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# FIELD CHEMICAL EMISSIONS MONITORING PROJECT SITE 115 EMISSIONS REPORT

## PRELIMINARY DRAFT

Prepared For:

ELECTRIC POWER RESEARCH INSTITUTE
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NOVEMBER 14, 1994

EPRI
Electric Power
Research Institute *Leadership in Electrification through Global Collaboration*

October 27, 1994

Mr. William H. Maxwell, P.E. (MD13)
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Dear Mr. Maxwell:

In response to the Clean Air Act Amendments of 1990, the Electric Power Research Institute (EPRI) initiated the PISCES (Power Plant Integrated Systems: Chemical Emissions Studies) program to better characterize the source, distribution, and fate of trace elements from utility fossil-fuel-fired power plants. As part of the PISCES program, the Field Chemical Emissions Monitoring (FCEM) program has sampled extensively at a number of utility sites, encompassing a range of fuels, boiler configurations, and particulate, $SO_2$, and $NO_X$ control technologies. EPRI is actively pursuing additional FCEM sampling programs, with 29 sites either completed or planned.

This site report presents a preliminary summary of data gathered during a sampling program conducted at one of the FCEM sampling programs - Site 115. Site 115 consists of a pulverized coal boiler burning a western bituminous coal, with a fabric filter for particulate control. Baseline tests were conducted in November 1992. Phase II tests were conducted along with urea injection in March 1993.

The Site 115 sampling and analytical plan included some differences from the standard sampling and analytical plans at other FCEM sites. Specifically, the California Air Regulatory Board (CARB) methods were used to sample for the volatile organic compounds (VOCs) and the polycyclic aromatic hydrocarbons (PAHs). In the multi-metals trains, the filter and associated rinses were combined with the impinger fractions in order to obtain lower detection limits - thus only total metal concentrations are available, instead of differentiating between particulate and vapor phase concentrations.

The primary objective of this report is to transmit the preliminary results from Site 115 to the EPA for use in evaluating select trace chemical emissions from fossil-fuel-fired steam generating plants. **It should be noted that the results presented in this report are considered PRELIMINARY.** As additional data from other sites are collected and evaluated, EPRI may conduct verification

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tests at this site. If this is done, the new data will be made available to the Environmental Protection Agency (EPA).

In addition to the raw data in the Appendix, the report provides an assessment of the material balances, discusses the data quality, identifies suspect data, and offers possible explanations for the questionable data. This report does not compare the results from Site 115 with the results from previous utility sites. Nor does this site report attempt to address the environmental and health risk impacts associated with the trace chemical emissions.

EPRI hopes that this site report is of assistance to the EPA in evaluating utility trace chemical emissions as well as the associated health risk impacts.

Sincerely,

Paul Chu
Manager, Toxic Substances Control
Environmental Control Business Unit

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# SECTION 1.0

# INTRODUCTION

## 1.1 BACKGROUND AND OBJECTIVES

This report summarizes data gathered by Carnot at a power plant designated Site 115 for a program sponsored by the Electric Power Research Institute (EPRI) and the host utility. The objective of the Field Chemical Emissions Monitoring Project (FCEM) sponsored by EPRI is to measure the concentrations of selected inorganic and organic substances in the process and discharge streams of power plants. These data are being used to determine the fate and control of these substances.

The primary objectives of this report are to provide information on fuel composition and stack emissions and to evaluate these data according to the criteria outlined below. The information is presented in a format suitable for the U.S. Environmental Protection Agency (EPA) to use to study emissions from fossil fuel fired power plants, as mandated by the Clean Air Act Amendments (CAAA) of 1990. This report summarizes fuel and stack gas concentration data measured during the two phases of the operation of a pulverized western bituminous coal-fired boiler. Emissions were controlled by a low $NO_x$ burner with over-fire air (LNB/OFA) and a fabric filter dust collector (FFDC) during the first phase. Urea injection was added to the $NO_x$ controls during the second phase of the evaluation. Phase I testing was conducted in November 1992 with the unit at normal operating (baseline) conditions. Phase II testing was conducted in March 1993 with and without urea injection. Tests conducted during Phase II without urea injection included mercury and chromium speciation tests, and benzene and toluene tests. The benzene and toluene tests were repeated for verification of Phase I results.

Table 1-1 lists the substances of interest to the FCEM project. The target analyte list for Site 115 includes cyanide, ammonia and radionuclides. Cyanide and ammonia were added to the target list as possible products of urea injection. Additional evaluation tests for chromium and mercury were also chosen for study at Site 115. Carnot conducted the testing and has prepared this report using the following procedures to evaluate the data:

- The type and quantity of quality assurance samples were reviewed to determine the confidence that can be placed in the results; and

- The QA/QC results were compared with data quality objectives to evaluate precision and accuracy.

## TABLE 1-1
## FCEM SUBSTANCES OF INTEREST
## SITE 115

| Inorganic Species | Organic Compounds |
|---|---|
| Arsenic | Benzene |
| Barium | Toluene |
| Beryllium | Formaldehyde |
| Cadmium | Naphthalene |
| Chlorine (as chloride) | Acenaphthylene |
| Chromium | Acenaphthene |
| Cobalt | Fluorene |
| Copper | Phenanthrene |
| Fluorine (as fluoride) | Anthracene |
| Lead | Fluoranthene |
| Manganese | Pyrene |
| Mercury | Benz(a)anthracene |
| Molybdenum | Chrysene |
| Nickel | Benzo(b)fluoranthene |
| Phosphorus | Benzo(k)fluoranthene |
| Selenium | Benzo(a)pyrene |
| Vanadium | Indeno (1,2,3-cd)pyrene |
| Cyanide | Dibenzo(a,h)anthracene |
| Ammonia | Benzo(g,h,i)perylene |
| | 2-Methylnaphthalene |
| | 7,12-Dimethylbenz(a)anthracene |
| | 3-Methylcholanthrene |

Additional Substances

Total and hexavalent chromium by the EPA recirculation method*
Hg (0) and Hg (II) by the Nick Bloom/Frontier Geosciences methodology
Radionuclides:
- Uranium-233 & -234
- Uranium-235
- Uranium-238
- Radium-226
- Radium-228
- Lead-210
- Polonium-210
- Thorium-228
- Thorium-230
- Thorium-232

* Determination of Hexavalent Chromium Emissions from Stationary Sources, Methods Manual for Compliance with BIF Regulations, EPA/530-SW-91-010.

Results are presented for each substance by individual run and as an averaged total. To demonstrate data variability, the 95% confidence interval about the mean is also presented.

## 1.2 SAMPLING AND ANALYSIS PROTOCOL

The sampling and analysis protocol for Site 115 is described in Appendix A. The FCEM program has attempted to employ standard sampling and analytical procedures when possible. The methods used are comparable to those used at other FCEM sites with the following major exceptions:

- Benzene and toluene samples were collected in tedlar bags according to California Air Resources Board (CARB) methodology rather than using VOST sampling. At the time of sampling there were some concerns about the VOST method. Previous experience indicated that tedlar bag sampling gives adequate results.

- Exhaust gas metals were determined as the total per sample train rather than differentiating between particulate and vapor phase metals.

- PAHs were collected and analyzed according to CARB methodology. These samples were analyzed using isotope dilution methodology by high resolution gas chromatography/low resolution mass spectrometry with selected ion monitoring (HRGC/LRMS-SIM)

- Trace elements in coal were analyzed by ICP-AES, except lead which was analyzed by GFAAS and arsenic, barium, mercury and selenium which were analyzed by INAA.

## 1.3 QUALITY ASSURANCE/QUALITY CONTROL

The completeness of the quality assurance data was reviewed to judge whether the quality of the measurement data could be evaluated with the available information. In general, the results of the QC checks available for Site 115 indicate that the sample results are well characterized. An evaluation of the accuracy, precision, and bias of the data, even if only qualitative, is considered to be an important part of the data evaluation. A full discussion of each of these components of quality can be found in Section 5.0.

Standard QA/QC checks for this type of sampling program involve the use of: 1) replicate tests, duplicate field samples and lab analyses, and matrix spike and lab control duplicates to determine precision; 2) matrix spikes, surrogate spikes, and laboratory control samples to determine accuracy; and 3) field blanks, trip blanks, method blanks, and reagent blanks to determine if any of the samples were contaminated during collection or analysis. Most of these standard QA/QC checks were used on samples form Site 115. Some QA/QC checks do not apply to some types of analyses, for example, surrogate spikes do not apply to metals and anion analysis. The absence of any of these "standard" quality control checks from the Site 115 report does not necessarily reflect poorly on the quality of the data but does limit the ability to measure the various components of measurement error.

## 1.4 DATA QUALITY

The available QA/QC results were compared to the data quality objectives shown in Section 5.0. QA/QC results outside the data quality objectives are noted and discussed, other quality assurance values are evaluated, and the potential effect on data quality is noted. The detailed information presented in Section 5.0 supports the conclusion that the data quality objectives were met with the following exceptions:

- The collection and compositing of coal, bottom ash and flyash samples did not completely follow ASTM procedures. Coal and flyash samples were collected and composited from each of eight coal feed hoppers, and from the bottom of each of twelve ash hoppers. Bottom ash samples were collected during each bottom ash sluice. Results for metals and anions in coal and ash may not be representative.

- There are concerns with the quality of the FFDC inlet and outlet toluene results. Phase I toluene levels were 10 times higher at the FFDC outlet than at the inlet. Repeat tests performed during Phase II resulted in higher toluene levels at both sample locations, however blank levels for these tests represent 33-59% of sample levels.

- Results for three PAH compounds: indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene were not well quantified. Internal spike recoveries for these compounds in inlet samples were very low (<10%), and sample results were not recovery corrected.

- The mercury speciation tests performed at the FFDC inlet may not have accurately speciated mercury because half of the total mercury measured was collected in particulate which built up at the inlet of the first trap. It is not known in what proportions mercury species might have been trapped by carbon or other materials in this particulate. Results for one of the inlet tests were invalidated because of suspected sampling problems.

- Formaldehyde concentrations may be biased high. Formaldehyde field blank levels were 1-3 times the sample levels. The method allows field blank correction, however because the blank levels were high and extremely variable, this was not performed.

## 1.5 REPORT ORGANIZATION

Section 2.0 of this report briefly describes the plant, the FFDC and the sample locations. Section 3.0 discusses the results of the chemical analyses of the coal, ash and flue gas streams for baseline and urea injection tests. Section 4.0 discusses the results of the chromium and mercury speciation tests. Section 5.0 presents QA/QC and engineering evaluations of the data. Section 6.0 presents example calculations, and a glossary of terms is provided in Section 7.0. The appendices contain information on sampling and analytical methods, stream concentrations, sampling data, process operation, error propagation equations, and detailed QA/QC data.

# SECTION 2.0

## SITE DESCRIPTION

This section presents a description of the test site, designated Site 115, and the sampling locations at this site.

## 2.1 FACILITY INFORMATION

Site 115 is a roof-fired Babcock and Wilcox (B&W) boiler commissioned in 1955. The maximum rated capacity on this unit is 117 MW gross. This unit is capable of firing both coal and natural gas, however, only coal-firing was included in this project. Site 115 fires a western bituminous coal which enters the unit through 12 burners mounted on the roof. The unit shares a stack with another adjacent boiler unit.

Coal bunkers located on-site provide coal through eight coal feeders to four coal pulverizers before the fuel is introduced into the boiler. Each pulverizer supplies three burners, two on one side of the furnace division wall and one on the other. The configuration of Site 115 is summarized in Table 2-1. Figure 2-1 is a process flow diagram of Site 115.

