RPD	Error	Date	Date	Date
1124000805	Untreated Soil	Uranium, Total	54	pCi/g		8.4	2/2/94	2/8/94	2/10/94
1124000805	Untreated Soil	Uranium 238	19.4	pCi/g		3.1	2/2/94	2/8/94	2/10/94
1124000805	Untreated Soil	Uranium 235/236	1.22	pCi/g		0.76	2/2/94	2/8/94	2/10/94
1124000805	Untreated Soil	Uranium 234	33.4	pCi/g		4.6	2/2/94	2/8/94	2/10/94
1124000806	Untreated Soil	Uranium, Total	41.2	pCi/g		6.1	2/2/94	2/8/94	2/10/94
1124000806	Untreated Soil	Uranium 238	17.8	pCi/g		2.6	2/2/94	2/8/94	2/10/94
1124000806	Untreated Soil	Uranium 235/236	0.85	pCi/g		0.44	2/2/94	2/8/94	2/10/94
1124000806	Untreated Soil	Uranium 234	22.5	pCi/g		3.1	2/2/94	2/8/94	2/10/94
1124000806 DUP	Untreated Soil	Uranium, Total	47.9	pCi/L	15.04	7.4	2/2/94	2/8/94	2/10/94
1124000806 DUP	Untreated Soil	Uranium 238	18.9	pCi/L	5.99	3	2/2/94	2/8/94	2/10/94
1124000806 DUP	Untreated Soil	Uranium 235/236	0.89	pCi/g	4.60	0.51	2/2/94	2/8/94	2/10/94
1124000806 DUP	Untreated Soil	Uranium 234	28.1	pCi/g	22.13	4	2/2/94	2/8/94	2/10/94
Method Blank	Method Blank	Uranium, Total	<1.05	pCi/g			NA	2/8/94	2/10/94
Method Blank	Method Blank	Uranium 238	<0.35	pCi/g			NA	2/8/94	2/10/94
Method Blank	Method Blank	Uranium 235/236	<0.29	pCi/L			NA	2/8/94	2/10/94
Method Blank	Method Blank	Uranium 234	<0.41	pCi/g			NA	2/8/94	2/10/94
< = Values preceded by this symbol are the detection limits.									

APPENDIX G - CHARACTERIZATION

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APPENDIX G - CHARACTERIZATION

MMES LEFPC - METALS									
Characterization Results									
Date Received:	2/2/94		2/2/94		2/2/94	2/2/94		NA	
Prep. Date:	2/8/94		2/8/94		2/8/94	2/8/94		2/8/94	
Analysis Date:	2/9/94		2/9/94		2/9/94	2/9/94		2/9/94	
Description:	Untreated		Untreated		Untreated	Untreated		Method	
	Soil		Soil		Soil	Soil		Blank	
Sample No.	112400801		112400802		112400801MS	112400801DUP		Blank	
Units	mg/Kg	Q	mg/Kg	Q	% Rec	mg/Kg	% RPD	mg/Kg	Q
arsenic	5.4		5.1		121.1	5.07	6	0.08	U
barium	194	N	162	N	73.8	201.26	3.9	0.09	U
cadmium	81		87		-1750	78	3.8	0.03	U
chromium	57.2	N	49.5	N	36	53.73	6.3	0.32	U
lead	79.1	N	77.1	N	69.8	81.61	3.1	5.47	U
mercury	300		215		1300	246.8	19.3	0.05	U
selenium	<14.8	U	<14.8	U	95.5	<14.81 U	NA	14.81	U
silver	9.5	N	9.3	N	43.6	9.86	4.2	0.31	U
< = Values proceed by this symbol are the detection limits.									
U = The analyte was analyzed but not detected.									
N = Spiked sample recovery is not within control limits.									
NA = Not applicable									

APPENDIX G - CHARACTERIZATION

MMES LEFPC - VOLATILES						
Characterization Results						
Date Received:	2/2/94		2/2/94		NA	
Date Analyzed:	2/12/94		2/12/94		2/12/94	
Matrix	Soil		Soil		Liquid	
Dilution Factor:	1		1		1	
Description	Untreated		Untreated		Method	
	Soil		Soil		Blank	
Sample No.	112400803		112400804		VBLK01	
Concentration Units	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q
dichlorodifluoromethane	<10	U	<10	U	<10	U
chloromethane	<10	U	<10	U	<10	U
bromomethane	<10	U	<10	U	<10	U
vinyl chloride	<10	U	<10	U	<10	U
chloroethane	<10	U	<10	U	<10	U
methylene chloride	<5	U	<5	U	<5	U
trichlorofluoromethane	<5	U	<5	U	<5	U
1,1-dichloroethene	<5	U	<5	U	<5	U
1,1-dichloroethane	<5	U	<5	U	<5	U
trans-1,2-dichloroethene	<5	U	<5	U	<5	U
dibromochloromethane	<5	U	<5	U	<5	U
cis-1,2-dichloroethene	<5	U	<5	U	<5	U
chloroform	<5	U	<5	U	<5	U
1,2-dichloroethane	<5	U	<5	U	<5	U
2,2-dichloropropane	<5	U	<5	U	<5	U
bromochloromethane	<5	U	<5	U	<5	U
1,1,1-trichloroethane	<5	U	<5	U	<5	U
carbon tetrachloride	<5	U	<5	U	<5	U
1,1-dichloropropene	<5	U	<5	U	<5	U
bromodichloromethane	<5	U	<5	U	<5	U
1,2-dichloropropane	<5	U	<5	U	<5	U
trichloroethene	<5	U	<5	U	<5	U
1,1,2-trichloroethane	<5	U	<5	U	<5	U
benzene	<5	U	<5	U	<5	U
dibromomethane	<5	U	<5	U	<5	U
toluene	<5	U	<5	U	<5	U
1,2-dibromoethane	<5	U	<5	U	<5	U
tetrachloroethene	<5	U	<5	U	<5	U
1,3-dichloropropane	<5	U	<5	U	<5	U
chlorobenzene	<5	U	<5	U	<5	U
1,1,1,2-tetrachloroethane	<5	U	<5	U	<5	U
ethylbenzene	<5	U	<5	U	<5	U
styrene	<5	U	<5	U	<5	U
U = Compound analyzed for but not detected.						
< = Values proceed by this symbol are the detection limits.						

APPENDIX G - CHARACTERIZATION

[illegible]

APPENDIX G - CHARACTERIZATION

LEFPC - SEMIVOLATILES						
Characterization Results						
Date Received:	2/2/94		2/2/94		NA	
Date Prep:	2/9/94		2/9/94		2/9/94	
Date Analyzed:	2/11/94		2/11/94		2/10/94	
Matrix:	Untreated Soil		Untreated Soil		Method Blank	
Dilution Factor:	1		1		1	
Sample No.	112400801		112400802		SBLK01	
Concentration Units:	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q
phenol	<330	U	<330	U	<330	U
bis(2-chloroethyl)ether	<330	U	<330	U	<330	U
2-chlorophenol	<330	U	<330	U	<330	U
1,3-dichlorobenzene	<330	U	<330	U	<330	U
1,4-dichlorobenzene	<330	U	<330	U	<330	U
benzyl alcohol	<660	U	<660	U	<660	U
1,2-dichlorobenzene	<330	U	<330	U	<330	U
2-methylphenol	<330	U	<330	U	<330	U
bis(2-chloroisopropyl)ether	<330	U	<330	U	<330	U
4-methylphenol	<330	U	<330	U	<330	U
N-nitroso-di-n-propylamine	<330	U	<330	U	<330	U
hexachloroethane	<330	U	<330	U	<330	U
nitrobenzene	<330	U	<330	U	<330	U
isophorone	<330	U	<330	U	<330	U
2-nitrophenol	<330	U	<330	U	<330	U
2,4-dimethylphenol	<330	U	<330	U	<330	U
benzoic acid	<1600	U	<1600	U	<1600	U
bis(2-chloroethoxy) methane	<330	U	<330	U	<330	U
2,4-dichlorophenol	<330	U	<330	U	<330	U
1,2,4-trichlorobenzene	<330	U	<330	U	<330	U
naphthalene	<330	U	<330	U	<330	U
4-chloroaniline	<660	U	<660	U	<660	U
hexachlorobutadiene	<330	U	<330	U	<330	U
4-chloro-3-methylphenol	<660	U	<660	U	<660	U
2-methylnaphthalene	37	J	42	J	<330	U
hexachlorocyclopentadiene	<330	U	<330	U	<330	U
2,4,6-trichlorophenol	<330	U	<330	U	<330	U
2,4,5-trichlorophenol	<330	U	<330	U	<330	U
2-chloronaphthalene	<330	U	<330	U	<330	U
2-nitroaniline	<1600	U	<1600	U	<1600	U
dimethyl phthalate	<330	U	<330	U	<330	U
acenaphthylene	96	J	110	J	<330	U
2,6-dinitrotoluene	<330	U	<330	U	<330	U
U = Compound analyzed but not detected.						
< = Values proceed by this symbol are the detection limits.						
J = Compound detected but below the contract required quantitation limit						
(the value given is an estimate)						

APPENDIX G - CHARACTERIZATION

LEFPC - SEMIVOLATILES (continued)						
Characterization Results						
Date Received:	2/2/94		2/2/94		NA	
Date Prep:	2/9/94		2/9/94		2/9/94	
Date Analyzed:	2/11/94		2/11/94		2/10/94	
Matrix:	Untreated Soil		Untreated Soil		Method Blank	
Dilution Factor:	1		1		1	
Sample No.	112400801		112400802		SBLK01	
Concentration Units:	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q
3-nitroaniline	<1600	U	<1600	U	<1600	U
acenaphthene	<330	U	<330	U	<330	U
2,4-dinitrophenol	<1600	U	<1600	U	<1600	U
4-nitrophenol	<1600	U	<1600	U	<1600	U
dibenzofuran	<330	U	<330	U	<330	U
2,4-dinitrotoluene	<330	U	<330	U	<330	U
diethylphthalate	<330	U	<330	U	<330	U
4-chlorophenyl-phenylether	<330	U	<330	U	<330	U
fluorene	<330	U	37	J	<330	U
4-nitroaniline	<1600	U	<1600	U	<1600	U
4,6-dinitro-2-methylphenol	<1600	U	<1600	U	<1600	U
N-nitrosodiphenylamine (1)	<330	U	<330	U	<330	U
4-bromophenyl-phenylether	<330	U	<330	U	<330	U
hexachlorobenzene	<330	U	<330	U	<330	U
pentachlorophenol	<1600	U	<1600	U	<1600	U
phenanthrene	500		570		<330	U
anthracene	110	J	130	J	<330	U
di-n-butylphthalate	<330	U	<330	U	<330	U
fluoranthene	1100		1100		<330	U
pyrene	870		980		<330	U
butylbenzylphthalate	<330	U	<330	U	<330	U
3,3'-dichlorobenzidine	<660	U	<660	U	<660	U
benzo(a)anthracene	510		510		<330	U
chrysene	580		570		<330	U
bis(2-ethylhexyl)phthalate	200	J	150	J	<330	U
di-n-octyl phthalate	<330	U	<330	U	<330	U
benzo(b)fluoranthene	1000		1100		<330	U
benzo(k)fluoranthene	310	J	320	J	<330	U
benzo(a)pyrene	660		670		<330	U
indeno(1,2,3-cd)pyrene	520		460		<330	U
dibenz(a,h)anthracene	130	J	110	J	<330	U
benzo(g,h,i)perylene	490		410		<330	U
(1) = Cannot be separated from diphenylamine.						
U = Compound analyzed but not detected.						
< = Values proceed by this symbol are the detection limits.						
J = Compound detected but below the contract required quantitation limit						
(the value given is an estimate)						

APPENDIX G - CHARACTERIZATION

LEFPC - PCBs									
Characterization Results									
Date Received:	2/2/94		2/2/94		2/2/94		2/2/94		NA
Date Prep:	2/9/94		2/9/94		2/9/94		2/9/94		2/9/94
Date Analyzed:	2/10/94		2/10/94		2/10/94		2/10/94		2/10/94
Description:	Untreated Soil		Untreated Soil		Untreated Soil		Untreated Soil		Method Blank
Dilution Factor:	1		10		1		10		1
Sample No.	112400801		112400801		112400802		112400802		PBLK01
Concentration Units:	µg/kg (ppb)	Q	µg/kg (ppb)	Q	µg/kg (ppb)	Q	µg/kg (ppb)	Q	µg/kg (ppb) Q
Arochlor - 1016	<33	U		SS	<33	U		SS	<33 U
Arochlor - 1221	<33	U		SS	<33	U		SS	<33 U
Arochlor - 1232	<33	U		SS	<33	U		SS	<33 U
Arochlor - 1242	<33	U		SS	<33	U		SS	<33 U
Arochlor - 1248	<33	U		SS	<33	U		SS	<33 U
Arochlor - 1254	<33	U		SS	<33	U		SS	<33 U
Arochlor - 1260		SD	2100	D		SD	1600	D	<33 U
SD - See dilution.									
SS - See undiluted run.									
U = Compound analyzed but not detected.									
D = Surrogates diluted out.									
< = Values preceded by this symbol are the detection limits.									
LEFPC - PCBs QC									
350°C Thermal Run									
Date Received:	NA		NA						
Date Prep:	2/9/94		2/9/94						
Date Analyzed:	2/10/94		2/10/94						
Description:	Matrix Spike		Matrix Spike						
Dilution Factor:	1		1						
Sample No.	112400801MS		112400801MSD			QC			
Concentration Units:	µg/kg (ppb)	% Rec.	µg/kg (ppb)	% Rec.	%RPD	Limits			
Arochlor - 1016	0	0	0	0					
Arochlor - 1221	0	0	0	0					
Arochlor - 1232	0	0	0	0					
Arochlor - 1242	0	0	0	0					
Arochlor - 1248	0	0	0	0					
Arochlor - 1254	1690	1012*	1405	841*	nd	29-131			
Arochlor - 1260	0	0	0	0					
Spike Rec: 2 out of 2 outside limits.									
* Values outside of QC limits.									
nd: not determined.									

APPENDIX G - CHARACTERIZATION

LEFPC - TOTAL ORGANIC CARBON					
Characterization Results					
Sample	Prep.	Analysis			Dilution
No.	Date	Date	Results	Units	Factor
112400801	2/11/94	2/11/94	>15700	µg/g	1
112400801DUP	2/11/94	2/11/94	>15700	µg/g	1
112400801MS	2/11/94	2/11/94	101	% Rec.	1
112400802	2/11/94	2/11/94	>15800	µg/g	1
Method Blank	2/11/94	2/11/94	<25.0	µg/g	1
< = Values preceded by this symbol are the detection limits.					
> = Value greater than the number following this symbol.					

**Martin Marietta Energy Systems
Lower East Fork Poplar Creek
Trial Pilot Test 1 Data**

APPENDIX G - TRIAL RUN

MMES LEFPC - TCLP VOLATILES									
Trial Thermal Run									
Date Received:	3/5/94		3/5/94		3/5/94		3/5/94		3/5/94
Date Analyzed:	3/7/94		3/7/94		3/8/94		3/7/94		3/7/94
Description	Scrubber		Scrubber		Scrubber		QC Reagent		QC Trip
	Water		Sludge		Sludge		Blank		Blank
Dilution Factor:	2		1		2		5		1
Sample No.	IT 5091		IT 5092		IT 5092DL		IT 5093		IT 5094
PCE Sample No.	1042300BC		1042300D		1042300D		1041607RB		1041600TB
Concentration Units	µg/L	Q	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/L
chloromethane	<10	U	<1100	U	<2100	U	150		<5
dichlorodifluoromethane	<10	U	<1100	U	<2100	U	<25	U	<5
bromomethane	<10	U	<1100	U	<2100	U	50		<5
vinyl chloride	<10	U	<1100	U	<2100	U	<25	U	<5
chloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
methylene chloride	<10	U	<1100	U	<2100	U	<25	U	<5
trichlorofluoromethane	<10	U	<1100	U	<2100	U	<25	U	<5
1,1-dichloroethene	<10	U	<1100	U	<2100	U	<25	U	<5
1,1-dichloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
cis-1,2-dichloroethene	<10	U	<1100	U	<2100	U	<25	U	<5
trans-1,2-dichloroethene	<10	U	<1100	U	<2100	U	<25	U	<5
2,2-dichloropropane	<10	U	<1100	U	<2100	U	<25	U	<5
chloroform	<10	U	<1100	U	<2100	U	<25	U	<5
1,1-dichloropropene	<10	U	<1100	U	<2100	U	<25	U	<5
1,2-dichloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
1,1,1-trichloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
carbon tetrachloride	<10	U	<1100	U	<2100	U	<25	U	<5
bromodichloromethane	<10	U	<1100	U	<2100	U	<25	U	<5
bromochloromethane	<10	U	<1100	U	<2100	U	<25	U	<5
dibromomethane	<10	U	<1100	U	<2100	U	<25	U	<5
1,3-dichloropropane	<10	U	<1100	U	<2100	U	<25	U	<5
1,2-dibromomethane	<10	U	<1100	U	<2100	U	<25	U	<5
1,1,1,2-tetrachloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
isopropylbenzene	<10	U	420	J	470	JD	6	J	<5
bromobenzene	<10	U	<1100	U	<2100	U	<25	U	<5
1,2,3-trichloropropane	<10	U	<1100	U	<2100	U	<25	U	<5
n-propylbenzene	8	J	2200		2000	JD	22	J	<5
1,2-dichloropropane	<10	U	<1100	U	<2100	U	<25	U	<5
trichloroethene	<10	U	<1100	U	<2100	U	<25	U	<5
dibromochloromethane	<10	U	<1100	U	<2100	U	<25	U	<5
1,1,2-trichloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
benzene	87		880	J	810	JD	560		<5
cis-1,3-dichloropropene	<10	U	<1100	U	<2100	U	<25	U	<5
trans-1,3-dichloropropene	<10	U	<1100	U	<2100	U	<25	U	<5
bromoform	<10	U	<1100	U	<2100	U	<25	U	<5
U = Concentration of analyte is less than the value given.									
< = Values preceded by this symbol are the detection limits.									
J = Compound detected but below the contract required quantitation limit (the value given is an estimate).									
D = Compound analyzed at a secondary dilution factor.									

APPENDIX G - TRIAL RUN

MMES LEFPC - VOLATILES									
Trial Thermal Run									
Date Received:	3/5/94		3/5/94		3/5/94		3/5/94		3/5/94
Date Analyzed:	3/7/94		3/7/94		3/8/94		3/7/94		3/7/94
Description	Scrubber		Scrubber		Scrubber		QC Reagent		QC Trip
	Water		Sludge		Sludge		Blank		Blank
Dilution Factor:	2		1		2		5		1
Sample No.	IT 5091		IT 5092		IT 5092DL		IT 5093		IT 5094
PCE Sample No.	1042300BC		1042300D		1042300D		1041607RB		1041600TB
Concentration Units	µg/L	Q	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/L
tetrachloroethene	<10	U	<1100	U	<2100	U	<25	U	<5
1,1,2,2-tetrachloroethane	<10	U	<1100	U	<2100	U	<25	U	<5
toluene	92		3000	B	2700	D	470		<5
chlorobenzene	<10	U	<1100	U	<2100	U	<25	U	<5
ethylbenzene	14		1300		1200	JD	58		<5
styrene	140		7100		6600	D	420		<5
o-xylene	30		2300		2100	JD	<25	U	<5
p/m-xylene	35		3600	B	3300	JD	140		<10
1,3-dichlorobenzene	<10	U	<1100	U	<2100	U	<25	U	<5
1,4-dichlorobenzene	<10	U	<1100	U	<2100	U	<25	U	<5
1,2-dichlorobenzene	<10	U	<1100	U	<2100	U	<25	U	<5
2-chlorotoluene	<10	U	<1100	U	<2100	U	<25	U	<5
4-chlorotoluene	<10	U	<1100	U	<2100	U	<25	U	<5
1,3,5-trimethylbenzene	<10	U	<1100	U	<2100	U	50		<5
tert-butylbenzene	<10	U	<1100	U	<2100	U	<25	U	<5
1,2,4-trimethylbenzene	12		8500		7900	D	100		<5
sec-butylbenzene	<10	U	430	J	<2100	U	<25	U	<5
p-isopropyltoluene	<10	U	8500		8000	D	<25	U	<5
n-butylbenzene	5	J	5700		5500	D	14	J	<5
1,2-dibromo-3-chloropropane	<10	U	<1100	U	<2100	U	<25	U	<5
1,2,4-trichlorobenzene	2	JB	840	JB	840	JD	<25	U	<5
hexachlorobutadiene	<10	U	<1100	U	<2100	U	<25	U	<5
naphthalene	370	B	47000	BE	46000	BD	380	B	<5
Number of TICs found:	10		10		8		10		0
(only knowns are listed)									
methane, isocyanato-	870	J	ND		ND		270	J	ND
propanal, 2-methyl-	590	J	ND		ND		160	J	ND
2-propenal, 2-methyl-	400	J	ND		ND		ND		ND
disulfide-, dimethyl-	210	J	ND		2600	J	ND		ND
furan	ND		ND		ND		850	J	ND
furan, 2-methyl	ND		ND		ND		450	J	ND
2-butanone	330	J	ND		ND		130	J	ND
benzene, methylethyl- or isomer	ND		6000	J	ND		ND		ND
benzene, methylpropyl- or isomer	ND		2300	J	ND		ND		ND
benzene, diethyl- or isomer	ND		2300	J	2800	J	ND		ND
E = Compound exceeded calibration range.									
D = Compound analyzed at a secondary dilution factor.									
U = Compound analyzed for but not detected.									
J = Compound detected but below the contract required quantitation limit (the value given is an estimate)									
B = Compound was found in the method blank.									
< = Values proceed by this symbol are the detection limits.									
ND = Not Detected.									