## 2.2 FLUE GAS TREATMENT FACILITIES

B&W XCL low-$NO_x$ burners and overfire air ports have been installed for $NO_x$ control. A urea injection system was used for selective non-catalytic $NO_x$ reduction (SNCR) during the second phase of the program. Particulate matter is controlled by a retrofitted Ecolaire fabric filter dust collector (FFDC) with an air/cloth ratio of 2. The FFDC is designated for a 0.007 gr/dscf outlet dust concentration for up to 600,000 acfm of flue gas at 290°F.

## 2.3 ASH REMOVAL FACILITIES

Bottom ash consists of the larger, fused ash particles, the majority of which is wall slag removed by the wall blowers. Bottom ash is sluiced from the hopper into an ash pit water box and grinder prior to transport to a settling pond. Water from the settling pond is recirculated to the ash sluicing system. Bottom ash from the settling pond is transported off site for disposal. Water is added to the system to make up for evaporative loss and replace water entrained with the ash.

## TABLE 2-1
## UNIT 2 CONFIGURATION

| | |
|---|---|
| Maximum Gross Electrical Output (MW): | 117 |
| Particulate Control: | Fabric Filter Dust Collector |
| $NO_x$ Control: | Low $NO_x$ Burners/Over-Fire Air, Urea Injection (Phase II only) |
| Boiler Type: | Roof-fired |
| Fuel Type: | Western Bituminous Coal |
| Fuel Sulfur Content (%)[a] | |
| Phase I Baseline: | 0.49 |
| Phase II Baseline: | 0.60 |
| Phase II Urea Injection: | 0.49 |
| Fuel Ash Content (%)[a] | |
| Phase I Baseline: | 9.94 |
| Phase II Baseline: | 9.57 |
| Phase II Urea: | 9.49 |
| Fuel Heating Value (Btu/lb, dry)[a] | |
| Phase I Baseline: | 12,565 |
| Phase II Baseline: | 12,627 |
| Phase II Urea Injection: | 12,638 |
| No. of Coal Pulverizers: | 4 |
| No. of Feeders per Pulverizer: | 2 |
| Bottom Ash Disposal: | On-Site Pond, transported to landfill |
| Flyash Disposal: | Collected dry, transported to landfill |
| Cooling System: | Mechanical tower fans |
| Cooling Water Source: | River Water |

(a) Average values measured during sampling

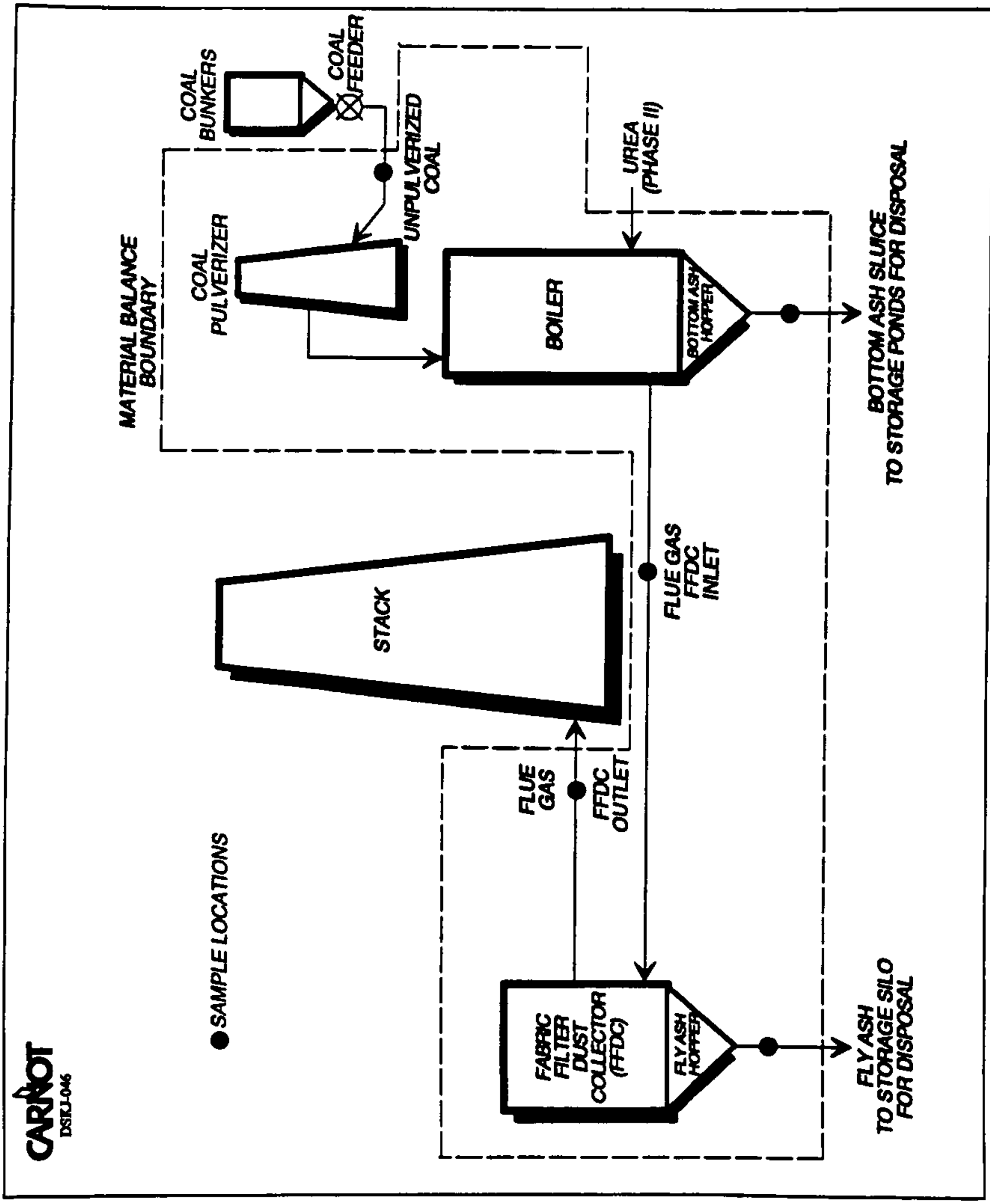



**Figure 2-1. Sample Locations at Site 115**

Flyash collects in 12 FFDC hoppers and is pneumatically conveyed to a flyash silo. This ash is also transported off site for disposal.

## 2.4 SAMPLING LOCATIONS

Samples were collected at the five sampling locations identified in Figure 2-1. Coal was the only feed stream sampled. One internal stream, the flue gas inlet to the FFDC, was sampled. Three discharge streams were sampled: the FFDC outlet exhaust gas, the flyash from the FFDC, and the bottom ash from the furnace.

A brief description of each sampling location follows:

- Coal samples were collected twice a day during flue gas emissions sampling. Samples were collected from each of eight coal feeder hoppers located just ahead of the coal pulverizers and combined. Phase I samples were composited daily for analysis and Phase II samples were analyzed separately to correspond with flue gas emissions tests.

- Flue gas entering the FFDC was sampled at the six available test ports on the FFDC inlet duct. A total of 42 points were sampled for each isokinetic test. This sampling location did not meet EPA Method 1 dimensional criteria, and three-dimensional velocity testing was conducted to determine the flow characteristics at this location. Ammonia tests were conducted at a location downstream of the primary inlet location.

- Flue gas exiting the FFDC was sampled at the eight available test ports on the outlet duct. This sampling location met EPA Method 1 criteria for minimum distances from flow disturbances. A total of 40 points were sampled for isokinetic tests. There were no accessible ports on the stack. Ammonia tests were conducted downstream of the primary outlet sampling location.

- Bottom ash sluicing was performed at the beginning, middle and end of each test day, immediately following sootblowing. Bottom ash was sluiced from the bottom ash hopper into the ash pit and then to a holding pond. Grab samples were collected from the ash pit during the midday and evening sluicing operations. Phase I samples were composited daily for analysis, and Phase II samples were analyzed separately to correspond with flue gas emissions tests. Sluice water blank samples were collected in conjunction with bottom ash samples for blank correction of bottom ash results.

- Flyash was removed from the FFDC hoppers to the ash storage silo at the beginning, middle and end of each test day immediately following FFDC bag cleaning. Grab samples were collected from each of the 12 FFDC hoppers and combined during the midday and evening ash removal. Phase I samples were composited daily for analysis, and Phase II samples were analyzed separately to correspond with flue gas emissions tests.

The procedures for collection, preparation and analysis of samples are discussed in Appendix A. Table 2-2 presents an overview of the types of analyses performed on these streams.

## 2.5 PROCESS OPERATION DURING TESTING

This FCEM test program was conducted in two phases. Both phases were performed after the LNB/OFA retrofit. Phase I tests were performed without operation of the urea injection system. During Phase II, tests were conducted both with and without operation of the urea injection system. Tests performed during Phases I and II were conducted at an average load of 104 MW with a range of 102-106 MW, which is 89% of the maximum rated load of 117 MW. The exceptions were the cyanide tests conducted during Phase II urea injection when the load was 115 MW, or 98% of the maximum rated load. A 32.5% solution was used for urea injection. The Phase II urea injection rate was 1.04 gpm for the first day of testing and 1.07 gpm for the second day of testing. Appendix E summarizes unit operating data for Phases I and II.

# TABLE 2-2
# PROCESS STREAM ANALYSES PERFORMED
# SITE 115

| Stream | Metals[a] | Anions[b] and anion precursors | Semi Volatile[c] Organics | Volatile[d] Organics | Particulate[e] | Radionuclides[f] | Cyanide | Ammonia | Total[g] and Hexavalent Chromium Evaluation | Mercury[h] Evaluation | Composition[i] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Baseline Tests:** | | | | | | | | | | | |
| Coal | ✓ | ✓ | | | | ✓ | | | | ✓ | ✓ |
| FFDC Inlet Gas | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| FFDC Outlet Gas | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | |
| Bottom Ash | ✓ | ✓ | | | | ✓ | | | | | |
| Flyash | ✓ | ✓ | | | | ✓ | | | | ✓ | |
| **Urea Injection Tests:** | | | | | | | | | | | |
| Coal | ✓ | ✓ | | | | | | | | | ✓ |
| FFDC Inlet Gas | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | |
| FFDC Outlet Gas | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | |
| Bottom Ash | ✓ | ✓ | | | | | | | | | |
| Flyash | ✓ | ✓ | | | | | | | | | |

(a) "Metals" include the target elements, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, phosphorus, selenium and vanadium.

(b) Anions include the target analytes, chloride, fluoride, and sulfate. These are collected in conjunction with particulate.

(c) Semi-Volatile Organics are nineteen PAH species.

(d) Volatile Organics are benzene, toluene, and formaldehyde.

(e) Particulate was collected in a combined train with anions for baseline and urea injection FFDC inlet and outlet tests. Radionuclides were added for baseline outlet tests only.

(f) Radionuclides include Uranium (3 isotopes), radium (2 isotopes), lead (1 isotope), polonium (1 isotope) and thorium (3 isotopes). These were analyzed from the solid particulate fractions of the baseline FFDC outlet samples only.

(g) Total and hexavalent chromium evaluation using EPA recirculation train, single point isokinetic test.

(h) Mercury evaluation was simultaneous single point sampling for mercury by Nick Bloom/Brooks Rand methodology. Coal and flyash were analyzed for total mercury only.

(i) Composition analysis of coal is carbon, hydrogen, nitrogen, sulfur, oxygen (by difference), moisture, ash, and higher heating value.

# SECTION 3.0

# RESULTS

This section summarizes the data collected at Site 115. Because the focus of this report is on exhaust gas emissions, only coal characterization data and gas stream data are presented here in detail. Sampling, preparation and analytical methods are summarized in Appendix A. Detailed data can be found in Appendices B and C. Baseline test results are presented in Section 3.3. Urea injection test results are presented in Section 3.4. Baseline ammonia tests were performed to establish baseline levels of ammonia in the exhaust gas, and the results are not used to calculate emissions. Results for these tests are located in Appendix C. Chromium and mercury speciation test results are presented in Section 4.0.

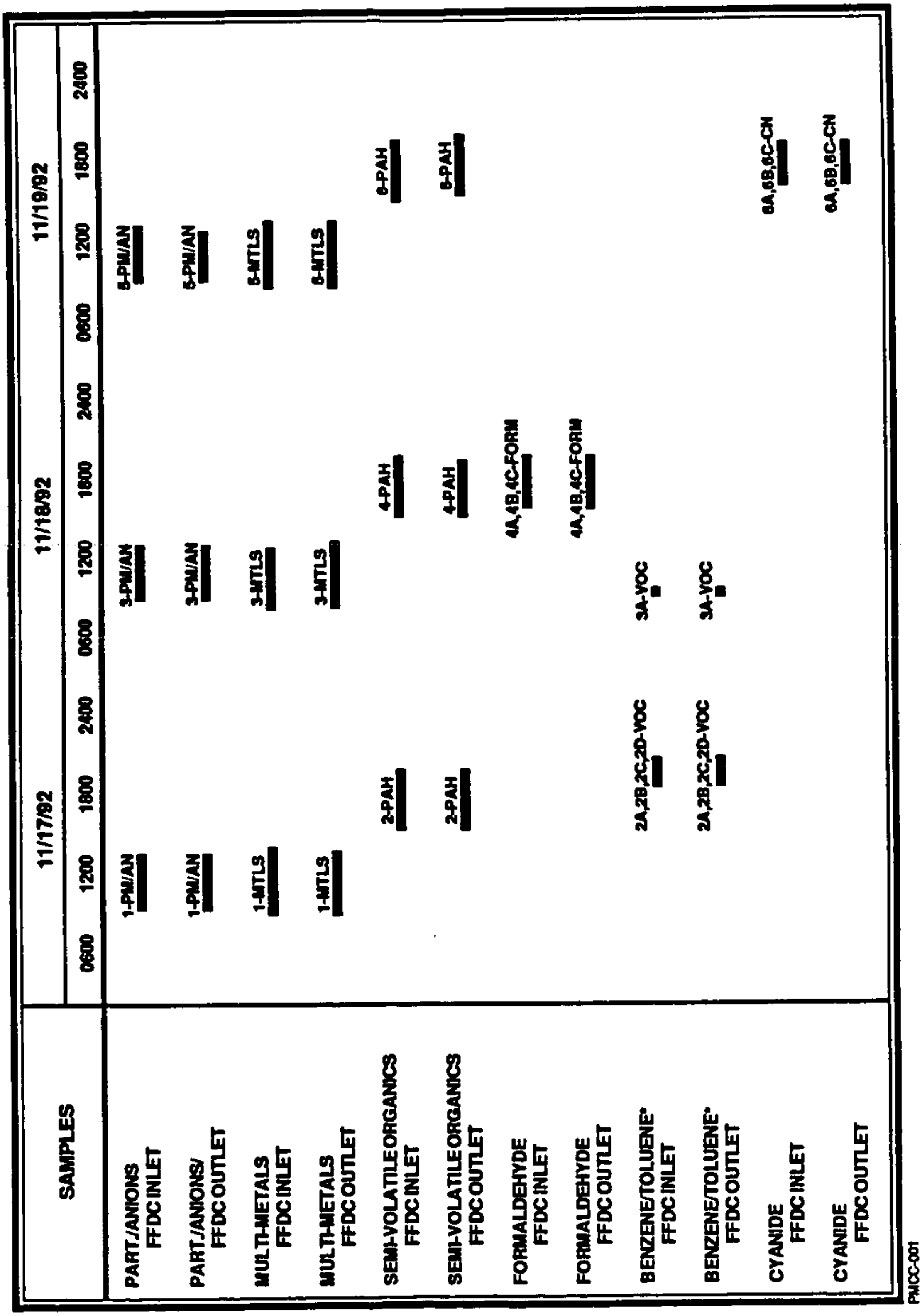
## 3.1 SAMPLING SCHEDULE

Phase I baseline testing at Site 115 was conducted in November 1992, and Phase II baseline and urea injection testing was conducted in March 1993. Figure 3-1 presents the sampling schedule for Phase I baseline testing. Figure 3-2 presents the sampling schedule for Phase II urea injection tests and Figure 3-3 presents the sampling schedule for Phase II baseline tests. Test numbers have been assigned sequentially and all tests conducted simultaneously have the same number. Additional designators indicate the sample train type and sampling location.

Seven types of sampling trains were used to collect flue gas samples from the FFDC inlet and outlet ducts during Phase I testing. These trains were: multi-metals trains, semi-volatile organics trains, particulate/anions/radionuclides trains, tedlar bag samples for benzene and toluene, formaldehyde trains, cyanide trains and ammonia trains. Radionuclides were only measured at the FFDC outlet. For Phase II urea injection testing, only emissions of species which could potentially be impacted by urea injection were sampled. The trains used included: multi-metals, particulate/anions, cyanide and ammonia trains. Sample trains used for Phase II baseline testing included tedlar bag samples for benzene and toluene, chromium speciation trains and mercury speciation trains.

Each multi-metals, particulate/anions/radionuclides, and semi-volatile organic sample required a simultaneous full traverse of the inlet and outlet ducts. Cyanide tests were conducted isokinetically at the midpoint of each of four ports on the FFDC inlet duct, and simultaneously at a single point at the FFDC outlet. Benzene/toluene and formaldehyde samples were collected non-isokinetically at four points at the inlet and a single point at the outlet.

Phase I baseline ammonia samples were collected non-isokinetically at the midpoint of each of six ports located fifteen feet downstream of the primary inlet sample location. Ammonia




NOTES:
▬ CONTINUOUS SAMPLING
* BAGS FOR INLET TESTS 2A AND 2D LEAKED AND WERE NOT ANALYZED. CORRESPONDING OUTLET BAGS WERE ALSO NOT ANALYZED.

***Figure 3-1. Site 115 Sampling Schedule - Phase I Baseline***

| SAMPLES | 11/17/92 | 11/18/92 | 11/19/92 |
| --- | --- | --- | --- |
| | 0600 1200 1800 2400 | 0600 1200 1800 2400 | 0600 1200 1800 2400 |
| AMMONIA FFDC INLET• | 2A,2B,2C-$NH_3$ ▬ | | |
| COAL+ | 1-COAL ● 2-COAL ● METALS, CHLORINE, FLUORINE, SULFUR, COMPOSITION, RADIONUCLIDES | 3-COAL ● 4-COAL ● METALS, CHLORINE, FLUORINE, SULFUR, COMPOSITION, RADIONUCLIDES | 5-COAL ● 6-COAL ● METALS, CHLORINE, FLUORINE, SULFUR, COMPOSITION, RADIONUCLIDES |
| BOTTOM ASH+• | 1-BOTTOM ASH ● 2-BOTTOM ASH ● METALS, ANIONS, RADIONUCLIDES, LOI | 1-BOTTOM ASH ● 2-BOTTOM ASH ● METALS, ANIONS, RADIONUCLIDES, LOI | 1-BOTTOM ASH ● 2-BOTTOM ASH ● METALS, ANIONS, RADIONUCLIDES, LOI |
| FLY ASH+ | 1-FLY ASH ● 2-FLY ASH ● METALS, ANIONS, RADIONUCLIDES, LOI | 3-FLY ASH ● 4-FLY ASH ● METALS, ANIONS, RADIONUCLIDES, LOI | 5-FLY ASH ● 6-FLY ASH ● METALS, ANIONS, RADIONUCLIDES, LOI |

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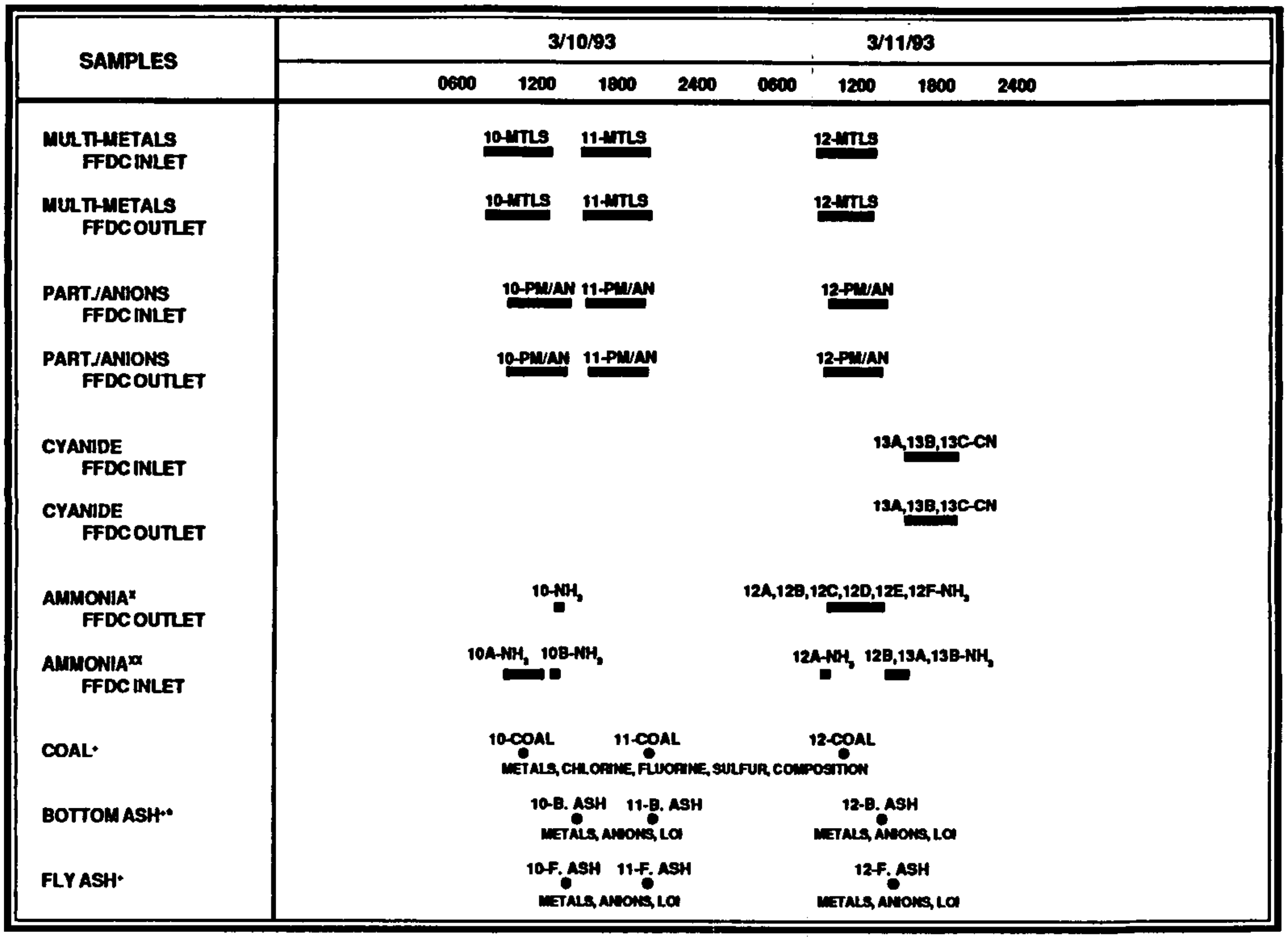
**NOTES:**

- ▬ CONTINUOUS SAMPLING
- ● GRAB SAMPLING
- \+ COAL, BOTTOM ASH AND FLY ASH SAMPLES FOR 11/17, 11/18 AND 11/19 WERE COMBINED INTO DAILY COMPOSITE SAMPLES FOR ANALYSIS. COAL SAMPLES WERE ANALYZED FOR COMPOSITION, METALS, ANION PRECURSORS AND RADIONUCLIDES. BOTTOM ASH AND FLY ASH SAMPLES WERE ANALYZED FOR METALS, ANIONS, RADIONUCLIDES AND LOI.
- • SLUICE WATER SAMPLES CORRESPONDING TO EACH BOTTOM ASH SAMPLE WERE COLLECTED AND ANALYZED FOR BLANK CORRECTION OF BOTTOM ASH RESULTS.
- • INLET AMMONIA TESTS WERE CONDUCTED AT THE MIDPOINT OF EACH OF SIX PORTS LOCATED 15 FEET DOWNSTREAM OF THE PRIMARY INLET SAMPLING LOCATION.