APPENDIX G - TRIAL RUN

MMES LEFPC - TCLP VOLATILES						
Trial Thermal Run						
Date Received:	3/5/94		3/5/94		3/5/94	
Date Analyzed:	3/7/94		3/7/94		3/8/94	
Matrix	Water		Soil		Soil	
Description						
Dilution Factor:	1					
Sample No.	VBLK1		VBLK2		VBLK3	
PCE Sample No.						
Concentration Units	µg/L	Q	µg/kg	Q	µg/kg	Q
chloromethane	<5	U	<620	U	<620	U
dichlorodifluoromethane	<5	U	<620	U	<620	U
bromomethane	<5	U	<620	U	<620	U
vinyl chloride	<5	U	<620	U	<620	U
chloroethane	<5	U	<620	U	<620	U
methylene chloride	<5	U	<620	U	<620	U
trichlorofluoromethane	<5	U	<620	U	<620	U
1,1-dichloroethene	<5	U	<620	U	<620	U
1,1-dichloroethane	<5	U	<620	U	<620	U
cis-1,2-dichloroethene	<5	U	<620	U	<620	U
trans-1,2-dichloroethene	<5	U	<620	U	<620	U
2,2-dichloropropane	<5	U	<620	U	<620	U
chloroform	<5	U	<620	U	<620	U
1,1-dichloropropene	<5	U	<620	U	<620	U
1,2-dichloroethane	<5	U	<620	U	<620	U
1,1,1-trichloroethane	<5	U	<620	U	<620	U
carbon tetrachloride	<5	U	<620	U	<620	U
bromodichloromethane	<5	U	<620	U	<620	U
bromochloromethane	<5	U	<620	U	<620	U
dibromomethane	<5	U	<620	U	<620	U
1,3-dichloropropane	<5	U	<620	U	<620	U
1,2-dibromomethane	<5	U	<620	U	<620	U
1,1,1,2-tetrachloroethane	<5	U	<620	U	<620	U
isopropylbenzene	<5	U	<620	U	<620	U
bromobenzene	<5	U	<620	U	<620	U
1,2,3-trichloropropane	<5	U	<620	U	<620	U
n-propylbenzene	<5	U	<620	U	<620	U
1,2-dichloropropane	<5	U	<620	U	<620	U
trichloroethene	<5	U	<620	U	<620	U
dibromochloromethane	<5	U	<620	U	<620	U
1,1,2-trichloroethane	<5	U	<620	U	<620	U
benzene	<5	U	<620	U	<620	U
cis-1,3-dichloropropene	<5	U	<620	U	<620	U
trans-1,3-dichloropropene	<5	U	<620	U	<620	U
bromoform	<5	U	<620	U	<620	U
U = Concentration of analyte is less than the value given.						
<= Values proceed by this symbol are the detection limits.						

APPENDIX G - TRIAL RUN

MMES LEFPC - VOLATILES						
Trial Thermal Run						
Date Received:	3/5/94		3/5/94		3/5/94	
Date Analyzed:	3/7/94		3/7/94		3/8/94	
Matrix	Water		Soil		Soil	
Description						
Dilution Factor:						
Sample No.	VBLK1		VBLK2		VBLK3	
PCE Sample No.						
Concentration Units	µg/L	Q				
tetrachloroethene	<5	U	<620	U	<620	U
1,1,2,2-tetrachloroethane	<5	U	<620	U	<620	U
toluene	<5	U	190	J	<620	U
chlorobenzene	<5	U	<620	U	<620	U
ethylbenzene	<5	U	<620	U	<620	U
styrene	<5	U	<620	U	<620	U
o-xylene	<5	U	<650	U	<650	U
p/m-xylene	<10	U	140	J	<1200	U
1,3-dichlorobenzene	1	J	<620	U	<620	U
1,4-dichlorobenzene	<5	U	<620	U	<620	U
1,2-dichlorobenzene	<5	U	<620	U	<620	U
2-chlorotoluene	<5	U	<620	U	<620	U
4-chlorotoluene	<5	U	<620	U	<620	U
1,3,5-trimethylbenzene	<5	U	<620	U	<620	U
tert-butylbenzene	<5	U	<620	U	<620	U
1,2,4-trimethylbenzene	<5	U	<620	U	<620	U
sec-butylbenzene	<5	U	<620	U	<620	U
p-isopropyltoluene	<5	U	<620	U	<620	U
n-butylbenzene	<5	U	<620	U	<620	U
1,2-dibromo-3-chloropropane	<5	U	<620	U	<620	U
1,2,4-trichlorobenzene	1	J	150	J	<620	U
hexachlorobutadiene	<5	U	<620	U	<620	U
naphthalene	2	J	340	J	170	J
Number of TICs found:	0		1		0	
(only knowns are listed)						
methane, isocyano-						
propanal, 2-methyl-						
2-propenal, 2-methyl-						
disulfide-, dimethyl-						
furan						
furan, 2-methyl						
2-butanone						
butane			1500	J		
benzene, methylethyl- or isomer						
benzene, methylpropyl- or isomer						
benzene, diethyl- or isomer						
U = Compound analyzed for but not detected.						
J = Compound detected but below the contract required quantitation limit						
(the value given is an estimate).						
< = Values proceed by this symbol are the detection limits.						

APPENDIX G - TRIAL RUN

MMES LEFPC - TCLP VOLATILES						
Trial Thermal Run						
	3/25/94		3/25/94			
Date Received:	3/30/94		3/30/94		3/30/94	
Date Analyzed:	Liquid		Liquid		Liquid	
Matrix	1		1		1	
Description	QC Reagent Blk		QC Reagent Blk		Method	
Dilution Factor:	Scrubber Water		Scrubber Water		Blank	
Sample No.	IT 5299		IT 5299RE		VBLK 1	
PCE Sample No.	3041530RB		3041530RB		BLANK	
Concentration Units	µg/L	Q	µg/L	Q	µg/L	Q
chloromethane	<10	U	<10	U	<10	U
dichlorodifluoromethane	<10	U	<10	U	<10	U
bromomethane	<10	U	<10	U	<10	U
vinyl chloride	<10	U	<10	U	<10	U
chloroethane	<10	U	<10	U	<10	U
methylene chloride	<5	U	4	J	<5	U
trichlorofluoromethane	<5	U	<5	U	<5	U
1,1-dichloroethene	<5	U	<5	U	<5	U
1,1-dichloroethane	<5	U	<5	U	<5	U
cis-1,2-dichloroethene	<5	U	<5	U	<5	U
trans-1,2-dichloroethene	<5	U	<5	U	<5	U
2,2-dichloropropane	22		16		<5	U
chloroform	<5	U	<5	U	<5	U
1,1-dichloropropene	<5	U	<5	U	<5	U
1,2-dichloroethane	<5	U	<5	U	<5	U
1,1,1-trichloroethane	<5	U	<5	U	<5	U
carbon tetrachloride	<5	U	<5	U	<5	U
bromodichloromethane	<5	U	<5	U	<5	U
bromochloromethane	<5	U	<5	U	<5	U
dibromomethane	<5	U	<5	U	<5	U
1,3-dichloropropane	<5	U	<5	U	<5	U
1,2-dibromomethane	<5	U	<5	U	<5	U
1,1,1,2-tetrachloroethane	1	J	<5	U	<5	U
isopropylbenzene	<5	U	<5	U	<5	U
bromobenzene	2	J	2	J	<5	U
1,2,3-trichloropropane	<5	U	<5	U	<5	U
n-propylbenzene	<5	U	<5	U	<5	U
1,2-dichloropropane						
trichloroethene						
dibromochloromethane						
1,1,2-trichloroethane						
benzene						
cis-1,3-dichloropropene						
trans-1,3-dichloropropene						
bromoform						
U = Concentration of analyte is less than the value given.						
< = Values proceed by this symbol are the detection limits.						
J = Compound detected but below the contract required quantitation limit						
(the value given is an estimate).						

**Martin Marietta Energy Systems
Lower East Fork Poplar Creek
350°C Verification Pilot Test 2 Data**

APPENDIX G - 350°C THERMAL RUN

MMES LEFPC METALS														
350°C THERMAL RUN														
No.	Sample No.	Description	Matrix	arsenic	Q	cadmium	Q	mercury	Q	selenium	Q	lead	Q	units
IT 5139	2022030	Treated Soil	Solid	8.9	N	10.8	N	16.8		NA		NA		mg/Kg (ppm)
IT 5139MS	2022030	Treated Soil	Solid	161.5		70		-390		NA		NA		% Recovery
IT 5139MSD	2022030	Treated Soil	Solid	140.2		-110		-1830		NA		NA		% Recovery
		Treated Soil	Solid	14.1		NC		NC		NA		NA		% RPD
IT 5142	2022030	Treated Soil	Solid	8.5		11	N	13.9		0.49	N	109		mg/Kg (ppm)
IT 5142D	2022030	Treated Soil	Solid	7.6		10.5		13		0.45		109		mg/Kg (ppm)
				11		4.7		0.6		6.3		8.3		% RPD
IT 5142MS	2022030	Treated Soil	Solid	190.6	N	40		35		-170		55	N	% Recovery
IT 5142MSD	2022030	Treated Soil	Solid	162.6	N	-140		-240		-620		46.1	N	% Recovery
				15.9		NC		NC		NC		17.6		% RPD
IT 5145	2022030	Cyclone Solids	Solid	9.3	N	12.5		35.4		NA		NA		mg/Kg (ppm)
				185.2	N	-40		-740		NA		NA		% Recovery
				175	N	-60		-10		NA		NA		% Recovery
				5.7		NC		NC		NA		NA		% RPD
IT 5154	2022030D	Scrubber Sludge	Solid	5.8	N	9.4	N	3840	*	NA		NA		mg/Kg (ppm)
IT 5154D	2022030D	Scrubber Sludge	Solid	5.62		7.9		4010		NA		NA		mg/Kg (ppm)
				3.6		17.3		4.3		NA		NA		mg/Kg (ppm)
IT 5154MS	2022030D	Scrubber Sludge	Solid	67.8	N	1861.2	N	NA		NA		NA		% Recovery
IT 5154MSD	2022030D	Scrubber Sludge	Solid	68.8	N	1441.2	N	NA		NA		NA		% Recovery
				1.5		NC		NC		NA		NA		% RPD
Blank	Method Blank	Method Blank	Solid	<0.08	U	<0.03	U	<0.06	U	<0.05	U	<0.07	U	mg/Kg (ppm)
IT 5149	2022030	Scrubber Water	Liquid	22.2		9.1		6170	*	NA		NA		µg/L (ppb)
IT 5149MS	2022030	Scrubber Water	Liquid	92.2		105		83000		NA		NA		% Recovery
IT 5149MSD	2022030	Scrubber Water	Liquid	90.1		90		-90000		NA		NA		% Recovery
				11.2		8		NC		NA		NA		% RPD
NC - Not calculated.														
NA - Not analyzed														

APPENDIX G - 350°C THERMAL RUN

MMES LEFPC - METALS												
350°C Thermal Run												
Date Received:	3/12/94		3/12/94	3/12/94		NA		3/12/94		NA		
Prep. Date:	3/24/94		3/24/94	3/24/94		3/24/94		3/24/94		3/24/94		3/23/94
Analysis Date:	3/24/94		3/24/94	3/24/94		3/24/94		3/24/94		3/24/94		3/24/94
Matrix:	TCLP		TCLP	TCLP		TCLP		TCLP		Method		TOTAL
Description:	Treated		Treated	Treated		EXT. Blank		Treated		Blank		Scrubber
	Soil		Soil	Soil		blank		Soil		Water		Shudge
Sample No.	IT 5142		IT 5142MS	IT 5142MSD		PBT34128		IT 5142D		Method Blank		IT 5154D
PCE Sample No.	2022030		2022030	2022030		EXT. Blk.		2022030		Blank		2022030D
Units	µg/L (ppb)	Q	% Rec.	% Rec.	% RPD	µg/L (ppb)	Q	µg/L (ppb)	Q	% RPD	µg/L (ppb)	Q mg/Kg (ppm)
Arsenic	<21.4	U	94.5	93.7	0.9	<21.4	U	<21.4	U		<21.4	U
Barium	2010		90.3	89.9	0.4	202		2010		0.1	<4.2	U 5.6
Cadmium	131	N	87.4	86.8	0.7	<1.3	U	131		0.2	<1.3	U 7.9
Chromium	27.4		90.2	89.6	0.7	<4.3	U	27.4		24.4	<4.3	U
Lead	<40.4	U	90.9	90.4	0.6	<40.4	U	<40.4			<40.4	U
Mercury	1.6	B	91.5	88.5	3.3	<1.0	U	<1.0	U	200	<0.1	U 4010.0
Selenium	<250	U	95.7	96.5	0.8	<250	U	<250			<250	U
Silver	<2.7	U	91.3	91	0.3	<2.7	U	<2.7			<2.7	U
Date Received:	3/12/94		3/12/94	3/12/94		3/12/94		3/12/94		3/12/94		3/12/94
Prep. Date:	3/23/94		3/23/94	3/23/94		3/23/94		3/23/94		3/23/94		3/23/94
Analysis Date:	3/24/94		3/24/94	3/24/94		3/24/94		3/24/94		3/24/94		3/24/94
Matrix:	TOTAL		TOTAL	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL
Description:	Treated		Treated	Treated		Treated		Treated		Treated		Treated
	Soil		Soil	Soil		Soil		Soil		Soil		Soil
Sample No.	IT 5139		IT 5139MS	IT 5139MSD		IT 5142		IT 5142D		IT 5142MS		IT 5142MSD
PCE Sample No.	2022030		2022030	2022030		2022030		2022030		2022030		2022030
Units	mg/Kg (ppm)	Q	% Rec.	% Rec.	% RPD	mg/Kg (ppm)	Q	mg/Kg (ppm)	Q	% RPD	% Rec.	% Rec. % RPD
arsenic	8.9	N	161.5	140.2	14.1	8.5		7.6			190.6	162.6 15.9
cadmium	10.8	N	70	-110	NC	11	N	10.5		11	40.0	-140 NC
mercury	16.8		-390	-1830	NC	13.9		13.0		0.6	-170	-620 NC
selenium	NA		NA	NA	NA	0.49	N			6.3	55.0	46.1 17.6
lead	NA		NA	NA	NA	NA		109		4.7	35.0	-240 NC
U = The analyte was analyzed but not detected.												
N = Spiked sample recovery is not within control limits.												
B = The reported value is less than the CRDL but greater than the IDL.												
NA = Not analyzed.												
NC = Not Calculated												
< = Values preceded by this symbol are the detection limits.												

APPENDIX G - 350°C THERMAL RUN

[illegible]

APPENDIX G - 350°C THERMAL RUN

MMES LEFPC - METALS					
350°C Thermal Run					
Date Received:	3/12/94		3/12/94	3/12/94	
Prep. Date:	3/23/94		3/23/94	3/23/94	
Analysis Date:	3/24/94		3/24/94	3/24/94	
Matrix:	TOTAL		TOTAL	TOTAL	
Description:	Cyclone		Cyclone	Cyclone	
	Solids		Solids	Solids	
Sample No.	IT 5145		IT 5145MS	IT 5145MSD	
PCE Sample No.	2022030		2022030	2022030	
Units	mg/Kg (ppm)	Q	% Rec.	% Rec.	% RPD
arsenic	9.3	N	185.2	175	5.7
cadmium	12.5	N	-40.0	-60	NC
mercury	35.4		NA	NA	NA
selenium	NA		-740	-10	NC
Date Received:	3/15/94		3/15/94	3/15/94	
Prep. Date:	3/23/94		3/23/94	3/23/94	
Analysis Date:	3/24/94		3/24/94	3/24/94	
Matrix:	TOTAL		TOTAL	TOTAL	
Description:	Scrubber		Scrubber	Scrubber	
	Sludge		Sludge	Sludge	
Sample No.	IT 5154		IT 5154MS	IT 5154MSD	
PCE Sample No.	2022030D		2022030D	2022030D	
Units	mg/Kg (ppm)	Q	% Rec.	% Rec.	% RPD
arsenic	5.8	N	67.8	68.8	1.5
cadmium	9.4	N	1861.2	1441.2	NC
mercury	3840	*	NA	NA	NA
selenium	NA		NA	NA	NC
N = Spiked sample recovery is not within control limits.					
* = Duplicate analysis is not within control limits.					
NA = Not analyzed.					
NC = Not Calculated					
< = Values preceded by this symbol are the detection limits.					

APPENDIX G - 350°C THERMAL RUN

[illegible]

APPENDIX G - 350°C THERMAL RUN

MMES LEFPC - TOTAL URANIUM								
350°C Thermal Run								
Sample	PCE		Total		2-Sigma	Receipt	Prep.	Analysis
No.	Sample No.	Description	Uranium	Units	Error	Date	Date	Date
IT 5153	2042030	Scrubber Water	127	pCi/L	19.9	3/16/94	3/30/94	4/5/94
IT 5153D	2042030	Scrubber Water	131	pCi/L	23	3/16/94	3/30/94	4/5/94
IT 5191	Impingers 1,2,3	Post Scrubber Impingers	0.371	pCi/L	0.0394	3/16/94	3/30/94	4/5/94
IT 5197	Impingers 1,2,3	QC Reagent Blank/MS Multi-Metals Train	0.52	pCi/L	0.05	3/16/94	3/30/94	4/5/94
Blank	Blank	Method Blank	0.392	pCi/L	0.0418	NA	3/30/94	4/5/94
IT 5143	2022030	Treated Soil	17	pCi/g	1.68	3/12/94	3/28/94	4/5/94
IT 5143D	2022030	Treated Soil	14.7	pCi/g	1.44	3/12/94	3/28/94	4/5/94
IT 5145	2032030	Cyclone Solids	26.2	pCi/g	2.58	3/12/94	3/28/94	4/5/94
IT 5145D	2032030	Cyclone Solids	26.6	pCi/g	2.61	3/12/94	3/28/94	4/5/94
IT 5158	2042030D	Scrubber Sludge	15.8	pCi/g	1.56	3/16/94	3/28/94	4/5/94
IT 5158D	2042030D	Scrubber Sludge	16.4	pCi/g	1.61	3/16/94	3/28/94	4/5/94
Blank	Blank	Method Blank	0.375	pCi/g	0.00037	NA	3/28/94	4/5/94
IT 5183	Filter	Multi-Metals Train	2.19	pCi/Filter	0.11	3/16/94	3/24/94	3/29/94
IT 5183	Filter	Multi-Metals Train	87.6	pCi/L	12.2	3/16/94	3/24/94	3/29/94
IT 5189	Filter	Multi-Metals Train	0.03	pCi/Filter	0.0006	3/16/94	3/24/94	3/29/94
IT 5189	Filter	Multi-Metals Train	1.24	pCi/L	0.13	3/16/94	3/24/94	3/29/94
Blank	Filter Blank	Method Blank	0.53	pCi/L	0.06	NA	3/24/94	3/29/94
IT 5191	Impingers 1,2,3	Multi-Metals Train	0.37	pCi/L	0.04	3/16/94	3/30/94	4/5/94
IT 5195 & IT 5196	Filter Blank	QC Reagent Blk/Multi-Metals Train	0.02	pCi/Filter	0.0004	3/16/94	3/24/94	3/29/94
IT 5195 & IT 5196	Rinse Blk Nitric	QC Reagent Blk/Multi-Metals Train	0.72	pCi/L	0.08	3/16/94	3/24/94	3/29/94
IT 5185	Impingers 1,2,3	Multi-Metals Train	113	pCi/L	16	3/16/94	4/29/94	4/29/94
Blank	Water Blank	Water Blank	<0.707	pCi/L		NA	4/29/94	4/29/94
IT 5161	2052030	HEPA Filter	<3.55	pCi/g		3/12/94	3/30/94	3/31/94
IT 5161D	2052030	HEPA Filter	<3.81	pCi/g		3/12/94	3/30/94	3/31/94
Blank	Filter Blank	Method Blank	<1.5	pCi/g		NA	3/30/94	3/31/94
NA = Not applicable.								