***Figure 3-1. Site 115 Sampling Schedule - Phase I Baseline (Continued)***

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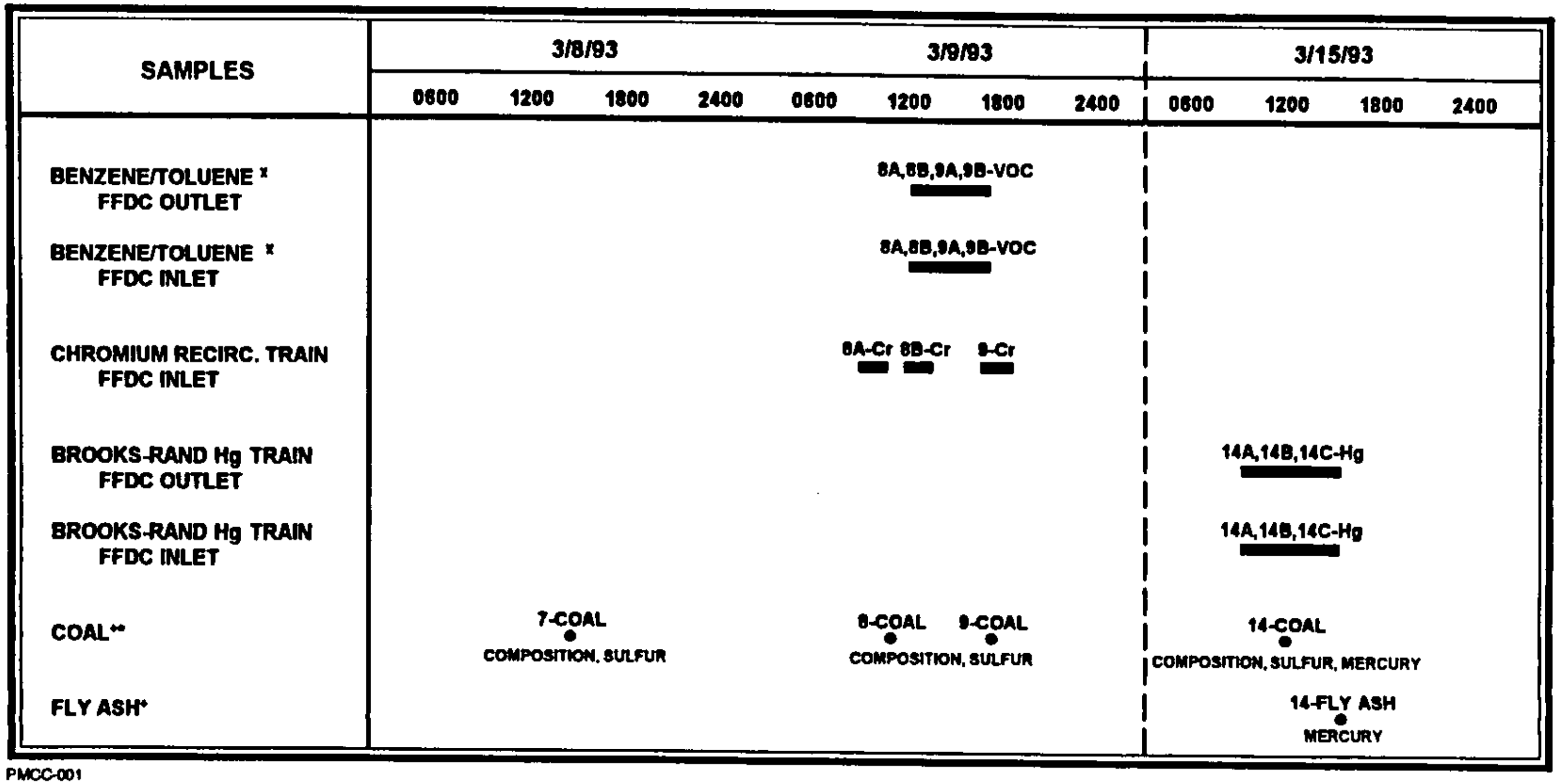
**NOTES:**

- ▬ CONTINUOUS SAMPLING
- ● GRAB SAMPLE
- * OUTLET AMMONIA TESTS WERE CONDUCTED AT A SINGLE POINT 20 FEET DOWNSTREAM OF THE PRIMARY OUTLET LOCATION.
- ** INLET AMMONIA TESTS WERE CONDUCTED AT THE MIDPOINT OF EACH OF FOUR PORTS LOCATED 50 FEET DOWNSTREAM OF THE PRIMARY INLET SAMPLING LOCATION. TEST 10A IS A COMPOSITE OF FOUR SINGLE POINT TESTS, ONE AT THE MIDPOINT OF EACH PORT.
- \+ COAL SAMPLES FOR 3/10 WERE COMPOSITED AND ANALYZED ALONG WITH COAL 3/11 AM FOR COMPOSITION, CHLORINE AND METALS (INAA ONLY). COAL SAMPLES 10-COAL, 11-COAL AND 12-COAL WERE EACH ANALYZED FOR METALS AND ANION PRECURSORS. BOTTOM ASH AND FLY ASH SAMPLES 10, 11 AND 12 WERE EACH ANALYZED FOR METALS, ANIONS AND LOI.
- • SLUICE WATER SAMPLES CORRESPONDING TO EACH BOTTOM ASH SAMPLE WERE COLLECTED AND ANALYZED FOR BLANK CORRECTION OF BOTTOM ASH RESULTS.

*Figure 3-2. Site 115 Sampling Schedule - Phase II Urea Injection*

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***NOTES:***

- ▬ CONTINUOUS SAMPLING
- ● GRAB SAMPLING
- \+ COALSAMPLES FOR 3/8, 3/9 (COMPOSITE) AND 3/15 WERE ANALYZED FOR COMPOSITION.
- * COAL AND FLY ASH SAMPLES FOR 3/15 WERE ANALYZED FOR TOTAL MERCURY.
- x SAMPLES FOR INLET TEST 8B AND OULET TEST 9B WERE EXTRA SAMPLES COLLECTED IN CASE OF TEDLAR BAG LEAKS; ANALYSIS RESULTS FOR THESE TESTS WERE NOT USED.

***Figure 3-3. Site 115 Sampling Schedule - Phase II Baseline***

samples were not collected at the FFDC outlet during Phase I. Phase II urea injection ammonia samples were collected non-isokinetically at the midpoint of each of four ports located 50 feet downstream from the primary inlet sample location, and at a single point 20 feet downstream from the primary outlet sample location.

Phase II baseline hexavalent and total chromium tests were performed at a single point at the FFDC inlet using the EPA recirculation train. Chromium speciation tests were not performed at the FFDC outlet because outlet particulate levels were too low to allow accurate assessment of the $Cr^{6+}/Cr_{total}$ ratio.

Phase II baseline mercury speciation tests were performed simultaneously at the FFDC inlet and outlet using the Nick Bloom/Brooks Rand solid sorbent method, which speciates oxidized mercury (Hg(II)) and elemental mercury (Hg(0)) by collection on KCl/sodalime and iodated carbon cartridges. Coal and flyash samples collected during exhaust gas mercury speciation tests were also analyzed for total mercury by Nick Bloom.

## 3.2 DATA TREATMENT

Several conventions were developed for treating the test data and developing average concentrations of substances in the coal and flue gas streams. The conventions used in this report are consistent with the PISCES FCEM data treatment procedures.

### 3.2.1 Blank Corrections

The individual run measurements were corrected for the reagent blank analysis when it was available and when it is allowed by the reference method. If a reagent blank was not analyzed or was considered nonrepresentative, the measurement was corrected for a laboratory blank. The laboratory blank is not exposed to field conditions and contains only the chemicals needed for analysis so it is expected to be lower than a reagent blank. Generally, field blank analyses are used to provide information on sample collection conditions but not to correct the results. When the blank correction is equal to or greater than 50% of the uncorrected measurement, the concentration is flagged with a "B". When the blank correction results in a value less than the reporting limit, the concentration is presented as detected at the reporting limit. Appendix H presents blank correction data, and an example of how blank correction contribution is calculated.

### 3.2.2 Average Concentrations

The following criteria were used to average data from the individual runs.

- When all values are above the reporting limit, the mean arithmetic concentration is calculated using the reported quantities.

- For results that include values both above and below the reporting one-half of the reporting limit is used for values below the reporting limit to calculate the mean. For example:

| Analytical Values | Calculation | Mean Value |
|---|---|---|
| 10,12,ND(8) | (10+12+[8/2])/3 | 8.7 |

By our convention, the calculated mean cannot be smaller that the largest reporting limit value. In the following example, the calculated mean is 2.8. This is less than the largest reporting limit, so the reported mean becomes ND(4).

| Analytical Values | Mean Value |
|---|---|
| 5,ND(4), ND(3) | ND(4) |

- When all analytical results are less then the reporting limit, the presented value is the largest reporting limit value expressed as ND (the largest reporting limit value).

### 3.2.3 Summation of Multiple Train Fractions

Some sample trains, such as the anions, are analyzed in multiple fractions. If all fractions were detected, the total emissions were reported as the sum of the measurements. If all fractions were not detected, total emissions were reported as not detect, less than the sum of the reporting limits of the fractions. If one or more, but not all fractions were not detected, the total is reported as the sum of the detected values and one-half of the reporting limit for the non-detected values.

### 3.2.4 Method Detection Limit and Reporting Limit

The method detection limit (MDL) is defined by 40 CFR 136, Appendix B - Definition and Procedure for the Determination of the Method Detection Limit - Revision 1. It states, "The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte." The MDL is determined by seven replicate analyses of an analyte in a given matrix at one to five times the estimated MDL. It is calculated as:

$$MDL = 3.143\ S$$

where:

S is the standard deviation of the replicate analyses, and

3.143 is the student "t" value corresponding to seven replicates with n-1 degrees of freedom at the 99% confidence level.