APPENDIX G - 350° THERMAL RUN

[illegible]

APPENDIX G - 350° THERMAL RUN

MMES LEFPC - VOLATILES													
350° C Thermal Run													
Date Received:	3/15/94		3/15/94		3/15/94		3/12/94		3/12/94		NA		NA
Date Analyzed:	3/24/94		3/24/94		3/24/94		3/24/94		3/24/94		3/24/94		3/24/94
Matrix	Solid		Solid		Water		Solid		Solid		Soil		Water
Dilution Factor:	20		20		1		1		1		1		1
Description	Carbon Bed		Carbon Bed		QC Trip		QC Reagent Blk/		QC Reagent Blk/		Method		Method
					Blank		Carbon Bed		Carbon Bed		Blank		Blank
Sample No.	IT 5181		IT 5181RE		IT 5213		IT 5182		IT 5182RE		VBK 1		VBK 2
PCE Sample No.	2062030		2062030		QC Blank		2062030RB		2062030RB		BLANK		BLANK
Concentration Units	µg/Kg	Q	µg/Kg	Q	µg/L	Q	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q	µg/L
dichlorodifluoromethane	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
chloromethane	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
bromomethane	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
vinyl chloride	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
chloroethane	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
methylene chloride	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
trichlorofluoromethane	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
1,1-dichloroethene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,1-dichloroethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
trans-1,2-dichloroethene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
cis-1,2-dichloroethene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
chloroform	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
2,2-dichloropropane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
bromochloromethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,1,1-trichloroethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
carbon tetrachloride	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,1-dichloropropene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
bromodichloromethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,2-dichloropropane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
trichloroethene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,1,2-trichloroethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
benzene	97000		109000		<5	U	<620	U	<620	U	<620	U	<5
1,2-dichloroethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
toluene	66000		67000		<5	U	<620	U	<620	U	<620	U	<5
1,2-dibromoethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
tetrachloroethene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,3-dichloropropane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
dibromochloromethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
chlorobenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,1,1,2-tetrachloroethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
ethylbenzene	8500	J	120000	J	<5	U	<620	U	<620	U	<620	U	<5
styrene	5600	J	9400	J	<5	U	<620	U	<620	U	<620	U	<5
bromoform	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
xylene (total)	10800	J	17000	J	<5	U	<620	U	<620	U	<620	U	<5
U = Compound analyzed for but not detected.													
J = Compound detected but below the contract required quantitation limit (the value given is an estimate)													
B = Compound was found in the method blank.													
< = Values preceded by this symbol are the detection limits.													

APPENDIX G - 350° THERMAL RUN

MMES LEFPC - VOLATILES (continued)													
350° C Thermal Run													
Date Received:	3/15/94		3/15/94		3/15/94		3/12/94		3/12/94		NA		NA
Date Analyzed:	3/24/94		3/24/94		3/24/94		3/24/94		3/24/94		3/24/94		3/24/94
Matrix	Solid		Solid		Water		Solid		Solid		Soil		Water
Dilution Factor:	20		20		1		1		1		1		1
Description	Carbon Bed		Carbon Bed		QC Trip		QC Reagent Blk		QC Reagent Blk		Method		Method
					Blank		Carbon Bed		Carbon Bed		Blank		Blank
Sample No.	IT 5181		IT 5181RE		IT 5213		IT 5182		IT 5182RE		VLBK 1		VLBK 2
PCE Sample No.	2062030		2062030		QC Blank		2062030RB		2062030RB		BLANK		BLANK
Concentration Units	µg/Kg	Q	µg/Kg	Q	µg/L	Q	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q	µg/L
isopropylbenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
bromobenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,1,2,2-tetrachloroethane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,2,3-trichloropropane	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
benzene, propyl-, or isomer	<12000	U	3400	J	<5	U	<620	U	<620	U	<620	U	<5
2-chlorotoluene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,3,5-trimethylbenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
4-chlorotoluene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
tert-butylbenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,2,4-trimethylbenzene	<12000	U	2600	J	<5	U	<620	U	<620	U	<620	U	<5
sec-butylbenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,3-dichlorobenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
4-isopropyltoluene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,4-dichlorobenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
n-butylbenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,2-dichlorobenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,2-dibromo-3-chloropropane	<25000	U	<25000	U	<10	U	<1200	U	<1200	U	<1200	U	<10
1,2,4-trichlorobenzene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
hexachlorobutadiene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
naphthalene	<12000	U	<12000	U	<5	U	<620	U	<620	U	<620	U	<5
1,2,3-trichlorobenzene	<12000	U	<12000	U	<5	U	140	J	<620	U	<620	U	<5
Number of TIC's found:	10		10		0		0		0				
Furan	280000	J	320000	J	ND		ND		ND				
Acetone	460000	J	36000	J	ND		ND		ND				
2-methyl-furan	160000	J	24000	J	ND		ND		ND				
dimethyl disulfide	160000	J	19000	J	ND		ND		ND				
U = Compound analyzed for but not detected.													
J = Compound detected but below the contract required quantitation limit (the value given is an estimate)													
ND = Not detected.													
< = Values proceed by this symbol are the detection limits.													

350°C Thermal Run

[illegible]

LEFPC - TCLP SEMIVOLATILES

[illegible]

APPENDIX E - 350°C THERMAL RUN

LEFPC - SEMIVOLATILES								
350°C Thermal Run								
Date Received:	3/15/94		NA		3/12/94		3/12/94	
Date Prep:	3/17/94		4/6/94		3/21/94		3/21/94	
Date Analyzed:	4/1/94		4/7/94		3/24/94		3/24/94	
Description:	Scrubber				Treated		Cyclone	
	Water				Soil		Solids	
Matrix:	Water				Soil		Soil	
Dilution Factor:	25/500		1		1		1	
Sample No.	IT 5151		SSPK03		IT 5141		IT 5145	
PCE Sample No.	2042030				2022030		2032030	
Concentration Units:	µg/L	Q	µg/L	Q	µg/Kg	Q	µg/Kg	Q
phenol	14000	D	36		34	J	100	J
bis(2-chloroethyl)ether	<250	U	<10	U	<330	U	<330	U
2-chlorophenol	<250	U	70		<330	U	<330	U
1,3-dichlorobenzene	<250	U	<10	U	<330	U	<330	U
1,4-dichlorobenzene	<250	U	34		<330	U	<330	U
benzyl alcohol	<500	U	<20	U	<660	U	<660	U
1,2-dichlorobenzene	<250	U	<10	U	<330	U	<330	U
2-methylphenol	<250	U	<10	U	<330	U	<330	U
bis(2-chloroisopropyl)ether	<250	U	<10	U	<330	U	<330	U
4-methylphenol	3400	DJ	<10	U	<330	U	<330	U
N-nitroso-di-n-propylamine	<250	U	40		<330	U	<330	U
hexachloroethane	<250	U	<10	U	<330	U	<330	U
nitrobenzene	<250	U	<10	U	<330	U	<330	U
isophorone	<250	U	<10	U	<330	U	<330	U
2-nitrophenol	<250	U	<10	U	<330	U	<330	U
2,4-dimethylphenol	830		<10	U	<330	U	<330	U
benzoic acid	<1200	U	<50	U	89	J	1200	J
bis(2-chloroethoxy) methane	<250	U	<10	U	<330	U	<330	U
2,4-dichlorophenol	<250	U	<10	U	<330	U	<330	U
1,2,4-trichlorobenzene	<250	U	35		<330	U	<330	U
naphthalene	260		<10	U	<330	U	58	J
4-chloroaniline	<500	U	<20	U	<660	U	<660	U
hexachlorobutadiene	<250	U	<10	U	<330	U	<330	U
4-chloro-3-methylphenol	<500	U	75		<660	U	<660	U
2-methylnaphthalene	85	J	<10	U	<330	U	<330	U
hexachlorocyclopentadiene	<250	U	<10	U	<330	U	<330	U
2,4,6-trichlorophenol	<250	U	<10	U	<330	U	<330	U
2,4,5-trichlorophenol	<250	U	<10	U	<330	U	<330	U
2-chloronaphthalene	<250	U	<10	U	<330	U	<330	U
2-nitroaniline	<1200	U	<50	U	<1600	U	<1600	U
dimethyl phthalate	<250	U	<10	U	<330	U	<330	U
acenaphthylene	<250	U	<10	U	<330	U	<330	U
2,6-dinitrotoluene	<250	U	<10	U	<330	U	<330	U
3-nitroaniline	<1200	U	<50	U	<1600	U	<1600	U
acenaphthene	<250	U	36		<330	U	<330	U
2,4-dinitrophenol	<1200	U	<50	U	<1600	U	<1600	U

APPENDIX E - 350°C THERMAL RUN

LEFPC - SEMIVOLATILES (continued)								
350°C Thermal Run								
Date Received:	3/15/94		NA		3/12/94		3/12/94	
Date Prep:	3/17/94		4/6/94		3/21/94		3/21/94	
Date Analyzed:	4/1/94		4/7/94		3/24/94		3/24/94	
Description:	Scrubber				Treated		Cyclone	
	Water				Soil		Solids	
Matrix:	Water				Soil		Soil	
Dilution Factor:	25/500		1		1		1	
Sample No.	IT 5151		SSPK03		IT 5141		IT 5145	
PCE Sample No.	2042030				2022030		2032030	
Concentration Units:	µg/L	Q	µg/L	Q	µg/Kg	Q	µg/Kg	Q
4-nitrophenol	<1200	U	32	J	<1600	U	<1600	U
dibenzofuran	<250	U	<10	U	<330	U	<330	U
2,4-dinitrotoluene	<250	U	36		<330	U	<330	U
diethylphthalate	<250	U	<10	U	<330	U	<330	U
4-chlorophenyl-phenylether	<250	U	<10	U	<330	U	<330	U
fluorene	<250	U	<10	U	<330	U	<330	U
4-nitroaniline	<1200	U	<50	U	<1600	U	<1600	U
4,6-dinitro-2-methylphenol	<1200	U	<50	U	<1600	U	<1600	U
N-nitrosodiphenylamine (1)	<250	U	<10	U	<330	U	<330	U
4-bromophenyl-phenylether	<250	U	<10	U	<330	U	<330	U
hexachlorobenzene	<250	U	<10	U	<330	U	<330	U
pentachlorophenol	<1200	U	76		<1600	U	<1600	U
phenanthrene	31	J	<10	U	<330	U	53	J
anthracene	<250	U	<10	U	<330	U	<330	U
di-n-butylphthalate	<250	U	<10	U	<330	U	<330	U
fluoranthene	<250	U	<10	U	<330	U	53	J
pyrene	<250	U	37		<330	U	<330	U
butylbenzylphthalate	<250	U	<10	U	<330	U	<330	U
3,3'-dichlorobenzidine	<500	U	<20	U	<660	U	<660	U
benzo(a)anthracene	<250	U	<10	U	<330	U	<330	U
chrysene	<250	U	<10	U	<330	U	<330	U
bis(2-ethylhexyl)phthalate	<250	U	<10	U	<330	U	76	J
di-n-octyl phthalate	<250	U	<10	U	<330	U	<330	U
benzo(b)fluoranthene	<250	U	<10	U	<330	U	<330	U
benzo(k)fluoranthene	<250	U	<10	U	<330	U	<330	U
benzo(a)pyrene	<250	U	<10	U	<330	U	<330	U
indeno(1,2,3-cd)pyrene	<250	U	<10	U	<330	U	<330	U
dibenz(a,h)anthracene	<250	U	<10	U	<330	U	<330	U
benzo(g,h,i)perylene	<250	U	<10	U	<330	U	<330	U
No. of TICs found:	21				6		15	
Identified TICs (unknowns not listed):								
Pyridine	12000	J			290	J	1000	J
2-furancarboxaldehyde, 5-met	8300	J			NA		NA	
Benzaldehyde	5700	J			210	J	180	J
Ethanone, 1-phenyl-	3200	J			NA		86	J
1H-Indole-1,3(wH)-dione	NA				250	J	NA	
(1) - Cannot be separated from diphenylamine.								
U = Compound analyzed but not detected.								
D = Surrogates diluted out.								

APPENDIX E - 350°C THERMAL RUN

LEFPC - SEMIVOLATILES						
350° C Thermal Run						
Date Received:	3/15/94		3/15/94		3/15/94	
Date Prep:	3/21/94		3/21/94		3/17/94	
Date Analyzed:	3/31/94		4/1/94		3/22/94	
Description:	Scrubber		Scrubber		QC Reagent	
	Sludge		Sludge		Scrubber Blnk	
Matrix:	Soil		Soil		Water	
Dilution Factor:	5/10		5/10		1	
Sample No.	IT-5156		IT-5156DUPDL		IT-5256	
PCE Sample No.	2042030D		2042030DUPDL		2042300RB	
Concentration Units:	µg/Kg	Q	µg/Kg	Q	µg/L	Q
phenol	13000		13000	D	22	
bis(2-chloroethyl)ether	<1600	U	<1600	U	<10	U
2-chlorophenol	<1600	U	<1600	U	<10	U
1,3-dichlorobenzene	<1600	U	<1600	U	<10	U
1,4-dichlorobenzene	<1600	U	<1600	U	<10	U
benzyl alcohol	<3300	U	<3300	U	<20	U
1,2-dichlorobenzene	<1600	U	<1600	U	<10	U
2-methylphenol	1200	J	1300	J	3	J
bis(2-chloroisopropyl)ether	<1600	U	<1600	U	<10	U
4-methylphenol	3200		3600		8	J
N-nitroso-di-n-propylamine	<1600	U	<1600	U	<10	U
hexachloroethane	<1600	U	<1600	U	<10	U
nitrobenzene	<1600	U	<1600	U	<10	U
isophorone	<1600	U	<1600	U	<10	U
2-nitrophenol	<1600	U	<1600	U	<10	U
2,4-dimethylphenol	<1600	U	<1600	U	4	J
benzoic acid	<8000	U	<8000	U	<50	U
bis(2-chloroethoxy) methane	<1600	U	<1600	U	<10	U
2,4-dichlorophenol	<1600	U	<1600	U	<10	U
1,2,4-trichlorobenzene	<1600	U	<1600	U	<10	U
naphthalene	7600		9000		8	J
4-chloroaniline	<3300	U	<3300	U	<20	U
hexachlorobutadiene	<1600	U	<1600	U	<10	U
4-chloro-3-methylphenol	<3300	U	<3300	U	<20	U
2-methylnaphthalene	7700		9100		4	J
hexachlorocyclopentadiene	<1600	U	<1600	U	<10	U
2,4,6-trichlorophenol	<1600	U	<1600	U	<10	U
2,4,5-trichlorophenol	<1600	U	<1600	U	<10	U
2-chloronaphthalene	<1600	U	<1600	U	<10	U
2-nitroaniline	<8000	U	<8000	U	<50	U
dimethyl phthalate	<1600	U	<1600	U	<10	U
acenaphthylene	1900		2200		2	J
2,6-dinitrotoluene	<1600	U	<1600	U	<10	U
3-nitroaniline	<8000	U	<8000	U	<50	U
acenaphthene	<1600	U	<1600	U	<10	U
2,4-dinitrophenol	<8000	U	<8000	U	<50	U

APPENDIX E - 350°C THERMAL RUN

LEFPC - SEMIVOLATILES (continued)						
350°C Thermal Run						
Date Received:	3/15/94		3/15/94		3/15/94	
Date Prep:	3/21/94		3/21/94		3/17/94	
Date Analyzed:	3/31/94		4/1/94		3/22/94	
Description:	Scrubber		Scrubber		QC Reagent	
	Sludge		Sludge		Scrubber Blnk	
Matrix:	Soil		Soil		Water	
Dilution Factor:	5/10		5/10		1	
Sample No.	IT-5156		IT-5156DUPDL		IT-5256	
PCE Sample No.	2042030D		2042030DUPDL		2042300RB	
Concentration Units:	µg/Kg	Q	µg/Kg	Q	µg/L	Q
4-nitrophenol	890	J	<8000	U	<50	U
dibenzofuran	3200		3800		2	J
2,4-dinitrotoluene	<1600	U	<1600	U	<10	U
diethylphthalate	<1600	U	<1600	U	<10	U
4-chlorophenyl-phenylether	<1600	U	<1600	U	<10	U
fluorene	1400	J	1200	DJ	2	J
4-nitroaniline	<8000	U	<8000	U	<50	U
4,6-dinitro-2-methylphenol	<8000	U	<8000	U	<50	U
N-nitrosodiphenylamine (1)	<1600	U	<1600	U	<10	U
4-bromophenyl-phenylether	<1600	U	<1600	U	<10	U
hexachlorobenzene	<1600	U	<1600	U	<10	U
pentachlorophenol	<8000	U	<8000	U	<50	U
phenanthrene	15000		18000	D	14	
anthracene	3800		4500		4	J
di-n-butylphthalate	<1600	U	<1600	U	<10	U
fluoranthene	12000		12000		6	J
pyrene	8400		9000		3	J
butylbenzylphthalate	<1600	U	<1600	U	<10	U
3,3'-dichlorobenzidine	<3300	U	<3300	U	<20	U
benzo(a)anthracene	2800		3500		<10	U
chrysene	3800		4600		<10	U
bis(2-ethylhexyl)phthalate	<1600	U	<1600	U	<10	U
di-n-octyl phthalate	<1600	U	<1600	U	<10	U
benzo(b)fluoranthene	2700		3300		<10	U
benzo(k)fluoranthene	<1600	U	<1600	U	<10	U
benzo(a)pyrene	<1600	U	1900		<10	U
indeno(1,2,3-cd)pyrene	700	J	860	J	<10	U
dibenz(a,h)anthracene	210	J	250	J	<10	U
benzo(g,h,i)perylene	640	J	810	J	<10	U
No. of TICs found:	23		21		23	
Identified TICs (unknowns not listed):						
Pyridine	11000	J	11000	J	14	J
2-furancarboxaldehyde, 5-met	NA		8700	J	6	J
Benzaldehyde	2800	J	8700	J	NA	
Ethanone, 1-phenyl-	2600	J	NA		NA	
1H-Isoindole-1,3(wH)-dione	NA		NA		NA	
Benzaldehyde, 4-hydroxy-3-mc	NA		NA		NA	
Tetradecane	1500	J	NA		NA	
Naphthalene, 1-methyl-	23		2300	J	NA	

350°C Thermal Run

350SVA.XLS

LEFPC - SEMIVOLATILES (continued)[illegible]

APPENDIX E - 350°C THERMAL RUN

[illegible]

APPENDIX G - 350°C THERMAL RUN

LEFPC - TCLP PESTICIDES												
350° Test Run												
Date Received:	NA		NA		NA		NA		Date Received:	NA	NA	
Date Prep:	3/23/94		3/23/94		3/23/94		3/23/94		Date Prep:	3/23/94	3/23/94	
Date Analyzed:	3/24/94		3/24/94		3/24/94		3/24/94		Date Analyzed:	3/24/94	3/24/94	
Matrix:	TCLP		TCLP		TCLP		TCLP		Matrix:	TCLP	TCLP	
Dilution Factor:	1		1		1		1		Dilution Factor:	1	1	
Sample No.	IT-5142		IT-5142DUP		PBLK 1		PBLK 2		Sample No.	IT-5142MS	IT-5142MSD	
PCE Sample No.	2022030		2022030		Method Blank		Method Blank					
Concentration Units:	µg/L (ppb)	Q	µg/L (ppb)	Q	µg/L (ppb)	Q	µg/L (ppb)	Q	Concentration Units:	% Rec.	% Rec.	%RPD
gamma - BHC	<0.20	U	<0.20	U	<0.20	U	<0.20	U	gamma - BHC	100	121	19
Heptachlor	<0.15	U	<0.15	U	<0.15	U	<0.15	U	Heptachlor	104	123 *	17
Heptachlor Epoxide	<4.2	U	<4.2	U	<4.2	U	<4.2	U	Heptachlor Epoxide	95	102	7
Endrin	<0.30	U	<0.30	U	<0.30	U	<0.30	U	Endrin	109	119	9
Methoxychlor	<8.8	U	<8.8	U	<8.8	U	<8.8	U	Methoxychlor	157	171	8
Chlordane	<0.70	U	<0.70	U	<0.70	U	<0.70	U				
Toxaphene	<12	U	<12	U	<12	U	<12	U	RPD: 0 out of 5 outside limits.			
									Spike Recovery: 1 out of 10 outside limits.			
U = Concentration of analyte is less than the value given.									* = Values outside of QC limits			
< = Values proceed by this symbol are the detection limits.												