Additional criteria are imposed by the procedure for calculating subsequent method reporting limits. In practice, the method detection limit can be impacted by variability in performing the analytical procedure, the sample matrix and the analyte concentration of the sample. Because the method detection limit may not completely specify the confidence an analytical laboratory has in reporting a result, a laboratory typically presents a reporting limit or quantitation limit. The numerical difference between the method detection limit as defined by the CFR and a laboratory's reporting limit varies for different types of analyses and sample matrices but generally varies from the MDL value to approximately three times greater than the MDL. The values presented in this report are all based on individual laboratories' stated reporting limits. Both the detection limit and the reporting limit are indicated by "ND" in this report.

### 3.2.5 Assignment of Bias and Uncertainty Estimates

In calculating uncertainties that are presented in this report, procedures were followed that have been previously established for FCEM data treatment. This procedure involved calculating an overall uncertainty for each result using standard statistical techniques and known measurement biases. An error propagation analysis was performed on calculated results to determine the contribution of process, sampling and analytical variability, and measurement bias, to the overall uncertainty in the result.

Example calculations and bias and uncertainty estimates are presented in Appendix F.

## 3.3 BASELINE TEST SERIES

### 3.3.1 Coal

This section presents the analytical results for the coal samples collected during the Phase I baseline test series. Complete results are presented in Appendix B for all samples. Appendix A presents the analytical methodology. Table 3-1 presents fuel composition, metals, radionuclides and anion precursor results for each of the three test days. Table 3-1 also presents the mean value and the percent uncertainty in the results calculated at the 95% confidence interval about the mean. The confidence interval is the range about the mean in which the true mean lies within a given probability. For example, it is 95% certain that the true mean nickel concentration in the coal is between 0.1 and 1.1 mg/kg. The confidence interval calculation is discussed in Section 6.0.

Coal sample collection procedures did not completely follow ASTM standard methods. Results for some target analytes may not be representative of the coal fired. Trace species results would be most impacted by nonrepresentative sampling. Results for coal composition, including sulfur, are likely to be unaffected and therefore representative.

Measurements of the analyte concentrations in coal reported here were made using what Carnot considered to be the most applicable method. The method chosen was an accepted

## TABLE 3-1
## COAL ANALYSIS FOR SITE 115
## PHASE I: BASELINE

| Parameter | Run 1/2 | Run 3/4 | Run 5/6 | Mean | 95% C.I. |
|---|---|---|---|---|---|
| Date | 11/17/92 | 11/18/92 | 11/19/92 | | |
| Fuel Flow, lb/hr (wet)[1] | 86,837/91,797 | 88,919/91,265 | 88,752/90,452 | 89,670 | 1941 |
| Moisture, % | | | | | |
| Ash, % (dry) | 10.45 | 10.00 | 9.38 | 9.94 | 1.33 |
| Sulfur, % (dry) | 0.53 | 0.49 | 0.46 | 0.49 | 0.09 |
| HHV, Btu/lb (dry) | 12,507 | 12,548 | 12,639 | 12,565 | 163 |
| Trace Metals, mg/kg (wet) | | | | | |
| Arsenic | 0.55 | 0.40 | 0.49 | 0.48 | 0.19 |
| Barium | 350 | 525 | 383 | 419 | 232 |
| Beryllium | 0.21 | 0.24 | 0.23 | 0.22 | 0.04 |
| Cadmium | 0.09 | ND(0.05) | ND(0.05) | ND(0.05) | NC |
| Chromium | 0.8 | 1.3 | 1.1 | 1.1 | 0.6 |
| Cobalt | 0.8 | 1.0 | 1.0 | 0.9 | 0.3 |
| Copper | 2.7 | 2.8 | 2.7 | 2.7 | 0.2 |
| Lead | 2.1 | 2.5 | 1.6 | 2.1 | 1.2 |
| Manganese | 3.4 | 5.9 | 3.4 | 4.2 | 3.6 |
| Mercury | 0.025 | 0.026 | 0.013 | 0.021 | 0.018 |
| Molybdenum | ND(0.1) | ND(0.1) | 0.2• | 0.1 | 0.2 |
| Nickel | 0.4• | 0.8• | 0.5• | 0.6 | 0.5 |
| Selenium | 0.75 | 0.77 | 0.93 | 0.82 | 0.25 |
| Vanadium | 2.6 | 3.5 | 2.8 | 3.0 | 1.2 |
| Anion Precursors, mg/kg, (wet) | | | | | |
| Chlorine | 19 | 22 | 26 | 22 | 7.6 |
| Fluorine | 79 | 89 | 85 | 84 | 13 |
| Phosphorus | 510 | 350 | 370 | 410 | 218 |

(continued)

Notes:
ND( ) - not detected at the reporting limit
NC - Not Calculated
• Species detected at less than five times the reporting limit.
INAA used for determination of arsenic, barium, mercury and selenium.
ICP-AES used for determination of Be, Cd, Cr, Co, Cu, Mn, Mo, Ni, P and V.
GFAAS used for determination of Pb.
[1] Fuel flow rate by plant instrumentation.
Fuel composition results are presented in Appendix B.

**TABLE 3-1 (continued)**
**COAL ANALYSIS FOR SITE 115**
**PHASE I: BASELINE**

| Parameter | Run 1/2 | Run 3/4 | Run 5/6 | Mean | 95% C.I. |
|---|---|---|---|---|---|
| Date | 11/17/92 | 11/18/92 | 11/19/92 | | |
| Radionuclides, pCi/g | | | | | |
| Uranium-233 & 234 | 0.16 | 0.13 | 0.11 | 0.13 | 0.06 |
| Uranium-235 | ND(0.01) | ND(0.01) | 0.02 | 0.01 | 0.02 |
| Uranium-238 | 0.12 | 0.05 | 0.11 | 0.09 | 0.09 |
| Radium-226 | 0.29 | 0.31 | 0.24 | 0.28 | 0.09 |
| Radium-228 | 0.35 | 0.20 | 0.16 | 0.24 | 0.25 |
| Lead-210 | 0.37 | ND(0.69) | 0.77 | ND(0.69) | NC |
| Polonium-210 | 0.10 | ND(0.10) | 0.20 | 0.12 | 0.20 |
| Thorium-228 | 0.09 | 0.08 | 0.12 | 0.10 | 0.05 |
| Thorium-230 | 0.12 | 0.17 | 0.30 | 0.20 | 0.24 |
| Thorium-232 | 0.12 | 0.04 | 0.15 | 0.10 | 0.14 |

Notes:
ND( ) - not detected at the reporting limit
NC - Not Calculated
Radionuclides results are presented on a dry basis.

analytical method for the sample matrix, had an acceptably low reporting limit and demonstrated acceptable precision and accuracy. The measurement methods used are listed in Appendix A.

Methods for metals analysis of coal using inductively coupled plasma atomic emission spectroscopy (ICP-AES) and atomic absorption techniques are well established and were used for determination of most elements. ICP-AES was used for the determination of beryllium, cadmium, chromium, cobalt, copper, manganese, molybdenum, nickel, phosphorus and vanadium. Graphite furnace atomic absorption spectrophotometry (GFAAS) was used for the determination of lead. Instrumental neutron activation analysis (INAA) was used for the determination of arsenic, barium, mercury and selenium. INAA analysis results were used primarily because INAA can achieve much lower reporting limits than conventional analysis. In addition, INAA analysis involves few handling procedures and no wet chemical digestions. This eliminates most analytical difficulties associated with contamination or volatilization of some elements.

Chlorine results by INAA were used instead of chlorine results obtained by ASTM D-2361 because of the better precision and reporting limits for INAA results. Fluorine concentrations were determined by ASTM D-3761 using an ion selective electrode. Sulfur concentrations were measured using a LECO SC-132 sulfur analyzer. Carbon, hydrogen and nitrogen measured with a LECO CHN/600 analyzer. The higher heating value of the fuel was measured by ASTM D-1989 using calorimetry. The fuel ash and moisture content were determined gravimetrically by ASTM D-5142. Radionuclides were measured by EPA Method 114 using alpha spectrometry.

### 3.3.2 FFDC Inlet Gas

Table 3-2 summarizes the concentration measurements made on the flue gas entering the FFDC during the baseline test series. Additional data are presented in Appendix B.

Particulate and anions were collected in a combined sample train. Particulate was analyzed from the front half (probe wash and filter) of this train. All sample train fractions were analyzed for anions.

For metals results, the front half rinse, filter and nitric acid/hydrogen peroxide impinger fractions were combined for analysis; therefore, the data represent the total (particulate plus vapor phase) concentration in the FFDC inlet gas. The components of the train were combined after digestion to lower the reporting limits. Mercury results were obtained by analyzing the permanganate impinger solution, and an aliquot of the front half and nitric acid/hydrogen peroxide fractions. These results were added together to provide the total mercury concentration.

During benzene and toluene testing, extra tedlar bag samples were collected because of leaks in some bags.

# TABLE 3-2
# INLET GAS COMPOSITION DATA AT SITE 115
## BASELINE

| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | | Average | 95% C.I. |
|---|---|---|---|---|---|---|---|---|---|
| Gas Stream Flow Rate[1] | | | | | | | | | |
| dscfm | 246,500 | 245,000 | 251,100 | 245,300 | 258,800 | 243,500 | | 249,300 | 4,600 |
| $Nm^3/hr$ | 390,200 | 387,800 | 397,600 | 388,300 | 409,700 | 385,600 | | 394,700 | 7,300 |
| Substance | | | | | | | | | |
| Particulate Loading, $mg/Nm^3$ | 7,706 | | 7,836 | | 5,307 | | | 6,949 | 3,857 |
| Metals, $\mu g/Nm^3$ | | | | | | | | | |
| Arsenic | 33.5 | | 19.4 | | 37.0 | | | 30.0 | 24.2 |
| Barium | 237 | | 88.4 | | 588 | | | 305 | 641 |
| Beryllium | 6.7 | | 14.4 | | 14.1 | | | 11.7 | 11.1 |
| Cadmium | 2.5 | | 2.7 | | 3.7 | | | 3.0 | 1.8 |
| Chromium | 36.7 | | 84.8 | | 73.6 | | | 65.0 | 64.2 |
| Cobalt | 21.6 | | 50.4 | | 44.4 | | | 38.8 | 38.8 |
| Copper | 249 | | 197 | | 214 | | | 220 | 82.1 |
| Lead | 147 | | 36.3 | | 65.0 | | | 82.9 | 144 |
| Manganese | 149 | | 310 | | 300 | | | 253 | 232 |
| Mercury | 2.4 | | 1.5 | | 1.3 | | | 1.7 | 1.6 |
| Molybdenum | 7.8 | | 15.5 | | 18.5 | | | 14.0 | 14.1 |
| Nickel | 19.4 | | 50.4 | | 48.1 | | | 39.3 | 43.9 |
| Phosphorus | 17,900 | | 19,000 | | 18,900 | | | 18,600 | 4,200 |
| Selenium | 23.5 | | 34.1 | | 29.6 | | | 29.1 | 14.9 |
| Vanadium | 100 | | 213 | | 215 | | | 176 | 168 |
| Anions, $\mu g/Nm^3$ | | | | | | | | | |
| Chloride | 1,020 | | 1,090 | | 990 | | | 1,030 | 309 |
| Fluoride | 7,200 | | 5,700 | | 5,700 | | | 6,200 | 1,200 |
| VOC, $\mu g/Nm^3$ (Phase I) | | Run 2B | Run 2C | Run 3A | | | | | |
| Benzene | | 2.1● | ND(0.9) | 1.6● | | | | 1.4 | 1.2 |
| Toluene | | 15.5 | 5.8 | 5.8 | | | | 9.1 | 7.3 |
| VOC, $\mu g/Nm^3$ (Phase II) | | Run 8A | Run 9A | Run 9B | | | | | |
| Benzene | | 10.2 | 13.8 | 16.1 | | | | 13.4 | |
| Toluene | | 78.5 | 137 | 51.4 | | | | 89.0 | |
| Formaldehyde, $\mu g/Nm^3$ | | | Run 4A | Run 4B | Run 4C | | | | |
| | | | 17.4 | 18.6 | 22.8 | | | 19.6F | 7.4 |
| Cyanide, $\mu g/Nm^3$ | | | | | Run 6A | Run 6B | Run 6C | | |
| | | | | | ND(10) | ND(10) | 11● | ND(10) | NC |

(continued)

Notes: ND( ) - Species not detected at the reporting limit.
NC - Not Calculated
● Species not detected at less than five times the reporting limit.
F - Field blank greater than 50% of average uncorrected sample measurement
Runs 2B and 2C were performed during Run 2. Run 3A was performed during Run 3. Runs 4A, 4B and 4C were performed during Run 4.
(1) Flow rate calculated from outlet pitot measured flow rate corrected to inlet $O_2$ levels. Flow rates for Runs 1, 3 and 5 are the average from particulate and metals tests. The flow rate for Runs 2, 4 and 6 are from the PAH tests. Calculations are contained in Appendix D.
All results are from Phase I tests unless noted otherwise.