APPENDIX G - 350°C THERMAL RUN

LEFPC - PCBs											
350°C Thermal Run											
Date Received:	NA		NA		NA		NA		NA		NA
Date Prep:	3/22/94		3/22/94		3/17/94		4/6/94		3/22/94		3/22/94
Date Analyzed:	3/24/94		3/25/94		3/21/94		4/11/94		3/25/94		3/25/94
Description:	Treated		Cyclone		Scrubber		Scrubber		Scrubber		Scrubber
	Soil		Solids		Water		Water		Sludge		Sludge
Matrix:	Soil		Solids		Liquid		Liquid		Solids		Solids
Dilution Factor:	1		1		1		1		1/100		1/100
Sample No.	IT-5140		IT-5145		IT-5150		IT-5150D		IT-5155		IT-5155DUP
PCE Sample No.	2022030		2032030		2042030		2042030		2042030D		2042030D
Concentration Units:	µg/kg (ppb)	Q	µg/kg (ppb)	Q	µg/L (ppb)	Q	µg/L (ppb)	Q	µg/kg (ppb)	Q	µg/kg (ppb)
Arochlor - 1221	<33	U	<33	U	<1	U	<1	U	<33	U	<33
Arochlor - 1232	<33	U	<33	U	<1	U	<1	U	<33	U	<33
Arochlor - 1242 / 1016	<33	U	48		<1	U	<1	U	<33	U	<33
Arochlor - 1248	<33	U	<33	U	5.5		4.4		21000	D	34000
Arochlor - 1254	<33	U	<33	U	3.4		3.1		26000	D	26000
Arochlor - 1260	<33	U	100		2.0		<1	U	13000	D	15000
U = Compound analyzed but not detected.											
D = Surrogates diluted out.											
< = Values proceeded by this symbol are the detection limits.											
Date Received:	NA		NA		NA						
Date Prep:	3/17/94		3/22/94		4/6/94						
Date Analyzed:	3/21/94		3/24/94		4/11/94						
Description:	Method		Method		Method						
	Blank		Blank		Blank						
Matrix:	Liquid		Solids		Liquid						
Dilution Factor:	1		1		1						
Sample No.	Blk 1		Blk 2		Blk 3						
PCE Sample No.	Method Blank		Method Blank		Method Blank						
Concentration Units:	µg/L (ppb)	Q	µg/kg (ppb)	Q	µg/L (ppb)	Q					
Arochlor - 1221	<1	U	<33	U	<1	U					
Arochlor - 1232	<1	U	<33	U	<1	U					
Arochlor - 1242 / 1016	<1	U	<33	U	<1	U					
Arochlor - 1248	<1	U	<33	U	<1	U					
Arochlor - 1254	<1	U	<33	U	<1	U					
Arochlor - 1260	<1	U	<33	U	<1	U					
U = Compound analyzed but not detected.											
D = Surrogates diluted out.											
< = Values proceeded by this symbol are the detection limits.											

APPENDIX G - 350°C THERMAL RUN

LEFPC - PCBs QC						
350°C Thermal Run						
Date Received:	NA	NA		NA	NA	
Date Prep:	3/22/94	3/22/94		3/22/94	3/22/94	
Date Analyzed:	3/24/94	3/24/94		3/25/94	3/25/94	
Description	Treated	Treated		Cyclone	Cyclone	
	Soil	Soil		Solids	Solids	
Matrix:	Soil	Soil		Soil	Soil	
Dilution Factor:	1 LOW	1 LOW		1 LOW	1 LOW	
Sample No.	IT-5140MS	IT-5140MSD		IT-5145MS	IT-5145MSD	
PCE Sample No.	2022030	2022030		2032030	2032030	
Concentration Units:	% Rec.	% Rec.	%RPD	% Rec.	% Rec.	%RPD
Arochlor - 1221	0	0		0	0	
Arochlor - 1232	0	0		0	0	
Arochlor - 1242 / 1016	0	0		0	0	
Arochlor - 1248	0	0		0	0	
Arochlor - 1254	106	108	2	170 *	160 *	8
Arochlor - 1260	0	0		0	0	
				* = Values outside of QC limits		
Spike Rec: 0 out of 2 outside limits.				Spike Rec: 2 out of 2 outside limits.		
Date Received:	NA	NA		NA	NA	
Date Prep:	3/17/94	3/17/94		3/22/94	3/22/94	
Date Analyzed:	3/21/94	3/21/94		3/25/94	3/25/94	
Description:	Scrubber	Scrubber		Scrubber	Scrubber	
	Water	Water		Sludge	Sludge	
Matrix:	Liquid	Liquid		Solids	Solids	
Dilution Factor:	1 LOW	1 LOW		1/100 LOW	1/100 LOW	
Sample No.	IT-5150MS	IT-5150MSD		IT-5155MS	IT-5155MSD	
PCE Sample No.	2042030	2042030		2042030D	2042030D	
Concentration Units:	% Rec.	% Rec.	%RPD	% Rec.	% Rec.	% Rec.
Arochlor - 1221	0	0		0	0	
Arochlor - 1232	0	0		0	0	
Arochlor - 1242 / 1016	0	0		0	0	
Arochlor - 1248	0	0		0	0	
Arochlor - 1254	15 *	18 *	18	0 *	2385 *	200
Arochlor - 1260	0	0		0	0	
				* = Values outside of QC limits		
Spike Rec: 2 out of 2 outside limits				Spike Rec: 2 out of 2 outside limits		

APPENDIX G - 350°C THERMAL RUN

MMES LEFPC - TCLP HERBICIDE							
350°C Thermal Run							
Date Received:	3/10/94		3/10/94	3/10/94		NA	
Date Extracted:	3/23/94		3/23/94	3/23/94		3/23/94	
Date Analyzed:	3/25/94		3/25/94	3/25/94		3/25/94	
Description	Treated		Treated	Treated		Method	
	Soil		Soil	Soil		Blank	
Matrix	TCLP		TCLP	TCLP		TCLP	
Dilution Factor:	1		1	1		1	
Sample No.	IT 5142		IT 5142MS	IT 5142MSD		HBLK	
PCE Sample No.	2022030		2022030	2022030		BLANK	
Concentration Units	µg/L	Q	% Rec	% Rec	% RPD	µg/L	Q
2,4-D	<120	U	85	92	7	<120	U
2,4,5-TP (Silvex)	<17	U	114	119	4	<17	U
< = Values proceed by this symbol are the detection limits.							
U = Concentration of analyte is less than the value given.							

APPENDIX G - 350°C THERMAL RUN

MMES LEFPC - DIOXIN/FURAN							
350°C Thermal Run							
Date Received:	3/12/94		3/16/94	3/16/94		NA	
Date Analyzed:	3/18/94		3/21/94	3/21/94		3/21/94	
Description	Treated Soil		Treated Soil	Treated Soil		Method Blank	
Sample No.	IT 5253		IT 5253MS	IT 5253MSD		Blank	
PCE Sample No.	2022030		2022030	2022030		Method Blank	
Concentration Units	ng/g	Q	% Rec	% Rec	% RPD	ng/g	Q
Total-TCDD	0.18	U	104	104	0	0.32	U
Total-PeCDD	0.25	U	100	104	-3.9	0.18	U
Total-HxCDD	0.29	U	96	100	-4.1	0.066	U
Total-HpCDD	0.58	J	94.4	90.4	3.8	0.053	U
OCDD	0.91	J	83.6	79.6	3.4	0.095	U
Total-TCDF	0.094	U	100	100	0	0.059	U
Total-PeCDF	0.17	U	100	100	0	0.1	U
Total-HxCDF	0.15	U	100	96	4.1	0.13	U
Total-HpCDF	0.71	U	100	104	-3.9	0.33	U
OCDF	0.23	U	92	112	-19.6	0.11	U
U = Concentration of analyte is less than the value given.							
< = Values proceed by this symbol are the detection limits.							
J = Estimate. only. Below instrument calibration range.							
NA = Not Applicable.							

APPENDIX G - 350°C THERMAL RUN

LEFPC - GENERAL CHEMISTRY					
350°C Test Run					
Anal Date: 3/22/94					
	Sample No.		Sample No.		Sample No.
	2042030		QCBLK34308-1		QCBLK34308-1
	µg/l (ppb)	Q	µg/l (ppb)	Q	
Description	Scrubber Water		Method Blank		Method Blank
TOC	429		<1.0	U	NA
Sulfate	28.4		NA		<1.0
					U
U = The analyte was analyzed but not detected.					

**Martin Marietta Energy Systems
Lower East Fork Poplar Creek
600° Verification Pilot Test 3 Data**

APPENDIX G - 600°C THERMAL RUN

MMES LEPC - TOTAL URANIUM

600°C Thermal Run

Sample No.	Sample No.	Description	Uranium	Units	2-Sigma	Receipt	Prep.	Analysis
	PCE	Total			Error	Date	Date	Date
IT 5306	3051530	HPA filter	<49.2	pCi/g		3/25/94	4/18/94	4/19/94
BLANK	BLANK	prep blank	<501	pCi/g		NA	4/18/94	4/21/94
IT 5287	3021530	treated soil	28	pCi/g	2.7	3/25/94	4/13/94	4/15/94
IT 5287D	3021530D	treated soil	24.3	pCi/g	2.4	3/25/94	4/13/94	4/15/94
IT 5287MS	3021530MS	treated soil	282	% Rec		3/25/94	4/13/94	4/15/94
IT 5287MSD	3021530MSD	treated soil	237	% Rec		3/25/94	4/13/94	4/15/94
IT 5291	3031530	cyclone solids	28.8	pCi/g	2.8	3/25/94	4/13/94	4/15/94
IT 5291D	3031530D	cyclone solids	26.7	pCi/g	2.6	3/25/94	4/13/94	4/15/94
IT 5292	3041530	scrubber water	137	pCi/L	23	3/25/94	4/21/94	4/21/94
IT 5292D	3041530D	scrubber water	140	pCi/L	23	3/25/94	4/21/94	4/21/94
IT 5300	3041530	scrubber sludge	34.4	pCi/g	3.4	3/25/94	4/13/94	4/15/94
IT 5300D	3041530D	scrubber sludge	27.8	pCi/g	2.7	3/25/94	4/13/94	4/15/94
IT 5300MS	3041530MS	scrubber sludge	0	% Rec		3/25/94	4/13/94	4/15/94
IT 5300MSD	3041530MSD	scrubber sludge	0	% Rec		3/25/94	4/13/94	4/15/94
IT 5316	3041530RB	QC Reagent Blank/scrubber water	1.19	pCi/L	0.13	3/25/94	4/8/94	4/8/94
BLANK	BLANK	soil	<0.707	pCi/g		NA	4/13/94	4/15/94
BLANK	BLANK	water	<0.707	pCi/L		NA	4/21/94	4/21/94
BLANK	BLANK	water	<0.707	pCi/L		NA	4/8/94	4/8/94
BLANK	BLANK	solid	<0.707	pCi/g		NA	4/13/94	4/15/94

< = Values preceded by this symbol are the detection limits.

APPENDIX G - 600° THERMAL RUN

MMMS LEPPC - METALS

600°C Thermal Run

Sample No.	PCE	Sample No.	arsenic	Q	units	cadmium	Q	units	mercury	Q	units	Description	Date
IT 5287	3021530	8.5	N	mg/Kg	7.8	mg/Kg	8.4	mg/Kg	Treated Soil	3/25/94	% RPD		
IT 5287D	3021530	12.6	% RPD	3.2	% RPD	4.9	% RPD	Treated Soil	3/25/94	% Rec			
IT 5287S	3021530	69.5	N	% Rec	80	% Rec	-220	% Rec	Treated Soil	3/25/94	% Rec		
IT 5287SD	3021530	71.2	N	% Rec	70	% Rec	-200	% Rec	Treated Soil	3/25/94	% Rec		
IT 5291	3031530	11.1	N	mg/Kg	19.3	mg/Kg	6.8	mg/Kg	Cyclone Solids	3/25/94	% Rec		
IT 5291S	3031530	137.4	N	% Rec	-20	% Rec	120	% Rec	Cyclone Solids	3/25/94	% Rec		
IT 5291SD	3031530	169.6	N	% Rec	20	% Rec	130	% Rec	Cyclone Solids	3/25/94	% Rec		
IT 5300	3041530	3.4	N	mg/Kg	18.4	mg/Kg	2980	mg/Kg	Scrubber Sludge	3/25/94	% RPD		
IT 5300D	3041530D	8.4	% RPD	7.3	% RPD	3.6	% RPD	Scrubber Sludge	3/25/94	% Rec			
IT 5300S	3041530D	59.3	% Rec	-320	% Rec	17000	% Rec	Scrubber Sludge	3/25/94	% Rec			
IT 5300SD	3041530D	49.9	N	% Rec	-280	% Rec	-65000	% Rec	Scrubber Sludge	3/25/94	% Rec		
IT 5333	3041530F	6.2	N	mg/Kg	21	mg/Kg	15300	mg/Kg	Soil Blank	3/25/94	mg/Kg		
Prep blank	BLANK	<0.12	U	mg/Kg	<0.2	U	<0.05	U	mg/Kg	NA			
< = Values proceed by this symbol are the detection limits.													
U = The analyte was analyzed but not detected.													
N = Spiked sample recovery is not within control limits.													
NA = Not applicable.													

APPENDIX G - 600° THERMAL RUN

MMES LEFPC - METALS										
600° C Thermal Run										
Date Received:	3/25/94		3/25/94	3/25/94		3/25/94		3/25/94	3/25/94	
Prep. Date:	4/4/94		4/4/94	4/4/94		4/1/94		4/1/94	4/1/94	
Analysis Date:	4/5/94		4/5/94	4/5/94		4/1/94		4/1/94	4/1/94	
Matrix:	TCLP		TCLP	TCLP		Liquid		Liquid	Liquid	
Description:	Scrubber		Scrubber	Scrubber		Scrubber		Scrubber	Scrubber	
	Water		Water	Water		Water		Water	Water	
Sample No.	IT 5290		IT 5290S	IT 5290SD		IT 5292		IT 5292MS	IT 5292MSD	
PCE Sample No.	3021530		3021530S	3021530SD		3041530		3041530	3041530	
Units	µg/L	Q	% Rec.	% Rec.	% RPD	µg/L	Q	% Rec	% Rec	% RPD
arsenic	21.3		98	97.6	0.4	125	N	64.2	50	24.9
barium	989.7		84.3	86	2	NA		NA	NA	NA
cadmium	26.1		140	-20	0	8.8		130	140	7.4
chromium	22.7		87.7	88.5	0.9	NA		NA	NA	NA
lead	5.3		98.1	102.1	4	NA		NA	NA	NA
mercury	<0.1	U	92.3	96.7	4.7	2340		15000	3000	300*
selenium	<1.8	UN	24.7	26.6	7.4	NA		NA	NA	NA
silver	<14.8	U	79.2	78.8	0.5	NA		NA	NA	NA
Date Received:	NA		NA		3/25/94					
Prep. Date:	4/1/94		4/1/94		4/1/94					
Analysis Date:	4/1/94		4/1/94		4/1/94					
Matrix:	Liquid		Liquid		Liquid					
Description:	Extraction		Method		QC Reagent					
	Blank		Blank		BLK					
Sample No.	TCLP BLK		Prep. BLK		IT 5316					
PCE Sample No.	EXT Blank		Method Blank		3041530RB					
Units	µg/L	Q	µg/L	Q	µg/L	Q				
arsenic	1.2	U	<1.2	U	3.3	N				
barium	19.8		<2.2	U	NA					
cadmium	<0.2	U	<0.2	U	0.45	B				
chromium	<4.2	U	<4.2	U	NA					
lead	4.3		<0.6	U	NA					
mercury	<0.1	U	<0.1	U	57.9					
selenium	<1.8	UN	<1.8	U	NA					
silver	<3.7	U	<3.7	U	NA					
< = Values proceed by this symbol are the detection limits.										
U = The analyte was analyzed but not detected.										
N = Spiked sample recovery is not within control limits.										
NA = Not applicable										

APPENDIX G - 600° THERMAL RUN

[illegible]

APPENDIX G - 600° THERMAL RUN

[illegible]

600°C Thermal Run

APPENDIX G - 600°C THERMAL RUN

MMES LEFPC - VOLATILES										
600° C Thermal Run										
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94			
Date Analyzed:	3/30/94		3/30/94		3/30/94		3/30/94		3/30/94	
Matrix	Liquid		Liquid		Liquid		Liquid		Liquid	
Dilution Factor:	20		20		1		1		1	
Description	Scrubber		Scrubber		QC Reagent Blk		QC Reagent Blk		Method	
	Water		Water		Scrubber Water		Scrubber Water		Blank	
Sample No.	IT 5295		IT 5295D		IT 5299		IT 5299RE		VBLK 1	
PCE Sample No.	3041530		3041530D		3041530RB		3041530RB		BLANK	
Concentration Units	µg/L	Q	µg/L	Q	µg/L	Q	µg/L	Q	µg/L	Q
dichlorodifluoromethane	<200	U	<200	U	<10	U	<10	U	<10	U
chloromethane	<200	U	<200	U	<10	U	<10	U	<10	U
bromomethane	<200	U	<200	U	<10	U	<10	U	<10	U
vinyl chloride	<200	U	<200	U	<10	U	<10	U	<10	U
chloroethane	<200	U	<200	U	<10	U	<10	U	<10	U
methylene chloride	<100	U	<100	U	<5	U	4	J	<5	U
trichlorofluoromethane	<100	U	<100	U	<5	U	<5	U	<5	U
1,1-dichloroethene	<100	U	<100	U	<5	U	<5	U	<5	U
1,1-dichloroethane	<100	U	<100	U	<5	U	<5	U	<5	U
trans-1,2-dichloroethene	<100	U	<100	U	<5	U	<5	U	<5	U
cis-1,2-dichloroethene	<100	U	<100	U	<5	U	<5	U	<5	U
chloroform	<100	U	<100	U	22		16		<5	U
1,2-dichloroethane	<100	U	<100	U	<5	U	<5	U	<5	U
2,2-dichloropropane	<100	U	<100	U	<5	U	<5	U	<5	U
bromochloromethane	<100	U	<100	U	<5	U	<5	U	<5	U
1,1,1-trichloroethane	<100	U	<100	U	<5	U	<5	U	<5	U
carbon tetrachloride	<100	U	<100	U	<5	U	<5	U	<5	U
1,1-dichloropropene	<100	U	<100	U	<5	U	<5	U	<5	U
bromodichloromethane	<100	U	<100	U	<5	U	<5	U	<5	U
1,2-dichloropropane	<100	U	<100	U	<5	U	<5	U	<5	U
trichloroethene	<100	U	<100	U	<5	U	<5	U	<5	U
1,1,2-trichloroethane	<100	U	<100	U	<5	U	<5	U	<5	U
benzene	200		240		1	J	<5	U	<5	U
dibromomethane	<100	U	<100	U	<5	U	<5	U	<5	U
toluene	140		150		2	J	2	J	<5	U
1,2-dibromoethane	<100	U	<100	U	<5	U	<5	U	<5	U
tetrachloroethene	<100	U	<100	U	<5	U	<5	U	<5	U
1,3-dichloropropane	<100	U	<100	U	<5	U	<5	U	<5	U
dibromochloromethane	<100	U	<100	U	<5	U	<5	U	<5	U
chlorobenzene	<100	U	<100	U	<5	U	<5	U	<5	U
1,1,1,2-tetrachloroethane	<100	U	<100	U	<5	U	<5	U	<5	U
ethyl benzene	<100	U	<100	U	<5	U	<5	U	<5	U
styrene	130		130		3	J	3	J	<5	U
bromoform	<100	U	<100	U	<5	U	<5	U	<5	U
xylene (total)	59	J	61	J	1	J	2	J	<5	U
U = Compound analyzed for but not detected.										
J = Compound detected but below the contract required quantitation limit (the value given is an estimate)										
B = Compound was found in the method blank.										
< = Values proceed by this symbol are the detection limits.										

APPENDIX G - 600°C THERMAL RUN

MMES LEFPC - VOLATILES (continued)

600°C Thermal Run

Date Received:	3/25/94		3/25/94		3/25/94		3/25/94		
Date Analyzed:	3/30/94		3/30/94		3/30/94		3/30/94		3/30/94
Matrix	Liquid		Liquid		Liquid		Liquid		Liquid
Dilution Factor:	20		20		1		1		1
Description	Scrubber		Scrubber		QC Reagent Blk		QC Reagent Blk		Method
	Water		Water		Scrubber Water		Scrubber Water		Blank
Sample No.	IT 5295		IT 5295D		IT 5299		IT 5299RE		VBK 1
PCE Sample No.	3041530		3041530D		3041530RB		3041530RB		BLANK
Concentration Units	µg/L	Q	µg/L	Q	µg/L	Q	µg/L	Q	µg/L
isopropylbenzene	<100	U	<100	U	<5	U	<5	U	<5
bromobenzene	<100	U	<100	U	<5	U	<5	U	<5
1,1,2,2-tetrachloroethane	<100	U	<100	U	<5	U	<5	U	<5
1,2,3-trichloropropane	<100	U	<100	U	<5	U	<5	U	<5
n-propylbenzene	<100	U	<100	U	<5	U	<5	U	<5
2-chlorotoluene	<100	U	<100	U	<5	U	<5	U	<5
1,3,5-trimethylbenzene	<100	U	<100	U	<5	U	<5	U	<5
4-chlorotoluene	<100	U	<100	U	<5	U	<5	U	<5
tert-butylbenzene	<100	U	<100	U	<5	U	<5	U	<5
1,2,4-trimethylbenzene	<100	U	<100	U	5		<5	U	<5
sec-butylbenzene	<100	U	<100	U	<5	U	<5	U	<5
1,3-dichlorobenzene	<100	U	<100	U	<5	U	<5	U	<5
4-isopropyltoluene	<100	U	<100	U	<5	U	<5	U	<5
1,4-dichlorobenzene	<100	U	<100	U	<5	U	<5	U	<5
n-butylbenzene	<100	U	<100	U	<5	U	<5	U	<5
1,2-dichlorobenzene	<100	U	<100	U	<5	U	<5	U	<5
1,2-dibromo-3-chloropropane	<200	U	<200	U	<10	U	<10	U	<10
1,2,4-trichlorobenzene	<100	U	<100	U	<5	U	<5	U	<5
hexachlorobutadiene	<100	U	<100	U	<5	U	<5	U	<5
naphthalene	2300		2100		32		44		<5
1,2,3-trichlorobenzene	<100	U	<100	U	<5	U	<5	U	<5
Number of TIC's found:	10		10		10		10		0
acetaldehyde	ND		880	J	68	J	55	J	ND
2-propanone	ND		ND		2800	J	2400	J	ND
acetone	87000	J	84000	J	ND		ND		ND
acetonitrile	4100	J	4200	J	93	J	84	J	ND
2-propenenitrile	ND		1600	J	ND		ND		ND
2-butanone	17000	J	17000	J	510	J	460	J	ND
butanal, 3-methyl-	ND		ND		21	J	ND		ND
benzaldehyde	1400	J	1400	J	ND		ND		ND
benzofuran	390	J	360	J	ND		ND		ND
benzonitrile	450	J	540	J	ND		ND		ND
disulfide, dimethyl	ND		ND		9.7	J	ND		ND
U = Compound analyzed for but not detected.									
J = Compound detected but below the contract required quantitation limit (the value given is an estimate)									
ND = Not detected.									
< = Values proceed by this symbol are the detection limits.									