All results are from Phase I tests unless noted otherwise.

**TABLE 3-2 (continued)**
**INLET GAS COMPOSITION DATA AT SITE 115**
**BASELINE**

| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | Average | 95% C.I. |
|---|---|---|---|---|---|---|---|---|
| Gas Stream Flow Rate[1] | | | | | | | | |
| dscfm | 246,500 | 245,000 | 251,100 | 245,300 | 258,800 | 243,500 | 249,300 | 4,600 |
| $Nm^3/hr$ | 390,200 | 387,800 | 397,600 | 388,300 | 409,700 | 385,600 | 394,700 | 7,300 |
| Substance | | | | | | | | |
| PAH, $\mu g/Nm^3$ | | | | | | | | |
| Naphthalene | | 0.31• | | 0.24• | | 0.40• | 0.31F | 0.22 |
| Fluorene | | 0.015• | | 0.013• | | 0.015• | 0.014F | 0.004 |
| 2-Methylnaphthalene | | 0.041• | | 0.026• | | 0.15• | 0.027F | 0.032 |

Notes:
ND( ) - Species not detected at the reporting limit.
• Species detected at less than five times the reporting limit.
F - Field blank greater than 50% of average uncorrected sample measurement.
[1] Flow rate calculated from outlet pitot measured flow rate and inlet $O_2$ levels. Flow rates for Runs 1, 3 and 5 are average from particulate and metals tests. Flow rate for Runs 2, 4 and 6 are from PAH tests. Calculations are contained in Appendix D.
All results are from Phase I tests unless noted otherwise.

For PAH, all fractions of the sample train were extracted and combined for analysis to obtain lower reporting limits. Only three compounds were detected, all at less than five times the reporting limit.

For cyanide, the sample train was modified to include an in-stack filter. Since particulate phase cyanide is not expected in exhaust gas, and since no cyanide was detected in the impinger fraction of the sample train, the filter was not analyzed.

The total concentrations from each run were averaged according to the convention outlined previously to obtain an overall mean concentration and the uncertainty at the 95% confidence interval. The uncertainty in isokinetic tests includes a 19% bias because of the difference between measured and calculated flow rates at this location. Appendix F contains detailed descriptions of bias estimates and uncertainty calculations. Uncertainties are high for barium and lead, but there were no major sampling problems to account for the high uncertainty.

### 3.3.3 FFDC Outlet Gas

Table 3-3 summarizes the concentrations of the species in the flue gas emitted from the FFDC during the baseline test series. Sampling and analytical procedures were the same as for the FFDC inlet samples with the addition of radionuclides, which were analyzed from the front half of the particulate train. Radium-226 and radium-228 were the only radionuclides detected, both at less than five times the reporting limit. Naphthalene and 2-methylnapthalene were the only PAH compounds detected; both at less than five times the reporting limit.

Phase I inlet toluene results are 10 times higher at the FFDC outlet than at the inlet, and tests were repeated during Phase II. Phase II toluene results are more similar between locations, but are higher than for Phase I. The blank contribution to the toluene sample results is minimal for Phase I, but 33% at the inlet and 59% at the outlet for Phase II. Benzene results are higher for Phase II than for Phase I but are still low, and not significantly different between the FFDC inlet and outlet. Phase I outlet results were used for emissions calculations.

The uncertainty in FFDC outlet isokinetic tests includes a 10% bias because of the difference between measured and calculated flow rates at this location. High uncertainties for arsenic and selenium are because of data scatter from low level ICP-hydride analysis results. Uncertainty is high for nickel because the average is based on only two results.

### 3.3.4 Emission Factors

Table 3-4 presents the mean emission factors, expressed as lb/$10^{12}$ Btu unless otherwise noted, for the FFDC outlet during the baseline test series.

Mean particulate emissions at the FFDC outlet were 0.0019 lb/$10^6$ Btu. Chloride emissions were 630 lb/$10^{12}$ Btu. Fluoride emissions were 4,300 lb/$10^{12}$ Btu.

# TABLE 3-3
# OUTLET GAS COMPOSITION DATA AT SITE 115
# BASELINE

| Stream | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | Average | 95% C.I. |
|---|---|---|---|---|---|---|---|---|
| Gas Stream Flow Rate(1) | | | | | | | | |
| dscfm | 245,000 | 248,200 | 252,100 | 247,100 | 261,900 | 244,800 | 250,900 | 5,400 |
| $Nm^3/hr$ | 387,900 | 393,000 | 399,100 | 391,200 | 414,600 | 387,600 | 397,200 | 8,500 |
| Substance | | | | | | | | |
| Particulate Loading, $mg/Nm^3$ | 0.7 | | 4.7 | | 2.1 | | 2.5 | 5.1 |
| Metals, $\mu g/Nm^3$ | | | | | | | | |
| Arsenic | 0.47 | | 1.8 | | 0.65 | | 0.97F | 1.8 |
| Barium | 2.2B | | 0.56B | | 1.6B | | 1.5F | 2.1 |
| Beryllium | ND(0.03) | | ND(0.03) | | ND(0.03) | | ND(0.03) | NC |
| Cadmium | 0.28@ | | 0.14@ | | ND(0.08) | | 0.15 | 0.29 |
| Chromium | 0.72 | | 0.70 | | 1.12 | | 0.85 | 0.61 |
| Cobalt | ND(0.28) | | ND(0.28) | | ND(0.26) | | ND(0.28) | NC |
| Copper | 1.6 | | 1.6 | | 1.0 | | 1.4F | 0.89 |
| Lead | 0.61 | | 0.56 | | 0.52@B | | 0.56 | 0.12 |
| Manganese | 1.3 | | 1.9 | | 0.65@ | | 1.3 | 1.5 |
| Mercury | ND(0.28) | | ND(0.45) | | ND(0.39) | | ND(0.45) | NC |
| Molybdenum | 0.22B | | 0.22B | | 0.21@B | | 0.22F | 0.04 |
| Nickel(2) | 19.5 | | 2.5@ | | 1.3@ | | 1.9 | 7.6 |
| Phosphorus | 8.1 | | 8.7 | | 9.2 | | 8.6 | 1.69 |
| Selenium | 0.42 | | 0.73 | | 0.26 | | 0.47 | 0.60 |
| Vanadium | 0.36@ | | 0.17@B | | 0.39@ | | 0.31F | 0.30 |
| Anions, $\mu g/Nm^3$ | | | | | | | | |
| Chloride | 1,060 | | 950 | | 430 | | 810 | 980 |
| Fluoride | 8,100 | | 6,400 | | 2,200 | | 600 | 7,600 |
| VOC, $\mu g/Nm^3$ (Phase I) | | Run 2B | Run 2C | Run 3A | | | | |
| Benzene | | 2.4* | 3.1* | 4.7 | | | 3.4 | 2.90 |
| Toluene | | 180 | 95.0 | 126 | | | 133 | 106 |
| VOC, $\mu g/Nm^3$ (Phase II) | | Run 8A | Run 8B | Run 9A | | | | |
| Benzene | | 9.6 | 8.8 | 6.3 | | | 8.2 | 4.3 |
| Toluene | | 180 | 222 | 77 | | | 160 | 185 |
| | | | | Run4A | Run 4B | Run 4C | | |
| Formaldehyde, $\mu g/Nm^3$ | | | | 14.5 | 33.4 | 16.9 | 21.6F | 25.9 |
| | | | | Run 6A | Run 6B | Run 6C | | |
| Cyanide, $\mu g/Nm^3$ | | | | 9* | ND(4) | ND(10) | ND(10) | NC |

(continued)

Notes: ND( ) - Species not detected in reporting limit.
NC: Not calculated.
@ Species detected at less than five times the reporting limit.
F - Field blank greater than 50% of average uncorrected sample measurement.
B indicates blank correction ≥ 50% of original sample value.
(1) Flow rate from pitot flow measurements conducted during metals, particulate and PAH testing. Flow rate for Runs 1, 3 and 5 are an average of particulate and metals flow rates. Flow rates for individual tests are contained in Appendix D.
(2) Nickel result for Run 1 is considered anomalous and is not included in the average.
All results are from Phase I tests unless otherwise noted.

## TABLE 3-3 (continued)
## OUTLET GAS COMPOSITION AT SITE 115
## BASELINE

| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | Average | 95% C.I. |
|---|---|---|---|---|---|---|---|---|
| Gas Stream Flow Rates,[1] | | | | | | | | |
| dscfm | 245,000 | 248,200 | 252,100 | 247,100 | 261,900 | 244,900 | 250,900 | 5,400 |
| $Nm^3/hr$ | 387,900 | 393,000 | 399,100 | 391,200 | 414,600 | 387,600 | 397,200 | 8,500 |
| Substance | | | | | | | | |
| PAH, $\mu g/Nm^3$ | | | | | | | | |
| Naphthalene | | 0.42@ | | 0.25@ | | 0.34@ | 0.34F | 0.21 |
| 2-Methylnaphthalene | | 0.063@ | | 0.020@ | | 0.022@ | 0.035 | 0.061 |
| Radionuclides, $pCi/Nm^3$ | | | | | | | | |
| Uranium-233 & -234 | ND(0.06) | | ND(0.06) | | 0.05B | | ND(0.06) | NC |
| Uranium-235 | ND(0.06) | | ND(0.06) | | 0.05 | | ND(0.06) | NC |
| Uranium-238 | ND(0.06) | | ND(0.06) | | ND(0.05) | | ND(0.06) | NC |
| Radium-226 | 0.1@ | | 0.1@ | | 0.1@ | | 0.1 | 0.02 |
| Radium-228 | 0.80@ | | 0.96@ | | 0.76@ | | 0.84 | 0.29 |
| Lead-210 | ND(0.75) | | ND(0.73) | | 0.22 | | ND(0.75) | NC |
| Polonium-210 | 0.06@ | | ND(0.06) | | ND(0.05) | | ND(0.06) | NC |
| Thorium-228 | ND(0.23) | | ND(0.34) | | ND(0.16) | | ND(0.34) | NC |
| Thorium-230 | ND(0.17) | | ND(0.06) | | ND(0.16) | | ND(0.17) | NC |
| Thorium-232 | ND(0.06) | | ND(0.11) | | ND(0.11) | | ND(0.11) | NC |

Notes:
ND( ) - Species not detected at the reporting limit.
NC: Not calculated
• Species detected at less than five times the reporting limit.
F - Field blank greater than 50% of average uncorrected sample measurement.
B indicates blank correction ≥50% of original sample value.
[1] Flow rate from pitot flow measurements conducted during metals, particulate and PAH testing. Flow rates for Runs 1, 3 and 5 are an average of particulate and metals flow rates. Flow rates for individual tests are contained in Appendix D.
All results are from Phase I tests unless otherwise noted.