MMES LEFPC - VOLATILES OC

[illegible]

APPENDIX G - 600°C THERMAL RUN

MMES LEFPC - VOLATILES						
600°C Thermal Run						
Date Received:	3/25/94		3/25/94			
Date Analyzed:	3/31/94		3/31/94		3/31/94	
Matrix	Soil		Soil		Soil	
Dilution Factor:	MED/10		MED/10		MED/1	
Description	Scrubber		Scrubber		Soil	
	sludge		sludge		Blank	
Sample No.	IT 5303		IT 5303D		VLK 2	
PCE Sample No.	3061530D		3061530D		BLANK	
Concentration Units	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q
dichlorodifluoromethane	<12000	U	<12000	U	<1200	U
chloromethane	<12000	U	<12000	U	<1200	U
bromomethane	<12000	U	<12000	U	<1200	U
vinyl chloride	<12000	U	<12000	U	<1200	U
chloroethane	<12000	U	<12000	U	<1200	U
methylene chloride	3000	J	<6200	U	<620	U
trichlorofluoromethane	<6200	U	<6200	U	<620	U
1,1-dichloroethene	<6200	U	<6200	U	<620	U
1,1-dichloroethane	<6200	U	<6200	U	<620	U
trans-1,2-dichloroethene	<6200	U	<6200	U	<620	U
cis-1,2-dichloroethene	<6200	U	<6200	U	<620	U
chloroform	<6200	U	<6200	U	<620	U
1,2-dichloroethane	<6200	U	<6200	U	<620	U
2,2-dichloropropane	<12000	U	<12000	U	<1200	U
bromochloromethane	<6200	U	<6200	U	<620	U
1,1,1-trichloroethane	<6200	U	<6200	U	<620	U
carbon tetrachloride	<6200	U	<6200	U	<620	U
1,1-dichloropropene	<6200	U	<6200	U	<620	U
bromodichloromethane	<6200	U	<6200	U	<620	U
1,2-dichloropropane	<6200	U	<6200	U	<620	U
trichloroethene	<6200	U	<6200	U	<620	U
1,1,2-trichloroethane	<6200	U	<6200	U	<620	U
benzene	<6200	U	<6200	U	<620	U
dibromomethane	<6200	U	<6200	U	<620	U
toluene	2900	J	5300	J	<620	U
1,2-dibromoethane	<6200	U	<6200	U	<620	U
tetrachloroethene	<6200	U	<6200	U	<620	U
1,3-dichloropropane	<6200	U	<6200	U	<620	U
dibromochloromethane	<6200	U	<6200	U	<620	U
chlorobenzene	<6200	U	<6200	U	<620	U
1,1,1,2-tetrachloroethane	<6200	U	<6200	U	<620	U
ethyl benzene	<6200	U	2100	J	<620	U
styrene	3600	J	8900		<620	U
U = Compound analyzed for but not detected.						
J = Compound detected but below the contract required quantitation limit						
(the value given is an estimate)						
< = Values proceed by this symbol are the detection limits.						

MMES LEFPC - VOLATILES (continued)

[illegible]

J = Compound detected but below the contract required quantitation limit

<= Values proceed by this symbol are the detection limits.

<= Values proceed by this symbol are the detection limits.

APPENDIX G - 600°C THERMAL RUN

MMES LEFPC - VOLATILES											
600°C Thermal Run											
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94		3/25/94		3/25/94
Date Analyzed:	3/31/94		3/31/94		3/31/94		3/30/94		3/31/94		3/30/94
Matrix	Solid		Solid		Solid		Solid		Solid		Liquid
Dilution Factor:	200		1		1		1		1		1
Description	Primary		Secondary		Secondary		Carbon Bed		Carbon Bed		Trip Blank
	Carbon Bed		Carbon Bed		Carbon Bed		Reagent Blank		Reagent Blank		
Sample No.	IT5309		IT5311		IT5311RE		IT5313		IT5313RE		IT5314
PCE Sample No.	3061530P		3061530S		3061530S		3061530RB		3061530RB		Trip Blank
Concentration Units	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q	µg/Kg	Q	µg/L
dichlorodifluoromethane	<250000	U	<1200	U	<1200	U	<1200	U	<1200	U	<10
chloromethane	<250000	U	<1200	U	<1200	U	<1200	U	<1200	U	<10
bromomethane	<250000	U	<1200	U	<1200	U	<1200	U	<1200	U	<10
vinyl chloride	<250000	U	<1200	U	<1200	U	<1200	U	<1200	U	<10
chloroethane	<250000	U	<1200	U	<1200	U	<1200	U	<1200	U	<10
methylene chloride	<120000	U	<620	U	340	J	540	J	380	J	<5
trichlorofluoromethane	<250000	U	<1200	U	<1200	U	<1200	U	<1200	U	<10
1,1-dichloroethene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,1-dichloroethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
trans-1,2-dichloroethene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
cis-1,2-dichloroethene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
chloroform	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
2,2-dichloropropane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
bromochloromethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,1,1-trichloroethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
carbon tetrachloride	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,1-dichloropropene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
bromodichloromethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,2-dichloropropane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
trichloroethene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,1,2-trichloroethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
benzene	2800000		<620	U	<620	U	<620	U	<620	U	<5
1,2-dichloroethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
toluene	1300000		<620	U	<620	U	190	J	<620	U	<5
1,2-dibromoethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
tetrachloroethene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,3-dichloropropane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
dibromochloromethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
chlorobenzene	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
1,1,1,2-tetrachloroethane	<120000	U	<620	U	<620	U	<620	U	<620	U	<5
ethyl benzene	130000		<620	U	<620	U	<620	U	<620	U	<5
styrene	130000		<620	U	<620	U	<620	U	<620	U	<5
U = Compound analyzed for but not detected.											
J = Compound detected but below the contract required quantitation limit											
(the value given is an estimate)											
< = Values proceed by this symbol are the detection limits.											

MMES LEFPC - VOLATILES (continued)[illegible]

**APPENDIX G - 600°C THERMAL RUN
MMES LEFPC - TCLP SEMIVOLATILES**

600°C Thermal Run								
Date Received:	3/25/94		3/25/94	3/25/94	NA		NA	
Date Prep:	4/1/94		4/1/94	4/1/94	4/1/94		4/1/94	
Date Analyzed:	4/6/94		4/6/94	4/6/94	4/6/94		4/6/94	
Matrix:	TCLP		TCLP	TCLP	TCLP		Blank	
Description:	Treated Soil		Treated Soil	Treated Soil	TCLP Blank		Method Blk	
Dilution Factor:	1		1	1	1		1	
Sample No.	IT 5290		IT 5290MS	IT 5290MSD	TCLP HLK		Method Blk	
PCE Sample No.	3021530		3021530MS	3021530MSD	EXT BLK		Blank	
Concentration Units:	mg/L	Q	% Rec	% Rec	µg/L	Q	µg/L	Q
pyridine	<0.04	U	38	40	<0.04	U	<0.04	U
1,4-dichlorobenzene	<0.04	U	59	66	<0.04	U	<0.04	U
2-methylphenol	<0.04	U	3	1*	<0.04	U	<0.04	U
4-methylphenol	<0.04	U	2	1*	<0.04	U	<0.04	U
hexachloroethane	<0.04	U	50	58	<0.04	U	<0.04	U
nitrobenzene	<0.04	U	65	71	<0.04	U	<0.04	U
hexachlorobutadiene	<0.04	U	47	57	<0.04	U	<0.04	U
2,4,6-trichlorophenol	<0.04	U	25*	19	<0.04	U	<0.04	U
2,4,5-trichlorophenol	<0.04	U	26	18	<0.04	U	<0.04	U
2,4-dinitrotoluene	<0.04	U	61	65	<0.04	U	<0.04	U
hexachlorobenzene	<0.04	U	65	70	<0.04	U	<0.04	U
pentachlorophenol	<0.20	U	38	38	<0.20	U	<0.20	U
* Values outside of required QC limits.								
U = Compound analyzed but not detected.								
< = Values proceed by this symbol are the detection limits.								

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES								
600° C Thermal Run								
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94	
Date Prep:	3/31/94		3/31/94		3/30/94		3/30/94	
Date Analyzed:	4/4/94		4/4/94		4/8/94		4/8/94	
Description:	Treated Soil		Cyclone Solids		Scrubber Water		QC Reagent Blk/ Scrubber Water	
Dilution Factor:	1		1		10/25/1000		1	
Sample No.	IT-5289		IT-5291		IT-5294		IT-5298	
PCE Sample No.	3021530		3031530		3041530		3041530RB	
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/L	Q
phenol	<330	U	<330	U	57000	D	<10	U
bis (2-chloroethyl) ether	<330	U	<330	U	<200	U	<10	U
2-chlorophenol	<330	U	<330	U	<200	U	<10	U
1,3-dichlorobenzene	<330	U	<330	U	<200	U	<10	U
1,4-dichlorobenzene	<330	U	<330	U	<200	U	<10	U
Benzyl Alcohol	<660	U	<660	U	<400	U	<21	U
1,2-dichlorobenzene	<330	U	<330	U	<200	U	<10	U
2-methylphenol	<330	U	<330	U	7400	DJ	<10	U
bis(2-Chloroisopropyl)Ether	<330	U	<330	U	<200	U	<10	U
4-methylphenol	<330	U	<330	U	22000	D	<10	U
N-nitroso-di-n-propylamine	<330	U	<330	U	<200	U	<10	U
hexachloroethane	<330	U	<330	U	<200	U	<10	U
nitrobenzene	<330	U	<330	U	<500	DU	<10	U
isophorone	<330	U	<330	U	<500	DU	<10	U
2-nitrophenol	<330	U	<330	U	<500	DU	<10	U
2,4-dimethylphenol	<330	U	<330	U	<500	DU	<10	U
Benzoic Acid	<1600	U	<1600	U	<2500	DU	<52	U
bis(2-Chloroethoxy)Methane	<330	U	<330	U	<500	DU	<10	U
2,4-dichlorophenol	<330	U	<330	U	<500	DU	<10	U
1,2,4-trichlorobenzene	<330	U	<330	U	<500	DU	<10	U
naphthalene	39	J	<330	U	1500	D	12	
4-Chloroaniline	<660	U	<660	U	440	DJ	<21	U
hexachlorobutadiene	<330	U	<330	U	<500	DU	<10	U
4-chloro-3-methylphenol	<660	U	<660	U	<1000	DU	<21	U
2-methylnaphthalene	<330	U	<330	U	320	DJ	<10	U
hexachlorocyclopentadiene	<330	U	<330	U	<200	U	<10	U
2,4,6-trichlorophenol	<330	U	<330	U	<200	U	<10	U
2,4,5-trichlorophenol	<330	U	<330	U	<200	U	<10	U
2-chloronaphthalene	<330	U	<330	U	<200	U	<10	U
2-nitroaniline	<1600	U	<1600	U	<1000	U	<52	U
dimethyl phthalate	<330	U	<330	U	<200	U	<10	U
acensphthylene	<330	U	<330	U	64	J	4	J
2,6-dinitrotoluene	<330	U	<330	U	<200	U	<10	U
3-nitroaniline	<1600	U	<1600	U	<1000	U	<52	U
acensphthene	<330	U	<330	U	<200	U	<10	U
2,4-dinitrophenol	<1600	U	<1600	U	<1000	U	<52	U
U = Compound analyzed but not detected.								
D = Dilution.								
J = Compound detected but below the contract required quantitation limit								
(the value given is an estimate)								
< = Values proceed by this symbol are the detection limits.								

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES (continued)

600°C Thermal Run							
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94
Date Prep:	3/31/94		3/31/94		3/30/94		3/30/94
Date Analyzed:	4/4/94		4/4/94		4/8/94		4/8/94
Description:	Treated Soil		Cyclone Solids		Scrubber Water		QC Reagent Blk/ Scrubber Water
Dilution Factor:	1		1		10/25/1000		1
Sample No.	IT-5289		IT-5291		IT-5294		IT-5298
PCE Sample No.	3021530		3031530		3041530		3041530RB
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/L
4-nitrophenol	<1600	U	<1600	U	<1000	U	<52
dibenzofuran	<330	U	<330	U	130	J	3
2,4-dinitrotoluene	<330	U	<330	U	<200	U	<10
diethylphthalate	<330	U	<330	U	<200	U	<10
4-chlorophenyl-phenyl ether	<330	U	<330	U	<200	U	<10
fluorene	<330	U	<330	U	38	J	2
4-nitroaniline	<1600	U	<1600	U	<1000	U	<52
4,6-dinitro-2-methylphenol	<1600	U	<1600	U	<1000	U	<52
N-nitrosodiphenylamine (1)	<330	U	<330	U	<200	U	<10
4-bromophenyl-phenylether	<330	U	<330	U	<200	U	<10
hexachlorobenzene	<330	U	<330	U	<200	U	<10
pentachlorophenol	<1600	U	<1600	U	<1000	U	<52
phenanthrene	<330	U	<330	U	46	J	10
anthracene	<330	U	<330	U	<200	U	3
di-n-butylphthalate	<330	U	<330	U	<200	U	<10
fluoranthene	<330	U	<330	U	<200	U	3
pyrene	<330	U	<330	U	<200	U	2
butylbenzylphthalate	<330	U	<330	U	<200	U	<10
3,3'-dichlorobenzidine	<660	U	<660	U	<400	U	<21
benzo (a) anthracene	<330	U	<330	U	<200	U	<10
chrysene	<330	U	<330	U	<200	U	<10
bis (2-ethylhexyl) phthalate	<330	U	<330	U	<200	U	<10
di-n-octyl phthalate	<330	U	<330	U	<200	U	<10
benzo (b) fluoranthene	<330	U	<330	U	<200	U	<10
benzo (k) fluoranthene	<330	U	<330	U	<200	U	<10
benzo (a) pyrene	<330	U	<330	U	<200	U	<10
indeno (1,2,3-cd) pyrene	<330	U	<330	U	<200	U	<10
dibenz (a,h) anthracene	<330	U	<330	U	<200	U	<10
benzo (g,h,i) perylene	<330	U	<330	U	<200	U	<10
No. of TICs found :	1		3		21		21
Identified TICs (unknowns not listed):							
Pyridine	ND		ND		120000	J	540
Pyridine, 3-methyl-	ND		ND		9000	J	ND
Ethanone, 1-(2-furanyl)-	ND		ND		3000	J	ND
Pyridine, 2-ethenyl-	ND		ND		1100	J	ND
Benzaldehyde	ND		ND		28000	J	ND
Benzonitrile	ND		ND		15000	J	ND
Benzenepropanenitrile	ND		ND		1300	J	5
Ethanone, 1-phenyl-	ND		ND		4100	J	48
Isoquinoline	ND		ND		2540	J	ND
1H-Indole	ND		ND		890	J	ND
Benzeneacetonitrile	ND		ND		1300	J	ND
2-Furancarboxaldehyde, 5-met	ND		ND		ND		97
(1) - Cannot be separated from diphenylamine.							
U = Compound analyzed but not detected.							
D = Surrogates diluted out							
J = Compound detected but below the contract required quantitation limit							
(the value given is an estimate)							
ND = TICs not detected.							
< = Values proceed by this symbol are the detection limits.							

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES							
600°C Thermal Run							
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94
Date Prep:	3/31/94		3/31/94		3/31/94		3/31/94
Date Analyzed:	4/5/94		4/5/94		4/7/94		4/5/94
Description:	Scrubber		Scrubber		Primary		QC Reagent Blk/
	Sludge		Sludge		Carbon Bed		Carbon Bed
Dilution Factor:	50		50		50		1
Sample No.	IT-5302		IT-5302DUP		IT-5308		IT-5312
PCE Sample No.:	3041530D		3041530D		3061530P		3061530RB
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/kg	Q	µg/kg
phenol	41000		35000		<16000	U	<330
bis (2-chloroethyl) ether	<16000	U	<16000	U	<16000	U	<330
2-chlorophenol	<16000	U	<16000	U	<16000	U	<330
1,3-dichlorobenzene	<16000	U	<16000	U	<16000	U	<330
1,4-dichlorobenzene	<16000	U	<16000	U	<16000	U	<330
Benzyl Alcohol	<33000	U	<33000	U	<33000	U	<660
1,2-dichlorobenzene	<16000	U	<16000	U	<16000	U	<330
2-methylphenol	5600	J	4900	J	<16000	U	<330
bis(2-Chloroisopropyl)Ether	<16000	U	<16000	U	<16000	U	<330
4-methylphenol	16000	J	14000	J	<16000	U	<330
N-nitroso-di-n-propylamine	<16000	U	<16000	U	<16000	U	<330
hexachloroethane	<16000	U	<16000	U	<16000	U	<330
nitrobenzene	<16000	U	<16000	U	<16000	U	<330
isophorone	<16000	U	<16000	U	<16000	U	<330
2-nitrophenol	<16000	U	<16000	U	<16000	U	<330
2,4-dimethylphenol	2800	J	2600	J	<16000	U	<330
Benzoic Acid	<80000	U	<80000	U	<80000	U	<1600
bis(2-Chloroethoxy)Methane	<16000	U	<16000	U	<16000	U	<330
2,4-dichlorophenol	<16000	U	<16000	U	<16000	U	<330
1,2,4-trichlorobenzene	<16000	U	<16000	U	<16000	U	<330
naphthalene	100000		80000		67000		140
4-Chloroaniline	<33000	U	<33000	U	<33000	U	<660
hexachlorobutadiene	<16000	U	<16000	U	<16000	U	<330
4-chloro-3-methylphenol	<33000	U	<33000	U	<33000	U	<660
2-methylnaphthalene	56000		44000		7000	J	<330
hexachlorocyclopentadiene	<16000	U	<16000	U	<16000	U	<330
2,4,6-trichlorophenol	<16000	U	<16000	U	<16000	U	<330
2,4,5-trichlorophenol	<16000	U	<16000	U	<16000	U	<330
2-chloronaphthalene	<16000	U	<16000	U	<16000	U	<330
2-nitroaniline	<80000	U	<80000	U	<80000	U	<1600
dimethyl phthalate	<16000	U	<16000	U	<16000	U	<330
acenaphthylene	13000	J	10000	J	<16000	U	<330
2,6-dinitrotoluene	<16000	U	<16000	U	<16000	U	<330
3-nitroaniline	<80000	U	<80000	U	<80000	U	<1600
acenaphthene	4300	J	3300	J	<16000	U	<330
2,4-dinitrophenol	<80000	U	<80000	U	<80000	U	<1600
U = Compound analyzed but not detected.							
D = Dilution.							
J = Compound detected but below the contract required quantitation limit							
(the value given is an estimate)							
< = Values preceded by this symbol are the detection limits.							

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES (continued)

600°C Thermal Run								
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94	
Date Prep:	3/31/94		3/31/94		3/31/94		3/31/94	
Date Analyzed:	4/5/94		4/5/94		4/7/94		4/5/94	
Description:	Scrubber		Scrubber		Primary		QC Reagent Blk/	
	Sludge		Sludge		Carbon Bed		Carbon Bed	
Dilution Factor:	50		50		50		1	
Sample No.	IT-5302		IT-5302DUP		IT-5308		IT-5312	
PCE Sample No.:	3041530D		3041530D		3061530F		3061530RB	
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/kg	Q	µg/kg	Q
4-nitrophenol	1900	J	<80000	U	<80000	U	<1600	U
dibenzofuran	50000		40000		<16000	U	<330	U
2,4-dinitrotoluene	<16000	U	<16000	U	<16000	U	<330	U
diethylphthalate	<16000	U	<16000	U	<16000	U	<330	U
4-chlorophenyl-phenyl ether	<16000	U	<16000	U	<16000	U	<330	U
fluorene	16000	J	12000	J	<16000	U	<330	U
4-nitroaniline	<80000	U	<80000	U	<80000	U	<1600	U
4,6-dinitro-2-methylphenol	<80000	U	<80000	U	<80000	U	<1600	U
N-nitrosodiphenylamine (1)	<16000	U	<16000	U	<16000	U	<330	U
4-bromophenyl-phenyl ether	<16000	U	<16000	U	<16000	U	<330	U
hexachlorobenzene	<16000	U	<16000	U	<16000	U	<330	U
pentachlorophenol	<80000	U	<80000	U	<80000	U	<1600	U
phenanthrene	69000		56000		<16000	U	<330	U
anthracene	15000	J	12000	J	<16000	U	<330	U
di-n-butylphthalate	<16000	U	<16000	U	<16000	U	<330	U
fluoranthene	39000		31000		<16000	U	<330	U
pyrene	24000		19000		<16000	U	<330	U
butyl benzyl phthalate	<16000	U	<16000	U	<16000	U	<330	U
3,3'-dichlorobenzidine	<33000	U	<33000	U	<33000	U	<660	U
benzo (a) anthracene	9800	J	8000	J	<16000	U	<330	U
chrysene	13000	J	10000	J	<16000	U	<330	U
bis (2-ethylhexyl) phthalate	<16000	U	<16000	U	<16000	U	<330	U
di-n-octyl phthalate	<16000	U	<16000	U	<16000	U	<330	U
benzo (b) fluoranthene	9700	J	7700	J	<16000	U	<330	U
benzo (k) fluoranthene	<16000	U	<16000	U	<16000	U	<330	U
benzo (a) pyrene	5500	J	4300	J	<16000	U	<330	U
indeno (1,2,3-cd) pyrene	1800	J	<16000	U	<16000	U	<330	U
dibenz (a,h) anthracene	<16000	U	<16000	U	<16000	U	<330	U
benzo (g,h,i) perylene	1700	J	<16000	U	<16000	U	<330	U
No. of TICs found :	21		21		21		15	
Identified TICs (unknowns not listed):								
Pyridine	11000	J	10000	J	ND		ND	
Benzaldehyde	19000	J	16000	J	76000	J	420	J
Naphthalene, 1-methyl-	32000	J	25000	J	ND		ND	
1,1'-biphenyl	30000	J	24000	J	ND		ND	
9H-fluoren-9-one	21000	J	16000	J	ND		ND	
Dibenzothiophene	8100	J	7400	J	ND		ND	
Benzene, ethyl-, or isomer	ND		ND		220000	J	ND	
Benzene, propyl-, or isomer	ND		ND		33000	J	ND	
Benzonitrile	ND		ND		57000	J	ND	
Benzofuran	ND		ND		ND		430	J
Decane	ND		ND		ND		180	J
U = Compound analyzed but not detected.								
D = Dilution.								
J = Compound detected but below the contract required quantitation limit								
(the value given is an estimate)								
< = Values proceed by this symbol are the detection limits.								

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES										
600°C Thermal Run - SOIL										
Date Received:	3/25/94		3/25/94		NA		NA		NA	
Date Prep:	3/31/94		3/31/94		3/31/94		3/30/94		3/31/94	
Date Analyzed:	4/7/94		4/7/94		4/4/94		4/5/94		4/4/94	
Matrix:	Float		Float		Solid		Water		Solid	
	Solid		Solid							
Dilution Factor:	50		50		1		1		1	
Sample No.	IT-5333		IT-5333DUP		BLK1		BLK2		BLK3	
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/kg	Q
phenol	57000	J	56000	J	<330	U	<10	U	<330	U
bis (2-chloroethyl) ether	<99000	U	<95000	U	<330	U	<10	U	<330	U
2-chlorophenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
1,3-dichlorobenzene	<99000	U	<95000	U	<330	U	<10	U	<330	U
1,4-dichlorobenzene	<99000	U	<95000	U	<330	U	<10	U	<330	U
Benzyl Alcohol	<200000	U	<190000	U	<660	U	<20	U	<660	U
1,2-dichlorobenzene	<99000	U	<95000	U	<330	U	<10	U	<330	U
2-methylphenol	11000	J	12000	J	<330	U	<10	U	<330	U
bis(2-Chloroisopropyl)Ether	<99000	U	<95000	U	<330	U	<10	U	<330	U
4-methylphenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
N-nitroso-di-n-propylamine	<99000	U	<95000	U	<330	U	<10	U	<330	U
hexachloroethane	<99000	U	<95000	U	<330	U	<10	U	<330	U
nitrobenzene	<99000	U	<95000	U	<330	U	<10	U	<330	U
isophorone	<99000	U	<95000	U	<330	U	<10	U	<330	U
2-nitrophenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
2,4-dimethylphenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
Benzoic Acid	<480000	U	<460000	U	<1600	U	<50	U	<1600	U
bis(2-Chloroethoxy)Methane	<99000	U	<95000	U	<330	U	<10	U	<330	U
2,4-dichlorophenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
1,2,4-trichlorobenzene	<99000	U	<95000	U	<330	U	<10	U	<330	U
naphthalene	660000		630000		<330	U	<10	U	<330	U
4-Chloroaniline	<200000	U	<190000	U	<660	U	<20	U	<660	U
hexachlorobutadiene	<99000	U	<95000	U	<330	U	<10	U	<330	U
4-chloro-3-methylphenol	<200000	U	<190000	U	<660	U	<20	U	<660	U
2-methylnaphthalene	580000		560000		<330	U	<10	U	<330	U
hexachlorocyclopentadiene	<99000	U	<95000	U	<330	U	<10	U	<330	U
2,4,6-trichlorophenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
2,4,5-trichlorophenol	<99000	U	<95000	U	<330	U	<10	U	<330	U
2-chloronaphthalene	<99000	U	<95000	U	<330	U	<10	U	<330	U
2-nitroaniline	<480000	U	<460000	U	<1600	U	<50	U	<1600	U
dimethyl phthalate	<99000	U	<95000	U	<330	U	<10	U	<330	U
acronaphthylene	190000		180000		<330	U	<10	U	<330	U
2,6-dinitrotoluene	<99000	U	<95000	U	<330	U	<10	U	<330	U
3-nitroaniline	<480000	U	<460000	U	<1600	U	<50	U	<1600	U
acronaphthene	69000	J	67000	J	<330	U	<10	U	<330	U
2,4-dinitrophenol	<480000	U	<460000	U	<1600	U	<50	U	<1600	U
U = Compound analyzed but not detected.										
D = Dilution.										
J = Compound detected but below the contract required quantitation limit										
(the value given is an estimate)										
< = Values proceed by this symbol are the detection limits.										

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES (continued)

600° C Thermal Run - SOIL											
Date Received:	3/25/94		3/25/94		NA		NA		NA		
Date Prep:	3/31/94		3/31/94		3/31/94		3/30/94		3/31/94		
Date Analyzed:	4/7/94		4/7/94		4/4/94		4/5/94		4/4/94		
Matrix:	Float		Float		Solid		Water		Solid		
	Solid		Solid								
Dilution Factor:	50		50		1		1		1		
Sample No.	IT-5333		IT-5333DUP		BLK1		BLK2		BLK3		
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/kg	Q	
4-nitrophenol	<480000	U	<460000	U	<1600	U	<50	U	<1600	U	
dibenzofuran	590000		590000		<330	U	<10	U	<330	U	
2,4-dinitrotoluene	<99000	U	<95000	U	<330	U	<10	U	<330	U	
diethylphthalate	<99000	U	<95000	U	<330	U	<10	U	<330	U	
4-chlorophenyl-phenyl ether	<99000	U	<95000	U	<330	U	<10	U	<330	U	
fluorene	220000		220000		<330	U	<10	U	<330	U	
4-nitroaniline	<480000	U	<460000	U	<1600	U	<50	U	<1600	U	
4,6-dinitro-2-methylphenol	<480000	U	<460000	U	<1600	U	<50	U	<1600	U	
N-nitrosodiphenylamine (1)	<99000	U	<95000	U	<330	U	<10	U	<330	U	
4-bromophenyl-phenyl ether	<99000	U	<95000	U	<330	U	<10	U	<330	U	
hexachlorobenzene	<99000	U	<95000	U	<330	U	<10	U	<330	U	
pentachlorophenol	<480000	U	<460000	U	<1600	U	<50	U	<1600	U	
phenanthrene	750000		730000		<330	U	<10	U	<330	U	
anthracene	180000		180000		<330	U	<10	U	<330	U	
di-n-butylphthalate	<99000	U	<95000	U	<330	U	<10	U	<330	U	
fluoranthene	390000		380000		<330	U	<10	U	<330	U	
pyrene	230000		220000		<330	U	<10	U	<330	U	
butylbenzylphthalate	<99000	U	<95000	U	<330	U	<10	U	<330	U	
3,3'-dichlorobenzidine	<200000	U	<190000	U	<660	U	<20	U	<660	U	
benzo (a) anthracene	98000	J	96000		<330	U	<10	U	<330	U	
chrysene	130000		130000		<330	U	<10	U	<330	U	
bis (2-ethylhexyl) phthalate	<99000	U	<95000	U	<330	U	<10	U	<330	U	
di-n-octyl phthalate	<99000	U	<95000	U	<330	U	<10	U	<330	U	
benzo (b) fluoranthene	110000		110000		<330	U	<10	U	<330	U	
benzo (k) fluoranthene	29000	J	35000	J	<330	U	<10	U	<330	U	
benzo (a) pyrene	64000	J	63000	J	<330	U	<10	U	<330	U	
indeno (1,2,3-cd) pyrene	25000	J	26000	J	<330	U	<10	U	<330	U	
dibenz (a,h) anthracene	<99000	U	<95000	U	<330	U	<10	U	<330	U	
benzo (g,h,i) perylene	28000	J	27000	J	<330	U	<10	U	<330	U	
No. of TICs found :	21		21		1		1		0		
Identified TICs (unknowns not listed):											
1,1'-biphenyl	350000	J	300000	J	ND		ND				
Dibenzofuran, 4-methyl-	120000	J	ND		ND		ND				
Dibenzothiophene	43000	J	38000	J	ND		ND				
Carbazole	200000	J	190000	J	ND		ND				
U = Compound analyzed but not detected.											
D = Dilution.											
J = Compound detected but below the contract required quantitation limit											
(the value given is an estimate)											
< = Values preceded by this symbol are the detection limits.											

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES						
600° C Thermal Run - Spike Recovery						
Date Received:	3/25/94	3/25/94		3/25/94	3/25/94	
Date Prep:	3/31/94	3/31/94		3/31/94	3/31/94	
Date Analyzed:	4/4/94	4/4/94		4/5/94	4/5/94	
Description:	Cyclone Solids	Cyclone Solids		Scrubber	Scrubber	
				Sludge	Sludge	
Dilution Factor:	1	1		50	50	
Sample No.	IT-5291MS	IT-5291MSD		IT-5302MS	IT-5302MSD	
PCE Sample No.:	3031530MS	3031530MSD		3041530DMS	3041530DMSD	
Concentration Units:	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD
phenol	81	81	0	105 *	172 *	-48 *
2-chlorophenol	76	76	0	62	68	-9
1,4-dichlorobenzene	71	71	0	0 *	0 *	0
N-nitroso-di-n-propylamine	69	69	0	0 *	0 *	0
1,2,4-trichlorobenzene	69	70	-1	0 *	0 *	0
4-chloro-3-methylphenol	76	78	-3	0 *	0 *	0
acensphthene	72	76	-5	77	87	-12
4-nitrophenol	57	63	-10	10 *	91	-160 *
2,4-dinitrotoluene	66	72	-9	0 *	0 *	0
pentachlorophenol	8 *	10 *	-22	0 *	0 *	0
pyrene	33 *	37	-11	265 *	283 *	-7
* = Values outside of QC limits			* = Values outside of QC limits			
RPD: 0 out of 11 outside limits			RPD: 2 out of 11 outside limits			
Spike Rec: 3 out of 22 outside limits			Spike Rec: 17 out of 22 outside limits			

APPENDIX G - 600°C THERMAL RUN

LEFPC - SEMIVOLATILES (continued)

600°C Thermal Run - Spike Recovery						
Date Received:	3/25/94	3/25/94		3/25/94	3/25/94	
Date Prep:	3/30/94	3/30/94		3/31/94	3/31/94	
Date Analyzed:	4/8/94	4/8/94		4/4/94	4/4/94	
Description:	Scrubber	Scrubber		Treated	Treated	
	Water	Water		Soil	Soil	
Dilution Factor:	10/25/1000	10/25/1000		1 LOW	1 LOW	
Sample No.	IT-5294MS	IT-5294MSD		IT-5289MS	IT-5289MSD	
PCE Sample No.:	3041530MS	3041530MSD		3021530MS	3021530MSD	
Concentration Units:	% Rec.	% Rec.	% RPD	% Rec.	% Rec.	% RPD
phenol	9999 *	9999 *	0	69	67	3
2-chlorophenol	122	83	38	59	56	5
1,4-dichlorobenzene	0 *	0 *	0	60	60	0
N-nitroso-di-n-propylamine	0 *	0 *	0	60	62	-3
1,2,4-trichlorobenzene	0 *	0 *	0	58	58	0
4-chloro-3-methylphenol	0 *	0 *	0	62	62	0
acensphibene	116	110	5	61	64	-5
4-nitrophenol	0 *	0 *	0	37	30	21
2,4-dinitrotoluene	0 *	0 *	0	55	56	-2
pentachlorophenol	30	46	42	4 *	1 *	120 *
pyrene	83	87	5	22 *	21 *	5
	* = Values outside of QC limits			* = Values outside of QC limits		
	RPD: 0 out of 11 outside limits			RPD: 1 out of 11 outside limits		
	Spike Rec: 14 out of 22 outside limits			Spike Rec: 4 out of 22 outside limits		

APPENDIX G - 600°C THERMAL RUN

LEFPC - TCLP PESTICIDES									
600°C Thermal Run									
Date Received:	3/25/94		3/25/94	3/25/94		NA		NA	
Date Prep:	4/1/94		4/1/94	4/1/94		4/1/94		4/1/94	
Date Analyzed:	4/6/94		4/6/94	4/6/94		4/6/94		4/6/94	
Matrix:	Soil		Soil	Soil		Soil		Liquid	
Description	Treated		Treated	Treated		TCLP		Method	
	Soil		Soil	Soil		Blank		Blank	
Dilution Factor:	1		1	1		1		1	
Sample No.	IT 5290		IT 5290MS	IT 5290MSD		BLK1		BLK2	
PCE Sample No.	3021530		3021530MS	3021530MSD		TCLP Blank		Blank	
Concentration Units:	µg/L	Q	% Rec	% Rec	% RPD	µg/L	Q	µg/L	Q
gamma-BHC (Lindane)	0.24	B	148*	158*	6	0.59		<0.2	U
heptachlor	<0.15	U	110	114*	4	<0.15	U	<0.15	U
heptachlor epoxide	<4.2	U	101	103	2	<4.2	U	<4.2	U
endrin	<0.3	U	112	116	4	<0.3	U	<0.3	U
methoxychlor	<8.8	U	145	148	2	<8.8	U	<8.8	U
chlordan	<0.7	U	NA	NA	NA	<0.7	U	<0.7	U
toxaphene	<12	U	NA	NA	NA	<12	U	<12	U
RPD: 0 out of 5 outside limits.									
Spike Recovery: 3 out of 10 outside									
U = Concentration of analyte is less than the value given									
B = Analyte found in the blank.									
* = Values outside of the QC limits.									
NA = Not Analyzed.									

APPENDIX G - 600°C THERMAL RUN

LEFPC - PCB ORGANICS																
600°C Thermal Run																
Date Received:	3/25/94		3/25/94		3/25/94		3/25/94		3/25/94		3/25/94		3/25/94		NA	
Date Prep:	3/31/94		3/31/94		3/30/94		3/30/94		3/31/94		3/31/94		3/31/94		3/30/94	
Date Analyzed:	4/4/94		4/4/94		4/4/94		4/4/94		4/5/94		4/5/94		4/5/94		4/1/94	
Matrix:	Soil		Soil		Water		Water		Sludge		Sludge		Solid		Water	
Description:	Treated		Cyclone		Scrubber		Scrubber		Scrubber		Scrubber		Scrubber		Method	
	Soil		Solids		Water		Water		Sludge		Sludge		Water Float		Blank	
Dilution Factor:	1		1		10		10		100		100		100		1	
Sample No.	IT-5288		IT-5291		IT-5293		IT-5293DUP		IT-5301DL		IT-5301DUPDL		IT-5333		BLK1	
PCB Sample No.	3021530		3031530		3041530		3041530DUP		3041530D		3041530DUPDL		3041530F			
Concentration Units:	µg/kg	Q	µg/kg	Q	µg/L	Q	µg/L	Q	µg/kg	Q	µg/kg	Q	µg/kg	Q	µg/L	Q
Aroclor-1221	<33	U	<33	U	<10	U	<10	U	<3300	U	<3300	U	<20000	U	<1.0	U
Aroclor-1232	<33	U	<33	U	<10	U	<10	U	<3300	U	<3300	U	<20000	U	<1.0	U
Aroclor-1242/1016	<33	U	<33	U	<10	U	<10	U	<3300	U	<3300	U	<20000	U	<1.0	U
Aroclor-1248	<33	U	<33	U	<10	U	<10	U	15000		15000		300000*		<1.0	U
Aroclor-1254	<33	U	<33	U	<10	U	<10	U	11000		12000		120000		<1.0	U
Aroclor-1260	<33	U	<33	U	<10	U	<10	U	5200		5600		48000		<1.0	U
Date Received:	NA		3/25/94		3/25/94		3/25/94		3/25/94		3/25/94		3/25/94		3/25/94	
Date Prep:	3/31/94		3/31/94		3/31/94		3/30/94		3/31/94		3/31/94		3/31/94		3/30/94	
Date Analyzed:	4/4/94		4/4/94		4/4/94		4/4/94		4/5/94		4/4/94		4/4/94		4/4/94	
Matrix:	Solid		Soil		Soil		Water		Sludge		Soil		Soil		Water	
Description:	Method		Treated		Cyclone		Scrubber		Scrubber		Treated		Cyclone		Scrubber	
	Blank		Soil		Solids		Water		Sludge		Soil		Solids		Water	
Dilution Factor:	1		1		1		10		100		1		1		10	
Sample No.	BLK2		IT-5288MS		IT-5291MS		IT-5293MS		IT-5301MSDL		IT-5288MSD		IT-5291MSD		IT-5293MSD	
PCB Sample No.			3021530		3031530		3041530		3041530D		3021530		3031530		3041530	
Concentration Units:	µg/kg	Q	% Rec.		% Rec.		% Rec.		% Rec.		% Rec.	% RPD	% Rec.	% RPD	% Rec.	Q
Aroclor-1221	<33	U	0		0		0		0		0		0		0	
Aroclor-1232	<33	U	0		0		0		0		0		0		0	
Aroclor-1242/1016	<33	U	0		0		0		0		0		0		0	
Aroclor-1248	<33	U	0		0		0		0		0		0		0	
Aroclor-1254	<33	U	84		87		179**		1456**		76	10	46	62	208**	15
Aroclor-1260	<33	U	0		0		0		0		0		0		0	
* = 1:200 dilution.																
U = Concentration of analyte is less than the value given.																
< = Values proceed by this symbol are the detection limits.																
** = Values outside of OC limits.1:200 dilution.																

APPENDIX G - 600°C THERMAL RUN

LEFPC - PCB ORGANICS (Continued)													
600°C Thermal Run													
Date Received:	3/25/94		3/10/94		NA								
Date Prep:	3/31/94		4/6/94		4/6/94								
Date Analyzed:	4/5/94		4/11/94		4/11/94								
Matrix:	Sludge		Water		Water								
Description:	Scrubber		Treated		Method								
	Sludge		Soil		Blank								
Dilution Factor:	100		1		1								
Sample No.	IT-5301MSDDL		IT-5140DUP		BLK3								
PCE Sample No.	3041530D		2022030										
Concentration Units:	% Rec.	% RPD	µg/L	Q	µg/L	Q							
Aroclor-1221	0		<1.0	U	<1.0	U							
Aroclor-1232	0		<1.0	U	<1.0	U							
Aroclor-1242/1016	0		<1.0	U	<1.0	U			* = 1:200 diluti				
Aroclor-1248	0		4.4		<1.0	U			U = Concentration of analyte is less than the value given.				
Aroclor-1254	2549**	54	3.1		<1.0	U			< = Values proceed by this symbol are the detection limits.				
Aroclor-1260	0		<1.0	U	<1.0	U			** = Values outside of QC limits.1:200 dilution.				

APPENDIX G - 600°C THERMAL RUN

MMES LEFPC - TCLP HERBICIDE							
600°C Thermal Run							
Date Received:	2/14/94		2/14/94	2/14/94		NA	
Date Extracted:	4/1/94		4/1/94	4/1/94		4/1/94	
Date Analyzed:	4/5/94		4/5/94	4/5/94		4/5/94	
Description	Treated		Treated	Treated		Method	
	Soil		Soil	Soil		Blank	
Matrix	TCLP		TCLP	TCLP		TCLP	
Dilution Factor:	low/1		low/1	low/1		low/1	
Sample No.	IT 5290		IT 5290MS	IT 5290MSD		HBLK	
PCE Sample No.	3021530		3021530MS	3021530MSD		BLANK	
Concentration Units	µg/L	Q	% Rec	% Rec	% RSD	µg/L	Q
2,4-D	<120	U	90	86	4	<120	U
2,4,5-TP (Silvex)	<17	U	122	120	1	<17	U
< = Values proceed by this symbol are the detection limits.							
U = Concentration of analyte is less than the value given.							