**TABLE 3-4**
**OUTLET GAS EMISSION FACTORS AT SITE 115**
**PHASE I: BASELINE**
**($lb/10^{12}$ Btu unless noted)**

| Substance | Mean | 95% C.I. |
|---|---|---|
| Gas Flow, dscfm | 250,900 | 5,400 |
| Fuel Flow, lb/hr (wet) | 89,670 | 1,941 |
| Heating Value, Btu/lb | 12,565 | 163 |
| Particulate, $lb/10^6$ Btu | 0.0019 | 0.0039 |
| Metals | | |
| Arsenic | 0.75F | 1.37 |
| Barium | 1.1F | 1.6 |
| Beryllium | ND(0.02) | NC |
| Cadmium | 0.12@ | 0.24 |
| Chromium | 0.66 | 0.48 |
| Cobalt | ND(0.22) | NC |
| Copper | 1.1F | 0.69 |
| Lead | 0.44@ | 0.09 |
| Manganese | 1.0 | 1.2 |
| Mercury | ND(0.35) | NC |
| Molybdenum | 0.17F | 0.03 |
| Nickel | 1.5@ | 6.1 |
| Phosphorus | 6.7 | 1.3 |
| Selenium | 0.36 | 0.46 |
| Vanadium | 0.24@F | 0.24 |
| Anions | | |
| Chloride | 630 | 189 |
| Fluoride | 4,300 | 5,900 |
| Volatile Organic Species | | |
| Benzene | 2.6@ | 2.2 |
| Toluene | 105 | 84 |
| Formaldehyde | 16.5F | 19.7 |
| Cyanide | ND(8) | NC |

(continued)

Notes:
ND( ) - Not Detected at reporting limit.
NC - Not calculated
F - Field blank greater than 50% of average uncorrected sample measurements.
@ - Species detected at less than five times the reporting limit.
(1) Nickel value excludes result for one replicate.

**TABLE 3-4 (continued)**
**OUTLET GAS EMISSION FACTORS AT SITE 115**
**PHASE I: BASELINE**
**(lb/$10^{12}$ Btu unless noted)**

| Substance | Mean | 95% C.I. |
|---|---|---|
| PAH: | | |
| Naphthalene | 0.26@F | 0.17 |
| 2-Methylnaphthalene | 0.027@F | 0.047 |
| | | |
| Radionuclides, uCi/$10^{12}$ Btu | | |
| Uranium-233 & -234 | ND(20) | NC |
| Uranium-235 | ND(20) | NC |
| Uranium-238 | ND(20) | NC |
| Radium-226 | 39@ | 6 |
| Radium-228 | 295@ | 101 |
| Lead-210 | ND(260) | NC |
| Polonium-120 | ND(20) | NC |
| Thorium-228 | ND(119) | NC |
| Thorium-230 | ND(60) | NC |
| Thorium-232 | ND(20) | NC |

Notes:
ND - Not detected at reporting limit
NC - Not calculated
@ - Species detected at less than five times the reporting limit
F - Field blank is greater than 50% of the average uncorrected sample measurement

Of the radionuclide target isotopes, only radium-226 and radium-228 were detected, both at less than five times the reporting limit. Reagent blank levels are similar to sample levels for both isotopes, however, it cannot be definitively stated that a low level of radium-226 and radium-228 is not being emitted from the source. Their emission levels were 39 and 295 $uCi/10^{12}$ Btu respectively.

Twelve of the fifteen targeted metals species were detected at the FFDC outlet during the baseline test series. Beryllium, cobalt, and mercury were not detected in the range of 0.02 - 0.35 $lb/10^{12}$ Btu. The remaining metals were detected in the range of 0.12 to 6.7 $lb/10^{12}$ Btu.

Of the target PAH species, only naphthalene and 2-Methylnaphthalene were detected. Their emission levels were 0.26 and 0.027, respectively. The levels are less than five times the reporting limit for both compounds. In addition the naphthalene field blank level is approximately 1.5 times the average sample level. The remaining PAH species were not detected in the range of 0.007 - 0.14 $lb/10^{12}$ Btu.

Toluene had the highest emission factor of the volatile organic target species at 105 $lb/10^{12}$ Btu. The benzene emission factor was 2.6 $lb/10^{12}$ Btu, which is less than 5 times the reporting limit. The formaldehyde emission level was 16.5 $lb/10^{12}$ Btu. The formaldehyde field blank level represents 92% of the average sample level.

Cyanide was not detected at an emission factor of less than 8 $lb/10^{12}$ Btu.

### 3.3.5 Baghouse Performance

FFDC removal efficiency for particulate, metals, and anions is presented in Table 3-5. Removal efficiencies were calculated from average FFDC inlet and outlet concentrations of the element, expressed in $lb/10^{12}$ Btu. The FFDC had a particulate removal efficiency of 99.96%. Removal efficiency for metals ranges from greater than 86.9% for mercury to greater than 99.95% for selenium. The relatively large uncertainty in removal efficiency for most target species is because of sampling and analytical variability and does not represent the operation of the FFDC. An example calculation of the removal efficiency confidence interval is located in Section 6.0.

## 3.4 UREA INJECTION TEST SERIES

### 3.4.1 Coal

This section presents the analytical results for the coal samples taken during the Phase II urea injection test series. Complete results are presented in Appendix B for all samples. Appendix A presents the analytical methodology. Table 3-6 presents the fuel composition, metals, and anion results for each of the three sampling days covering the four test runs. Table 3-6 also presents the mean value and the percent uncertainty in the results calculated at the 95% confidence interval about the mean. The confidence interval calculation is discussed

**TABLE 3-5**
**SUMMARY OF FFDC REMOVAL EFFICIENCIES**
**SITE 115 - PHASE I: BASELINE**

| Substance | Removal Efficiency (%) | Uncertainty (as % Efficiency) |
|---|---|---|
| Total Particulate | 99.96 | 17 |
| | | |
| Arsenic[1] | 96.7 | 25 |
| Barium[1] | 99.5 | 68 |
| Beryllium[2] | >99.9 | NC |
| Cadmium | 94.8 | 17 |
| Chromium | 98.7 | 31 |
| Cobalt[2] | >99.6 | NC |
| Copper[1] | 99.4 | 10 |
| Lead | 99.3 | 57 |
| Manganese | 99.5 | 29 |
| Mercury[2] | >86.9 | NC |
| Molybdenum[1] | 98.4 | 32 |
| Nickel | 95.1 | 38 |
| Phosphorus | 98.4 | 15 |
| Selenium | 99.95 | 3 |
| Vanadium[1] | 99.8 | 30 |
| | | |
| Chloride | 21 | 19 |
| Fluoride | 10 | 30 |

Notes:
NC - Not Calculated
[1] Field blank was greater than 50% of the average uncorrected sample measurement for FFDC outlet samples.
[2] Beryllium, cobalt and mercury removal efficiency may be greater than the indicated value. These elements were not detected at the FFDC outlet.
Calculation of removal efficiency confidence interval is presented in Section 6.

# TABLE 3-6
## COAL ANALYSIS FOR SITE 115
## PHASE II: UREA INJECTION

| Parameter | Run 10 | Run 11 | Run 12 | Mean | 95% C.I. |
|---|---|---|---|---|---|
| Date | 03/10/93 | 03/10/93 | 03/11/93 | | |
| Fuel Flow, lb/hr (wet)[1] | 88,972 | 96,098 [2] | 93,683 | 92,918 | 9,004 |
| Ash (%)[2] | 9.13 | [2] | 9.84 | 9.49 | 1.23 |
| Sulfur (%)[2] | 0.49 | [2] | 0.48 | 0.49 | 0.02 |
| HHV, Btu/lb[2] | 12,692 | [2] | 12,584 | 12,638 | 190 |
| Trace Metals, mg/kg | | | | | |
| Arsenic | 0.75 | 0.47 | 0.70 | 0.64 | 0.37 |
| Barium | 350 | 335 | 333 | 339 | 30.5 |
| Beryllium | 0.30 | 0.58 | 0.77 | 0.55 | 0.59 |
| Cadmium | ND(0.05) | ND(0.05) | ND(0.06) | ND(0.06) | NC |
| Chromium | 1.2 | 2.1 | 1.0 | 1.4 | 1.4 |
| Cobalt | 1.1 | 1.4 | 1.4 | 1.3 | 0.46 |
| Copper | 3.8 | 4.0 | 3.3 | 3.7 | 0.7 |
| Lead | 1.7@ | 2.3 | 2.7 | 2.2 | 1.3 |
| Manganese | 4.2 | 6.7 | 4.8 | 5.2 | 3.3 |
| Mercury[2] | 0.011 | (2) | 0.027 | 0.019 | 0.10 |
| Molybdenum | 0.4@ | 0.4@ | 0.7@ | 0.5 | 0.4 |
| Nickel | 1.0@ | 1.0@ | 1.0@ | 1.0 | 0.10 |
| Selenium | 1.1 | 0.91 | 2.4 | 1.5 | 1.9 |
| Vanadium | 3.5 | 5.3 | 4.2 | 4.3 | 2.3 |
| Anion Precursors, mg/kg | | | | | |
| Chlorine | 16 | 17 | 16 | 16 | |
| Fluorine[3] | NR | NR | NR | NR | NR |
| Phosphorous | 320 | 310 | 320 | 317 | 28.2 |

Notes:
ND( ) - not detected at the reporting limit
NC - Not Calculated
NR - Not Reported
@ - Species detected at less than five times the reporting limit.
INAA analysis used for determination of arsenic, barium, mercury and selenium. ICP-AES analysis used for determination of beryllium, cadmium, chromium, cobalt, copper, manganese, molybdenum, nickel, phosphorus and vanadium.
GFAAS used for determination of lead.
[1] Fuel flow rate by plant instrumentation.
[2] Mercury and composition results (including sulfur, ash and HHV) presented for Run 10 are for a composite of samples from Runs 10 and 11. Ultimate analysis results are presented in Appendix B.
[3] Results for fluorine were inconsistent with previous analysis results and are not reported.
Fuel composition results are presented in Appendix B. Composition results are on a dry basis. Fuel flow, metals and anion precursor results are "as received."

in Section 6.0. Uncertainty is high for mercury, in part because results are from only two replicates.

The sampling and analysis procedures used for samples collected during the urea injection tests were the same as for baseline coal. The specific analysis techniques used for each target species are described in Section 3.3.1. Radionuclides were not determined for the urea injection test series. As mentioned in Section 3.3.1, the coal sampled may not have been representative of the coal fired during testing. The measurement methods used are listed in Appendix A. A comparison of baseline and urea injection test results is discussed in Section 3.4.6.