APPENDIX G - 600°C THERMAL RUN

MMES LEFPC - DIOXIN/FURAN							
600°C Thermal Run							
Date Received:	3/23/94		3/23/94	3/23/94		NA	
Date Analyzed:	3/30/94		3/30/94	3/30/94		3/30/94	
Description	Treated Soil		Treated Soil	Treated Soil		Method Blank	
Sample No.	IT 5317		IT 5317MS	IT 5317MSD		Blank	
PCE Sample No.	32021530		32021530	32021530		Method Blank	
Concentration Units	ng/g	Q	% Rec	% Rec	% RPD	ng/g	Q
Total-TCDD	<0.21	U	100	96	4.1	<0.16	U
Total-PeCDD	<0.29	U	104	96	8	<0.28	U
Total-HxCDD	<0.12	U	96	96	0	<0.12	U
Total-HpCDD	<0.15	U	96	104	-8	<0.22	U
OCDD	0.7	J	84	72	11.3	<0.15	U
Total-TCDF	<0.13	U	100	96	4.1	<0.12	U
Total-PeCDF	<0.28	U	100	96	4.1	<0.17	U
Total-HxCDF	<0.12	U	100	96	4.1	<0.067	U
Total-HpCDF	<1.1	U	96	88	8.7	<2.3	U
OCDF	<0.2	U	100	100	0	<0.063	U
U = Concentration of analyte is less than the value given.							
< = Values proceed by this symbol are the detection limits.							
J = Estimate only. Below instrument calibration range.							
NA = Not Applicable.							

APPENDIX G - 600°C THERMAL RUN

LEFPC - GENERAL CHEMISTRY			
350° Run			
Matrix:	Water	Water	Water
Prep Date:	4/4/94	4/4/94	4/4/94
Analytical Date:	4/4/94	4/4/94	4/4/94
Description	Scrubber	QC Reagent	Method
	Water	Blank	Blank
Sample No.	IT 5297	IT 5315	BLANK
PCE Sample No.	3041530	3061530RB	Blank
Concentration Units	mg/L	mg/L	mg/L
Sulfate	151	26.5	<1.0
< = Values proceed by this symbol are the detection limits.			
Matrix:	Water	Water	
Prep Date:	4/5/94	4/5/94	
Analytical Date:	4/5/94	4/5/94	
Description	Scrubber	Method	
	Water	Blank	
Sample No.	IT 5296	BLANK	
PCE Sample No.	3041530	Blank	
Concentration Units	mg/L	mg/L	
Total Organic Carbon	1650	<1.0	
< = Values proceed by this symbol are the detection limits.			

**Martin Marietta Energy Systems
Lower East Fork Poplar Systems
Residual Data**

APPENDIX G - RESIDUALS

LEFPC - PYRIDINE ANALYSIS					
Fenton's Reagent Treated - Run #3					
Sample	Concentration	Analysis	Metals	Fenton's Reagent	Sample
Number	ppm	Date	Precipitation	Treatment	Description
112404307	36.8	7/27/94	Yes	No	Scrubber Solution
112405910	25	8/1/94	Yes	Yes	pH 3 Trt Scrubber Soln
112406001	25.1	8/3/94	Yes	Yes	pH 7.5 Trt Scrubber Soln
LEFPC - PYRIDINE ANALYSIS					
Carbon Treated - Run #3					
Sample	Concentration	Analysis	Metals	Carbon	Sample
Number	ppm	Date	Precipitation	Treatment	Description
112406005	0.25	8/4/94	Yes	Yes	20:1 Carbon Trt Scrubber Soln
112406006	1.18	8/4/94	Yes	Yes	100:1 Carbon Trt Scrubber Soln
112406007	22.5	8/14/94	Yes	Yes	1000:1 Carbon Trt Scrubber Soln
112406008	2.28	8/10/94	Yes	Yes	100:1 Carbon Trt Scrubber Soln
112406101	0.54	8/12/94	Yes	Yes	50:1 Carbon Trt Scrubber Soln
112406102	0.93	8/12/94	Yes	Yes	50:1 Carbon Trt Scrubber Soln
LEFPC - PYRIDINE ANALYSIS					
Treated Decon Water					
Sample	Concentration	Analysis	Metals	Sample	
Number	ppm	Date	Precipitation	Description	
112406202	0.6	8/24/94	Yes	Treated Decon Water, Run #1	
112406203	0.5	8/24/94	Yes	Treated Decon Water, Run #2	
112406204	0.5	8/24/94	Yes	Treated Decon Water, Run #3	
112406201	1.7	8/24/94	Yes	Metals Precipitated Decon/Misc Water	
LEFPC - PYRIDINE ANALYSIS					
Scrubber Water					
Sample	Concentration	Analysis	Metals	Sample	
Number	ppm	Date	Precipitation	Description	
112406501	0.1	9/9/94	No	Scrubber Water	
112406502	0.3	9/9/94	No	Scrubber Water	
112406503	0.8	9/9/94	No	Scrubber Water	
Method Blank	<0.3	9/9/94	No	Method Blank	

APPENDIX G - RESIDUALS

[illegible]

APPENDIX G - RESIDUALS

[illegible]

APPENDIX G - RESIDUALS

[illegible]

APPENDIX G - RESIDUALS

[illegible]

Appendix H
LIST OF VARIANCES AND NONCONFORMANCES

Table F-1

**LEFPC Thermal Desorber Demo
Nonconformance Log Summary
IT Project No. 483138**

(Page 1 of 5)

Number	Date	Applicable Document	Description of Nonconformance
TDL-001-94	1/27/94	SAP	<p>Table 6-1 requires two samples to be analyzed for grain size but only one was pulled and analyzed. SAP requires two samples which is not common practice for geotechnical analyses for soils. Only one sample of representative size is normally used, not two.</p> <p>No corrective action required.</p>
TDL-002-94	1/27/94	WP	<p>Page 42 of Work Plan, para. 4-1, requires sample of the wet soil to be screened into 4-size fractions. Entire batch of soil screened at 0.5" and sample screened at approximately 0.1" + 1.0" screening was not performed. Because of the soil sample composition, a +1.0" screening was not practical. The entire soil batch was screened at +0.5" as part of the homogenization. 118.2 lbs. of clots, grass, and rock were removed with a majority of the material greater than +1.0".</p> <p>No corrective action required.</p>
TDL-003-94	2/23/94	SAP	<p>Changed the analytical from total U by gamma spec to calculation from α iso. Don Dihel, radiochemist at St. Louis lab, stated that gamma spec for U gave interferences from other isotopes and that by testing by KPA would not provide any more information than calculation from α iso. Work Plan says to test gamma spec for total U.</p> <p>Corrective action as stated above. Other analyses will be requested as calculations.</p>

Table F-1

(Page 2 of 5)

Number	Date	Applicable Document	Description of Nonconformance
TDL-005-94	2/23/94	WMP	<p>The Work Plan was deviated by storing the drum samples of LEFPC soil in a bermed area outside the high bay area. This was approved by the Task Manager, R. Anderson, and Waste Manager, K. Cole. This placed the samples in a storage area within the building and met the berming requirement. Lacked the material to construct a berm quickly for storage.</p> <p>Moved samples to bermed area.</p>
TDL-006-94	2/23/94	WP	<p>The Work Plan stated samples will be dropped in the chute test at 45°, 60°, and 75°. The 75° angle could not be obtained due to the construction of the chute. The maximum angle obtainable was 71° due to construction of chute.</p> <p>Test at 71°.</p>
TDL-016-94	4/21/94	SAP	<p>Metals analysis on TCLP extract performed by ICP SW-846 Method 6010 for all TCLP metals except Hg. Sampling and Analysis Plan specified GFAA methods for As, Cd, Se, and Pb. Lab misinterpreted RFA information/miscommunication. RFA was corrected by hand and GFAA analyses were added. Lab interpreted analyses to apply to solids instead of TCLP extract.</p> <p>ICP analyses provided data below regulatory limits for TCLP. Since ICP met data objectives, GAFF analyses will not be performed. Review and correct RFAs prior to test.</p>
TDL-017-94	3/10/94	SAP	<p>Total U analyses were performed on soil and sludge samples using KPA ASTM 5174-91 instead of gamma-spectroscopy as specified in Sampling and Analysis Plan. Lab suggested using KPA method to limit sample sizes needed which is important for some process stream samples - cyclone solids & DGTS solids.</p> <p>No corrective action needed since KPA analysis meets data quality objectives.</p>

Table F-1

(Page 3 of 5)

Number	Date	Applicable Document	Description of Nonconformance
TDL-018-94	3/10/94	SAP	<p>VOC analyses on cyclone solids obtained from Test 2 (pilot) were not performed as planned in project Sampling and Analysis Plan. Insufficient sample was collected for all analyses planned. VOCs were determined to be least important.</p> <p>VOC data will be obtained from VOST analyses, and off-gas treatment system liquid and sludge analyses as specified in SAP. Specify analyses will be performed provided sufficient sample is obtained.</p>
TDL-019-94	4/22/94	SAP	<p>Lab (ITAS-St. Louis) performed analysis + duplicate analysis for Level IV total U analysis where they were requested to test sample in triplicate. QC for total U is normally a duplicate analysis. Lab was requested to perform a duplicate analysis on some samples with QC which would result in triplicate analyses. Lab performed duplicate, considering it as QC.</p> <p>Duplicate analysis serves dual purposes of duplicate plus QC. No corrective action. Account for QC practice in sample type and number estimation needed for data objectives.</p>
TDL-020-94	3/14/94	SAP	<p>Samples sent to off-site lab for analysis were to be maintained at 4°C for preservation. Two coolers of samples sent to ITAS-St. Louis on 3/11 were returned to us by Federal Express on 3/14 for repacking and reshipping. Both cooler temperatures were measured to be 12°C upon receipt. Samples were improperly packaged/labeled.</p> <p>Sample-Hazard-Information-for-Package-Preparation (SHIPP) forms were prepared to plan sample packaging and labeling for proper shipment.</p>

Table F-1

(Page 4 of 5)

Number	Date	Applicable Document	Description of Nonconformance
TDL-023-94	4/22/94	SAP	<p>Due to confusion about our Request for Analysis, ITAS-St. Louis did not analyze the primary carbon sample (IT-5166) from the second pilot test (350°C) for SVOCs. Holding time for analysis has expired. Request for Analysis was corrected by hand to include SVOC analysis of reagent blank carbon using same analysis request description for IT-5166. Reagent blank carbon was analyzed in place of IT-5166 when it should have been analyzed in addition to IT-5166.</p> <p>Review and correct RFA information before sample collection.</p>
TDL-024-94	6/3/94 (3/4/94)		<p>Analyses of OGTS liquid & sludge for pre-pilot testing (RTA/Conditions Verification Test) were to be performed in duplicate. These analyses were performed but not in duplicate: Hg, VOC. Analyses originally slated for RTA testing were shifted to pilot conditions verification test and dups./scope were eliminated/reduced so analytical results could be obtained prior to final verification test.</p> <p>Single analyses results should meet data objectives.</p>
TDL-025-94	6/3/94		<p>Duplicate analyses on HEPA filter sample from 600°C test (Test 3) were not performed. Parameters - Hg, TCLP metals by ICP. Insufficient sample - per laboratory.</p> <p>Single analysis result should meet data objectives. Values were relatively low. Perform single analysis.</p>
TDL-026-94	6/3/94		<p>Duplicate analyses on OGTS liquid for Test 3 (600°C) were not performed. Parameters - Hg, As, Cd, SVOC. Miscommunication/misunderstanding of our request on FAS' request-for-analysis.</p> <p>Sample holding times have expired for SVOC analyses. Single sample analysis result should meet data objectives for all parameters. Clarify request on FAS' request-for-analysis (RFA) or use IT standard RFA.</p>

Table F-1

(Page 5 of 5)

Number	Date	Applicable Document	Description of Nonconformance
TDL-027-94	6/3/94 (3/10/94)		<p>Particle size analysis on cyclone solids from Test 2 (350°C) was not performed. Insufficient sample.</p> <p>Particle size analysis was performed on OGTS solids (sludge) from 350°C test (Test 2) and on both cyclone solids and OGTS solids from 600°C test (Test 3).</p>

Table F-2

**LEFPC Thermal Desorber Demo
Variance Log Summary
IT Project No. 483138**

(Page 1 of 4)

Number	Date	Applicable Document	Description of Variance
TDL-004-94V	2/23/94	WP	After testing the moist (as received) soil with no sticking at a 45 angle, the project manager directed to add moisture to obtain sticking condition and requested an accumulation weight on the chute be measured. Seven-foot drops were not performed.
TDL-007-94V	2/28/94	SAP	<p>Samples of aqueous liquid and solids will not be taken and analyzed for any RTA tests as called for in the WP. Instead these same matrices will be sampled and analyzed for the same parameters on samples from the shakedown pilot desorber test.</p> <p>Samples & analyses to be taken outside of the SAP for the shakedown pilot test: (1) Combined scrubber (condenser) liquid after filtration in recirculation system; (2) composite sludge sample from above solution (filter scrappings); (3) cyclone solids. Analyses: (1) Hg - Level II - in-house fast turnaround all samples; (2) gross alpha + beta - Level II in-house - all samples; (3) VOA - Level III - send to ITAS St. Louis, 3-day turnaround - scrubber liquid & sludge only plus scrubber liquid blank & trip blank. Above sampling should be essentially the same as for the verification tests except thorough scrubber system decon will not be done.</p> <p>Because of schedule compression and initial results from RTA tests, which led to focusing on achieving lower residual Hg, it does not make sense to take RTA scrubber liquid or solid samples. The data will not provide any advantage to further testing that cannot be better provided by actual pilot test samples.</p>

Table F-2

(Page 2 of 4)

Number	Date	Applicable Document	Description of Variance
TDL-008-94V	3/4/94	SAP	<p>Gas sampling of the desorber off-gas will be done using smaller flow rates to the sampling trains (e.g., 0.5 L/min) to minimize the amount of off-gas removed from the APC system. AQS, FAS, & PCE agreed on this change and that the concentrations of mercury, particulates and other constituents should be high enough to yield quantitative results.</p> <p>Original SAP called for 3 m³ of sample volumes (for 3 trains). Revised plan calls for (0.5 l/min) (4 trains) (60 min/hr) (6/m) = 720 l or 0.72 m³ vs original plan of (3 trains x 3 m³) + (1 train x 4 VOST pairs) (20 liters/pr) = 9.08 m³ of off-gas. This change requires modification of the 3 trains for metals, semi-vols & acid gases and rental of small capacity sampling pumps/control boxes.</p> <p>Use of normal larger flow rate sampling trains would remove 1/2 of the off-gas flow, making it more difficult to demonstrate Hg recovery and other treatment performance in the APC system. The original SAP should have reflected the smaller flow rate systems.</p>
TDL-009-94V	3/7/94	SAP	<p>Semi-vols for off-gas samples will be analyzed by the CLP method, EPA SOW OLMO1.8 instead of SW846-8270. This is due to need to send these samples to an outside lab (SRI) which normally uses the EPA SOW method. The client approved this change verbally on 3/7/94. Duane Root also approved.</p> <p>No corrective action required.</p>
TDL-010-94V	3/8/94	SAP	<p>Desorber off-gas solids from off-gas sampling train will not be analyzed for particle size as stated in SAP. Insufficient sample size expected on filter from sampling train for adequate testing.</p> <p>Particulate analyses will be performed on cyclone solids and filter bag solids as sample size will allow. This materials will provide better results of desorber particulate carryover particle size.</p>

Table F-2

(Page 3 of 4)

Number	Date	Applicable Document	Description of Variance
TDL-011-94V	3/22/94	SAP	<p>Soil/solid samples will be analyzed for Hg by SW-846 Method 7471 using a single analysis instead of being performed in triplicate as stated in Method. Triplicate analyses will make it difficult for results to be reported in desired TAT and project need does not require triplicate analyses to follow desorption process for a single material.</p> <p>Prescribed method will be followed using single aliquot analysis instead of triplicate aliquot analyses. Specify Method 7471 with single aliquot analysis.</p>
TDL-012-94V	3/24/94	SAP	<p>SAP specifies ammonia analysis by EPA method 350.2 on off-gas train samples. ITAS-St. Louis will perform by EPA 350.1. Originally, ITAS-MBK preferred EPA method 350.2. ITAS-St. Louis only performs EPA method 350.1. When analyses switched labs, standard analyses for ammonia at the labs changed. ITAS-St. Louis has automated equipment.</p> <p>Perform analysis by EPA 350.1. The methods are essentially equivalent and are both appropriate for data needs. Method 350.2 is a wet-chemical titrimetric procedure. Method 350.1 is an automated titrimetric procedure. Identify lab options and specify all method options which are acceptable.</p>
TDL-013-94V	3/24/94	SAP	<p>The loading on the VOST tubes from off-gas sampling exceeded calibration/linear ranges and, in some cases, saturated the instrument response. These VOST tubes (first in pair) will be desorbed into chilled methanol and an aliquot of the methanol will be analyzed by 8240. Gas stream is rich in organics and sampling time exceeded need.</p> <p>VOST tubes from off-gas sampling (first tube in pair) will be desorbed into methanol and an aliquot of the methanol analyzed by 8240. Decrease sampling time for VOST at this sampling point.</p>

Table F-2

(Page 4 of 4)

Number	Date	Applicable Document	Description of Variance
TDL-014-94V	3/22/94	SAP	<p>Loading of sampling media on SVOST samples (IT-5227) exceeded calibration/linear range for off-gas samples. Gas stream is rich in organics and sampling time was too long.</p> <p>SVOST samples for desorber off-gas will be diluted and re-analyzed (IT-5227) by 8270. Decrease sampling time for SVOST samples at desorber off-gas for future tests.</p>
TDL-015-94V	3/16/94	SAP	<p>Lab (ITAS-St. Louis) performed MS/MSD QC sample analyses instead of MS/PDS (post digestion spike) QC analyses requested on RFA. Lab performs MS/MSD analyses routinely for QC on CLP projects. Suggested consistency with CLP reporting, etc.</p> <p>No corrective action needed.</p>
TDL-021-94V	3/10/94	QAPjP	<p>Chain-of-Custody/Request for Analysis forms stated in QAPjP were not used. Instead computer generated forms developed by ITAS-FAS group were used where FAS collected samples.</p>
TDL-022-94V	5/11/94	SAP	<p>Section 7.4.5 of Sampling and Analysis Plan requires boring or cutting a representative section of the HEPA filter. Actual sampling required cutting filter apart and obtaining sample. HEPA filter construction and configuration make boring an unacceptable technique for obtaining sample. The only practical way is to cut and sample.</p> <p>No corrective action needed.</p>

Appendix I
CALCULATIONS

Material Balance Assumptions for Full-Scale Conceptual Thermal Description Facility

Poplar Creek
Project: 483138.07.02

Assumptions:

1. Wet soil feed rate = 35 tons/hour (70,000 pounds/hour)
2. Moisture in the wet soil = 25 percent
3. Purge gas = 3,000 scfm (dry)
4. Temperature of soil in the desorber = 350°C
5. Temperature in the off-gas to the Quench Scrubber = 175°C (347°F)
6. Particles carry-over to the Quench Scrubber = 1.5% of dry solids in feed
7. Temperature in the Quench Scrubber outlet water = 43°C (110°F)
8. Temperature of the recycle water to the Quench Scrubber = 30°C (85°F)
9. Solids concentration in the recycle water to the Quench Scrubber = 1%
10. Hg concentration in the recycle water to the Quench Scrubber = 1% of recycled dry solid
11. Particles in the off-gas from the Quench Scrubber = 1% of dry solids carryover from desorber
12. Slurry from centrifuge is 20% solids
13. Solids concentration in the centrate from the centrifuge = 1000 ppm
14. Ferric sulphate concentration to the flocculation water = 50 ppm as iron = 178.6 ppm as $\text{Fe}_2(\text{SO}_4)_3$
15. Solid concentration in the clarified water from the clarifier = 25 ppm
16. Solid concentration at the bottom of the clarifier = 6%
17. Mercury concentration in the off-gas from the Quench Scrubber = 52 ppm
18. Solids concentration in filter cake from filter press = 50% solids

POPLAR CREEK, OAK RIDGE, TN
PROJECT # 483138
ESTIMATOR: FHG. CHECKED: PCL

06/20/94

ITEM	QTY.	UNIT	MATERIAL COST	LABOR HRS	LABOR COST	OTHER COS & SUBCONT	TOTAL COST
MATERIALS HANDLING-FEED SOIL	-	-	-	-	-	-	-
GRIZZLY-110 TPH, 110 CYH	1	EA	\$98,000	40	\$1,694	\$25,000	\$124,694
2" VIBRATORY SCREEN-110 TPH, 110 CYH	1	EA	INCL. IN ABOVE	40	\$1,694		\$1,694
CONVEYOR-110 TPH, 110 CYH	1	EA	INCL. IN ABOVE	120	\$5,082		\$5,082
RADIAL STACKER CONVEYOR-110 TPH, 110 CYH, 100 FPM, 15 DEGREES	1	EA	\$32,000	120	\$5,082		\$37,082
SLOPE, 36" WIDTH, 50 FT LONG	-	-	-	-	-	-	-
SHREDDER	1	EA	\$145,000	80	\$3,388		\$148,388
MAGNETIC SEPARATOR-6.5KW-5' BELT. SELF CLEANING.	1	EA	\$33,000	48	\$2,033		\$35,033
LIVE BOTTOM HOPPER- 70 TONS, 70 CY(CARBON STEEL HOPPER)	1	EA	\$230,000	48	\$2,033		\$232,033
INCLINE FEED CONVEYOR-70 TPH,70CYH, 100 FPM, 15 DEGREES	1	EA	\$55,000	120	\$5,082		\$60,082
SLOPE,24" WIDTH, 135 FT LONG.	-	-	-	-	-	-	-
FEED PREP LOADER-CAT # 938 WHEEL LOADER	1	EA	\$102,000	32	\$1,355		\$103,355
FEED HOPPER LOADER-CAT # 938 WHEELLOADER	1	EA	\$102,000	32	\$1,355		\$103,355
CAT SS-250-SOIL STABILIZER	1	EA	\$225,000	32	\$1,355		\$226,355
SUBTOTAL MATERIALS HANDLING-FEED SOIL	1	LS	\$1,022,000	712	\$30,153	\$25,000	\$1,077,153
THERMAL TREATMENT	-	-	-	-	-	-	-
KILN FEED AIRLOCK VALVES-24" SQUARE	2	EA	\$14,654	24	\$1,016		\$15,670
THERMAL DESORBER (INDIRECTLY HEATED), 9' ID X 70 FT. LONG	2	EA	\$3,440,000	480	\$20,328		\$3,460,328
SUBTOTAL THERMAL TREATMENT	1	LS	\$3,454,654	504	\$21,344		\$3,475,998
MATERIALS HANDLING-TREATED SOIL	-	-	-	-	-	-	-
WET SOIL DRAG CONVEYOR-70 TONS/HR, 70 CYH	1	EA	\$150,000	240	\$10,164		\$160,164
RADIAL STACKER CONVEYOR-70 TPH, 70 CYH, 100 FPM, 15 DEGREES	1	EA	\$58,000	120	\$5,082		\$63,082
SLOPE, 24" WIDTH,100 FT LONG	-	-	-	-	-	-	-
SUBTOTAL MATERIALS HANDLING TREATED SOIL	1	LS	\$208,000	360	\$15,246		\$223,246
OFF-GAS TREATMENT	-	-	-	-	-	-	-
SPRAY TOWER-13,700 ACFM-GAS FLOW-31,800 LBS/HR	1	EA	\$277,860	80	\$3,388		\$281,248
SPRAY TOWER HEAT EXCHANGER-21MMBTUH	1	EA	INCL. IN ABOVE	32	\$1,355		\$1,355
MIST ELIMINATOR--GAS FLOW-14,300 LBS/HR-3,500 ACFM	1	EA	INCL. IN ABOVE	32	\$1,355		\$1,355
CHILLED BRINE CONDENSER IN @ 110 DEG F-OUT @ 45 DEG F.	1	EA	INCL. IN ABOVE	32	\$1,355		\$1,355
WET ELECTRO STATIC PRECIPITATOR-GAS FLOW-13,500 LBS/HR	1	EA	INCL. IN ABOVE	120	\$5,082		\$5,082
GAS REHEATER-3,100 ACFM-45-70 DEG. F.	1	EA	\$5,115	16	\$678		\$5,793
DUAL HEPA FILTER -REMOVAL EFFICIENCY-99.97 %	1	EA	\$7,000	32	\$1,355		\$8,355
VAPOR PHASE CARBON ADSORBERS	2	EA	RENTAL UNITS	-	-		-
VAPOR PHASE CARBON ADSORBER-SULPHIDE IMPREGNATED	1	EA	\$28,000	60	\$2,541		\$30,541
I D FAN-3,500 ACFM @ 12 INCHES WC	1	EA	\$3,435	60	\$2,541		\$5,976
STACK -15" OD X 9' TALL CARBON STEEL UNLINED STACK w/ TRNSITION	1	EA	\$2,900	32	\$1,355		\$4,255
PIECE FOR ID FAN & REQUIRED PORTS	-	-	-	-	-	-	-
SUBTOTAL OFF-GAS TREATMENT	1	LS	\$324,310	496	\$21,005		\$345,315

POPLAR CREEK, OAK RIDGE, TN
PROJECT # 483138
ESTIMATOR: FHG. CHECKED: PCL

06/20/94

ITEM	QTY.	UNIT	MATERIAL COST	LABOR HRS	LABOR COST	OTHER COS & SUBCONT	TOTAL COST
EFFLUENT TREATMENT	-	-	-	-	-	-	-
CENTRIFUGE-SOLID BOWL-160 GPM, 30" DIA X 96" LONG-2,000 GS	1	EA	\$400,000	60	\$2,541	-	\$402,541
CLARIFIER w/ FLOCCULATOR CENTER FEEDWELL AND INTERNALS.	1	EA	\$35,000	48	\$2,033	-	\$37,033
32 GPM, 12' DIA.- COATED CARBON STEEL CONSTRUCTION.	-	-	-	-	-	-	-
SLUDGE THICKENING TK. w/ BOTTOM RAKE-10,000 GALS-1/4" THK CS CONST	1	EA	\$35,000	48	\$2,033	-	\$37,033
12' DIA x 12' HIGH APPROX. w/ RAKE DRIVE & CONTROLS	-	-	-	-	-	-	-
FILTER PRESS w/FEED PUMP & CONTROLS 67 CU FT.	2	EA	\$301,286	32	\$1,355	-	\$302,641
CHEMICAL TREATMENT TANK-1200 GALS-CS	1	EA	\$2,800	24	\$1,016	-	\$3,816
CHEMICAL TREATMENT TANK-5000 GALS-CS	1	EA	\$3,600	24	\$1,016	-	\$4,616
CHEMICAL TREATMENT TANK-1200 GALS-CS	1	EA	\$2,800	24	\$1,016	-	\$3,816
CHEMICAL TREATMENT TANK-2000 GALS-CS	1	EA	\$2,800	24	\$1,016	-	\$3,816
AGITATORS FOR ABOVE TANKS	4	EA	\$15,000	64	\$2,710	-	\$17,710
AUTOMATIC BACKWASH FILTER, 32 GPM 7.5 LBS/DAY SOLIDS	1	PLC	\$23,000	32	\$1,355	-	\$24,355
LIQUID PHASE CARBON ADSORBERS	2	EA	RENTAL UNITS	-	-	-	-
SUBTOTAL EFFLUENT TREATMENT	1	LS	\$821,286	380	\$16,091	-	\$837,377

SUMMARY OF EQUIPMENT COSTS							
SUBTOTAL MATERIALS HANDLING-FEED SOIL	1	LS	\$1,022,000	712	\$30,153	\$25,000	\$1,077,153
SUBTOTAL THERMAL TREATMENT	1	LS	\$3,454,654	504	\$21,344	-	\$3,475,998
SUBTOTAL MATERIALS HANDLING TREATED SOIL	1	LS	\$208,000	360	\$15,246	-	\$223,246
SUBTOTAL OFF-GAS TREATMENT	1	LS	\$324,310	496	\$21,005	-	\$345,315
SUBTOTAL EFFLUENT TREATMENT	1	LS	\$821,286	380	\$16,091	-	\$837,377
SUBTOTAL EQUIPMENT COSTS	1	LS	\$5,830,250	2,452	\$103,839	\$25,000	\$5,959,089
ALLOWANCE UNIDENTIFIED EQUIPMENT (10% OF EQUIPMENT COST)	1	EA	-	-	-	\$595,909	\$595,909
ALLOWANCE OFF LOAD/SETTING.(5% OF EQUIPMENT COST)	1	EA	-	-	-	\$297,954	\$297,954
FREIGHT ALLOWANCE (5% OF EQUIPMENT COST)	1	EA	-	-	-	\$291,513	\$291,513
WORKMEN'S COMPENSATION(7% OF LABOR COSTS)	1	EA	-	-	-	\$7,269	\$7,269
TOTAL ADJUSTED PURCHASED EQUIPMENT COSTS	1	LS	\$5,830,250	2,452	\$103,839	\$1,217,645	\$7,151,734

POPLAR CREEK, OAK RIDGE, TN
 PROJECT # 483138
 ESTIMATOR: FHG. CHECKED: PCL

06/20/94

ITEM	QTY.	UNIT	MATERIAL COST	LABOR HRS	LABOR COST	OTHER COS & SUBCONT	TOTAL COST
ADJUSTED PURCHASED EQUIPMENT COST	1	LS	\$5,830,250	2,452	\$103,839	\$1,217,645	\$7,151,734
INFRASTRUCTURE COSTS							
SITE PREP& SITE IMPR OV,0.55% OF ADJUSTED PURCH. EQUIP'T COSTS	1	LS					\$39,335
CONCRETE- 1.1% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$78,669
STRUCTURAL STEEL-1.8% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$128,731
BUILDING-PREFABRICATED BUTLER BLDG FOR FEED PREP SYSTEM	1	LS					\$394,000
UNDERGROUND PIPING-.8% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$57,214
ABOVEGROUND PIPING -2.4% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$171,642
UNDERGROUND ELECTRICAL-1.1% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$78,669
ABOVEGROUND ELECTRICAL-2.6% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$185,945
INSTRUMENTATION-4% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$286,069
INSULATION-1% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$71,517
PAINTING-1% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$71,517
PAVING- .6% OF ADJUSTED PURCH. EQPT.COSTS	1	LS					\$42,910
PRORATABLES-.6% OF ADJUSTED PURCH.EQPT.COSTS	1	LS					\$42,910
SUBTOTAL: INFRASTRUCTURE COSTS.	1	LS					\$1,649,128
TOTAL DIRECT COSTS.	1	LS					\$8,800,862

POPLAR CREEK, OAK RIDGE, TN
 PROJECT # 483138
 ESTIMATOR: FHG. CHECKED: PCL

06/20/94

ITEM	QTY.	UNIT	MATERIAL COST	LABOR HRS	LABOR COST	OTHER COS & SUBCONT	TOTAL COST
INDIRECT COSTS	1	LS	-	-	-	-	-
SPARES-2% OF TOTAL ADJUSTED PUR.EQUPT.COSTS	1	LS	\$116,605	-	-	-	\$116,605
LIFTING EQUIPMENT(8 WEEKS RENTAL)(INCL. CRANE RENTAL FOR 1 WK)	1	LS	-	640	\$27,104	\$9,800	\$36,904
TRUCKS-2 TRUCKS- 8 WEEKS RENTAL	1	LS	-	640	\$27,104	\$3,200	\$30,304
MISCELLANEOUS EQUIPMENT RENTAL-8 WEEKS & CONSUMMABLES	1	LS	-	-	-	\$2,000	\$2,000
CONSUMMABLES-2% OF ADJUSTED PURCH. EQUPT. COSTS	1	LS	\$116,605	-	\$2,077	\$24,353	\$143,035
SALARY OF INDIRECT PERSONNEL(8 WEEKS DURATION)	1	LS	-	-	\$64,000	\$16,000	\$80,000
CONSTRUCTION FACILITIES (8 WEEKS RENTAL)	1	LS	-	-	-	\$8,000	\$8,000
OTHER INDIRECTS (1/2% OF TOTAL DIRECT COSTS)	1	LS	\$29,151	-	\$519	\$6,088	\$35,758
BONDING (3% OF TOTAL DIRECT COSTS)	1	LS	-	-	-	\$264,026	\$264,026
TAXES(5% OF ADJ.PURCH EQUIPMENT COSTS)	1	LS	\$291,513	-	-	-	\$291,513
HEALTH & SAFETY- FOR 8 WEEKS, ASSUMING 8 MEN WORKING CONTINUOUSLY	1	LS	-	-	\$18,960	\$4,740	\$23,700
WARRANTY COSTS(1% OF ADJ. PURCH. EQUPT. COSTS)	1	LS	\$58,303	-	-	-	\$58,303
SUBTOTAL INDIRECT COSTS.	1	LS	\$612,177	1,280	\$139,764	\$338,207	\$1,090,148
TOTAL CONTRACT COSTS.	1	LS	-	-	-	-	\$9,891,010
PROCESS ENGINEERING(3% OF CONTRACT COSTS)	1	LS	-	4,565	\$296,730	-	\$296,730
DETAIL ENGINEERING (9% OF CONTRACT COSTS)	1	LS	-	19,782	\$890,191	-	\$890,191
CONSTRUCTION MANAGEMENT(GENERAL CONTRACTOR)INCL.PROFIT	1	LS	-	-	-	\$692,371	\$692,371
PROJECT MANAGEMENT 15% OF TOTAL CONTRACT HRS @ \$100/HR.	1	LS	-	4,946	494,551	-	\$494,551
SUBTOTAL ENGINEERING,CONSTR.& PROJECT MANAGEMENT COSTS.	1	LS	-	29,293	\$1,681,472	\$692,371	\$2,373,843
TOTAL PLANT COSTS.	1	LS	-	-	-	-	\$12,264,853

POPLAR CREEK, OAK RIDGE, TN
PROJECT # 483138-YEARLY OPERATING & MAINTENANCE COSTS-90% ON- STREAM FACTOR
ESTIMATOR: FHG. CHECKED: PCL

06/20/94

ITEM	QTY.	UNIT	UNIT MAT'L COST	MATERIAL COST	LABOR HRS	LABOR BARE RATE	LABOR COST	TOTAL COST
CRAFT OPERATIONS	-	-	-	-	-	-	-	-
SHIFT SUPERVISORS	4	PERS			8,320	\$25	\$208,000	\$208,000
CONTROL ROOM OPERATORS	5	PERS			10,400	\$20	\$208,000	\$208,000
OUTSIDE SYSTEM OPERATORS	8	PERS			16,640	\$15	\$249,600	\$249,600
FEED PREP OPERATORS	13	PERS			27,040	\$15	\$405,600	\$405,600
TOTAL CRAFT OPERATIONS	1	LS			62,400		\$1,071,200	\$1,071,200
CRAFT MAINTENANCE	-	-	-	-	-	-	-	-
MAINTENANCE	10	PERS			20,800	\$16	\$332,800	\$332,800
TOTAL CRAFT MAINTENANCE	1	LS			20,800		\$332,800	\$332,800
I T - MANAGEMENT	-	-	-	-	-	-	-	-
I T FIELD STAFF	10	PERS			20,800	\$30	\$624,000	\$624,000
ON SITE Q/C TESTS	5	PERS			10,400	\$15	\$156,000	\$156,000
HEALTH & SAFETY	3	PERS			6,240	\$20	\$124,800	\$124,800
TOTAL I T MANAGEMENT	1	LS			37,440		\$904,800	\$904,800
I T - HOURLY	-	-	-	-	-	-	-	-
CLERICAL FIELD HIRE	9	EA			18,720	\$13	\$243,360	\$243,360
TOTAL I T HOURLY	1	LS			18,720		\$243,360	\$243,360
TOTAL YEARLY LABOR COSTS	1	LS			139,360		\$2,552,160	\$2,552,160
CHEMICALS	-	-	-	-	-	-	-	-
SULPHURIC ACID-98% STRENGTH	399,600	LBS	\$0.046	\$18,382				\$18,382
DOW CORNIND-#1400 ANTIFOAM-100% CONCENTRATION	252,000	LBS	\$2	\$504				\$504
DEGUSSA TMT-15 CHELANT-100% CONCENTRATION	5,040	LBS	\$0.2	\$1,008				\$1,008
FERRIC SULPHATE-50% CONCENTRATION	22,500	LBS	\$0.08	\$1,800				\$1,800
SODIUM HYDROXIDE-50%-CONCENTRATION	10,440	LBS	\$0.2825	\$2,950				\$2,950
NALCO NALCLEAR 7768-100% CONCENTRATION	684	LBS	\$2.52	\$1,724				\$1,724
TOTAL CHEMICALS	1	LS		\$26,368				\$26,368
UTILITIES	-	-	-	-	-	-	-	-
ELECTRICITY CONSUMPTION	18,920,206	KWHR	\$0.08	\$1,135,212				\$1,135,212
GAS CONSUMPTION	591,300,000	CUFT	\$0.00725	\$4,286,925				\$4,286,925
TOTAL UTILITIES	1	LS		\$5,422,137				\$5,422,137
ACTIVATED CARBON	-	-	-	-	-	-	-	-
VAPOR PHASE CARBON (ORGANICS)	32,850	LBS	\$2.3178	\$76,140				\$76,140
SULPHITE IMPREGNATED VAPOR PHASE CARBON (HG)	1,643	LBS	\$5.6438	\$9,273				\$9,273
LIQUID PHASE CARBON (ORGANICS & HG)	821,250	LBS	\$1.2111	\$994,616				\$994,616
TOTAL CARBON	1	LS		\$1,080,029				\$1,080,029
MANAGEMENT OF TREATMENT RESIDUES	5,749	TONS	\$800	\$4,599,200				\$4,599,200
TOTAL OPERATING & MAINTENANCE COSTS ON YEARLY BASIS	1	LS		\$11,127,734			\$2,552,160	\$13,679,894

POPLAR CREEK, OAK RIDGE, TN
PROJECT # 483138-DAILY OPERATING & MAINTENANCE COSTS ON-STREAM FACTOR
ESTIMATOR: FHG. CHECKED: PCL

09/07/94

ITEM	QTY.	UNIT	UNIT MAT'L COST	MATERIAL COST	LABOR HRS	LABOR BARE RATE	LABOR COST	TOTAL COST
CRAFT OPERATIONS	-	-	-	-	-	-	-	-
SHIFT SUPERVISORS	4	PERS	-	-	32	\$25	\$800	\$800
CONTROL ROOM OPERATORS	5	PERS	-	-	40	\$20	\$800	\$800
OUTSIDE SYSTEM OPERATORS	1	PERS	-	-	64	\$15	\$960	\$960
FEED PREP OPERATORS	1	PERS	-	-	104	\$15	\$1,560	\$1,560
TOTAL CRAFT OPERATIONS	1	LS	-	-	240	-	\$4,120	\$4,120
CRAFT MAINTENANCE	-	-	-	-	-	-	-	-
MAINTENANCE	10	PERS	-	-	80	\$16	\$1,280	\$1,280
TOTAL CRAFT OPERATIONS	1	LS	-	-	80	-	\$1,280	\$1,280
IT MANAGEMENT	-	-	-	-	-	-	-	-
IT FIELD STAFF	10	PERS	-	-	80	\$30	\$2,400	\$2,400
ON SITE Q/C TESTS	5	PERS	-	-	40	\$15	\$600	\$600
HEALTH & SAFETY	3	PERS	-	-	24	\$20	\$480	\$480
TOTAL IT MANAGEMENT	1	LS	-	-	144	-	\$3,480	\$3,480
IT-HOURLY	-	-	-	-	-	-	-	-
CLERICAL FIELD HIRE	9	PERS	-	-	72	\$13	\$936	\$936
TOTAL IT HOURLY	1	LS	-	-	72	-	\$936	\$936
TOTAL DAILY LABOR COSTS	1	LS	-	-	536	-	\$9,816	\$9,816
CHEMICALS	-	-	-	-	-	-	-	-
SULPHURIC ACID-98% STRENGTH	1,094	LBS	\$0.046	\$50	-	-	-	\$50
DOW CORNING-#1400 ANTI-FOAM-100% CONCENTRATION	690	LBS	\$2	\$1,380	-	-	-	\$1,380
DEGUSSA TMT-15 CHELANT-100% CONCENTRATION	13.50	LBS	\$0.2	\$3	-	-	-	\$3
FERRIC SULPHATE-50% CONCENTRATION	62.10	LBS	\$0.08	\$5	-	-	-	\$5
SODIUM HYDROXIDE-50% CONCENTRATION	288	LBS	\$0.2826	\$81	-	-	-	\$81
NALCO NALCLEAR 7768-100% CONCENTRATION	1.80	LBS	\$2.52	\$5	-	-	-	\$5
TOTAL CHEMICALS	1	LS	-	\$1,524	-	-	-	\$1,524
UTILITIES	-	-	-	-	-	-	-	-
ELECTRICITY CONSUMPTION	51,836	KWH	\$0.060	\$3,110	-	-	-	\$3,110
GAS CONSUMPTION	1,620,000	CUFT	\$0.00725	\$11,745	-	-	-	\$11,745
TOTAL UTILITIES	1	LS	-	\$14,855	-	-	-	\$14,855
ACTIVATED CARBON	-	-	-	-	-	-	-	-
VAPOR PHASE CARBON (ORGANICS)	90	LBS	\$2.3178	\$209	-	-	-	\$209
SULPHITE IMPREGNATED VAPOR PHASE CARBON (HG)	4.50	LBS	\$5.6438	\$25	-	-	-	\$25
LIQUID PHASE CARBON (ORGANICS & HG)	2,250	LBS	\$1.2111	\$2,725	-	-	-	\$2,725
TOTAL CARBON	1	LS	-	\$2,959	-	-	-	\$2,959
MANAGEMENT OF RESIDUES	15.750	TONS	\$800	\$12,600	-	-	-	\$12,600
TOTAL OPERATING & MAINTENANCE COSTS ON DAILY BASIS	1	LS	-	\$31,938	-	-	\$9,816	\$41,754