### 3.4.2 FFDC Inlet Gas

Table 3-7 summarizes the concentration measurements made on the flue gas entering the FFDC during the urea injection test series. Additional data are presented in Appendix B.

Particulate and anions were collected in a combined sample train. Particulate was analyzed from the front half (probe wash and filter) of this train. All sample fractions were analyzed for anions.

As for baseline tests, multi-metals sample fractions were combined for analysis, and the data represent the total (particulate plus vapor phase) metals concentrations in the FFDC inlet gas.

For cyanide, the sample train was modified to include an in-stack filter. Since particulate phase cyanide is not expected in exhaust gas, and since no cyanide was detected in the impinger fraction of the sample train, the filter was not analyzed.

The total concentrations from each run were averaged according to the convention outlined previously to obtain an overall mean concentration and the uncertainty at the 95% confidence interval. The uncertainty in isokinetic tests involves a 18% bias because of the difference between measured and calculated flow rates at this location. Appendix F contains detailed descriptions of bias estimates and uncertainty calculations.

### 3.4.3 FFDC Outlet Gas

Table 3-8 summarizes the concentrations of the species in the flue gas emitted from the FFDC during the urea injection test series. Sampling was conducted using the same sampling trains as for FFDC inlet sampling. Copper results were not blank corrected because reagent blank levels of copper were two to four times the average uncorrected sample level. Field and reagent blank levels for barium are higher than sample levels. Reagent blank correction to lead and nickel results for all three replicates and to molybdenum results for Runs 11 and 12 resulted in values below the reporting limit. The reporting limit value was used as the sample result. Uncertainties are high for barium, manganese and phosphorus. High manganese and phosphorus uncertainty are due to a broad spread in sample results between runs.

# TABLE 3-7
# INLET GAS COMPOSITION DATA AT SITE 115
# PHASE II: UREA INJECTION

| | Run 10 | Run 11 | Run 12 | Run 13 | | Average | 95% C.I. |
|---|---|---|---|---|---|---|---|
| Gas Stream Flow Rate,(1) | | | | | | | |
| dscfm | 248,800 | 256,000 | 255,800 | 265,700 | | 253,500 | |
| $Nm^3/hr$ | 393,900 | 405,300 | 404,900 | 420,600 | | 401,400 | |
| **Substance** | | | | | | | |
| Particulate Loading, $mg/Nm^3$ | 7,190 | 7,640 | 8,075 | | | 7,635 | 1,488 |
| Metals, $\mu g/Nm^3$ | | | | | | | |
| Arsenic | 22.6@ | 18.1@ | 7.7@ | | | 16.2 | 19.3 |
| Barium | 268 | 167 | 286 | | | 241 | 163 |
| Beryllium | 9.4 | 8.0 | 10.7 | | | 9.4 | 3.7 |
| Cadmium | 2.6 | 2.0 | 3.0 | | | 2.5 | 1.3 |
| Chromium | 57.3 | 55.1 | 78.7 | | | 63.7 | 33.9 |
| Cobalt | 35.2 | 25.9 | 37.9 | | | 33.0 | 16.5 |
| Copper | 228 | 203 | 341 | | | 258 | 187 |
| Lead | 18.8 | 65.0 | 87.2 | | | 57.0 | 87.2 |
| Manganese | 101 | 87.1 | 144 | | | 111 | 76.2 |
| Mercury | 4.3 | 1.7 | 1.1 | | | 2.4 | 4.2 |
| Molybdenum | 15.9 | 15.6 | 12.8 | | | 14.8 | 4.9 |
| Nickel | 33.7 | 29.1 | 47.6 | | | 36.8 | 24.6 |
| Phosphorus | 12,000 | 9,600 | 13,500 | | | 11,700 | 5,200 |
| Selenium | 22.8 | 17.1 | ND(10.0) | | | 15.0 | 22.8 |
| Vanadium | 152 | 124 | 176 | | | 151 | 69 |
| Anions, $\mu g/Nm^3$ | | | | | | | |
| Chloride | 1,200 | 1,300 | 1,300 | | | 1,300 | 220 |
| Fluoride | 7,000 | 7,700 | 7,100 | | | 7,300 | 1,400 |
| | | | Run 13A | Run 13B | Run 13C | | |
| Cyanide, $\mu g/Nm^3$ | | | ND(16) | ND(12) | ND(16) | ND(16) | NC |
| | Run 10A | Run 10B | | | | | |
| Ammonia, $\mu g/Nm^3$ | 15,400 | 10,900 | | | | 13,100 | NR |
| | | Run 12A | Run 12B | Run 13A | Run 13B | | |
| | | 15,900 | 15,900 | 17,800 | 17,200 | 16,700 | NR |

Notes:
ND( ) - Not detected at less than the reporting limit.
NC - Not Calculated
NR - Not Reported
@ - Species detected at less than five times the detection limit.
B - concentration is less than twice the reagent blank level.
F - Field blank greater than 50% of average uncorrected sample measurement.
Runs 10A and 10B performed during Run 10.
Runs 12A and 12B performed during Run 12.
Runs 13A, 13B and 13C performed during Run 13.
(1) Flow rate for Runs 10, 11 and 12 calculated from outlet pitot measured flow rate and inlet $O_2$ levels and are an average of flow rates from metals and particulate tests. Flow rate for Run 13 calculated from unit heat rate and F-factor and not included in average. Calculations are contained in Appendix D.

## TABLE 3-8
## OUTLET GAS COMPOSITION DATA AT SITE 115
## PHASE II: UREA INJECTION

| | Run 10 | Run 11 | Run 12 | Run 13 | | Average | 95% C.I. |
|---|---|---|---|---|---|---|---|
| Gas Stream Flow Rates,[1] | | | | | | | |
| dscfm | 250,500 | 259,700 | 261,900 | 273,400 | | 257,400 | |
| $Nm^3/hr$ | 396,600 | 411,100 | 414,700 | 432,800 | | 407,400 | |
| Substance | | | | | | | |
| Particulate Loading, $mg/Nm^3$ | 2.9 | 0.9 | 0.6 | | | 1.5 | 3.2 |
| Metals, $\mu g/Nm^3$ | | | | | | | |
| Arsenic | 0.23@B | 0.20@B | 0.13@B | | | 0.19 | 0.12 |
| Barium | 2.8B | 0.03@B | 1.1B | | | 1.3F | 3.5 |
| Beryllium | ND(0.03) | ND(0.03) | ND(0.03) | | | ND(0.03) | NC |
| Cadmium | ND(0.08) | ND(0.09) | ND(0.08) | | | ND(0.09) | NC |
| Chromium | 0.42@B | 0.26@B | 0.43@B | | | 0.37F | 0.24 |
| Cobalt | ND(0.28) | ND(0.29) | ND(0.27) | | | ND(0.29) | NC |
| Copper | 2.0 | 1.4 | 1.6 | | | 1.7F | 0.76 |
| Lead | 0.48@B | 0.50@B | 0.51@B | | | 0.50F | 0.06 |
| Manganese | 0.28@B | 2.7 | 0.30@B | | | 1.1 | 3.5 |
| Mercury | 0.79@ | 0.56@ | ND(0.40) | | | 0.52 | 0.76 |
| Molybdenum | 0.56@B | 0.23@B | 0.22@B | | | 0.34F | 0.41 |
| Nickel | 0.56@B | 0.58@B | 0.54@B | | | 0.56F | 0.07 |
| Phosphorus | 5.9 | 10.5 | ND(1.6) | | | 5.7 | 12 |
| Selenium | ND(0.08) | ND(0.08) | ND(0.08) | | | ND(0.08) | NC |
| Vanadium | 0.37@ | 0.29@ | 0.40@ | | | 0.35F | 0.14 |
| Anions, $\mu g/Nm^3$ | | | | | | | |
| Chloride | 830 | 840 | 990 | | | 890 | 260 |
| Fluoride | 6,100 | 6,900 | 7,900 | | | 6,900 | 1,000 |
| | | | Run 13A | Run 13B | Run 13C | | |
| Cyanide, $\mu g/Nm^3$ | | | ND(11) | ND(10) | ND(9) | ND(11) | NC |
| | Run 10 | Run 12A | Run 12B | | | | |
| Ammonia, $\mu g/Nm^3$ [2] | 5,390 | 11,500 | 13,300 | | | | |
| | | Run 12C | Run 12D | Run 12E | Run 12F | | |
| | | 9,410 | 9,940 | 12,500 | 8,500 | 10,900 | |

Notes:
ND( ) - Not detected at less than the reporting limit.
NC - Not Calculated
NR - Not Reported
@ - Species detected at less than five times the detection limit.
B indicates blank correction ≥50% of original sample value.
F - Field blank greater than 50% of average uncorrected sample measurement.
Runs 12A, 12B, 12C, 12D, 12E and 12F performed during Test 12. Runs 13A, 13B and 13C performed during Run 13.
(1) Flow rate for tests 10, 11 and 12 from pitot flow measurements and are an average of flow rates from metals and particulate tests. Flow rate for test 13 calculated from unit heat rate and F-factor, and is not included in average. Flow rates for individual tests and heat rate flow rate calculations are contained in Appendix D.
(2) Average is for Tests 12A-F.

### 3.4.4 Emission Factors

Table 3-9 presents the mean emission factors, expressed as lb/$10^{12}$ Btu unless otherwise noted, for the FFDC outlet during the urea injection test series.

Mean particulate emissions at the FFDC outlet were 0.0012 lb/$10^{6}$ Btu. Chloride emissions were 720 lb/$10^{12}$ Btu. Fluoride emissions were 4800 lb/$10^{12}$ Btu.

Eleven of the fifteen targeted metals species were detected at the FFDC outlet during the urea injection test series. Of these, only barium, copper and phosphorus were detected at more than five times the reporting limit. Field blank levels of barium, chromium, molybdenum, lead and copper are two to six times higher than the average uncorrected sample level. Beryllium, cadmium, cobalt, and selenium were not detected in the range of 0.02 - 0.23 lb/$10^{12}$ Btu. The remaining metals were detected in the range of 0.15 to 4.6 lb/$10^{12}$ Btu.

Cyanide was not detected with an emission factor of less than 9 lb/$10^{12}$ Btu.

Ammonia emission levels were determined for two urea injection rates, 1.07 gpm during runs 10 and 11, and 1.04 gpm during runs 12 and 13. Ammonia measurements were made during runs 10, 12 and 13. The emission factors for the two urea injection rates were 4300 and 8900 lb/$10^{12}$ Btu.

### 3.4.5 Baghouse Performance

FFDC removal efficiency for particulate matter, metals, and anions during the urea injection test series is presented in Table 3-10. Removal efficiencies were calculated from average FFDC inlet and outlet concentrations of the element, expressed in lb/$10^{12}$ Btu. The FFDC had a particulate removal efficiency of 99.98% during Phase II urea injection. Removal efficiency for metals ranged from 77.9 for mercury to 99.95% for phosphorus. An example calculation is located in Section 6.0.

### 3.4.6 Comparison of Baseline and Urea Injection Results

Only inorganic species for which concentrations might change were measured during the urea injection phase. This included trace metals, anions and nitrogen compounds. Table 3-11 presents a comparison of fuel, FFDC inlet and FFDC outlet results for these inorganic species.

The difference in trace metals and anion precursor concentrations in coal between the baseline and urea injection tests range from 5% to 132%. The elements with the largest difference (>50%) between baseline and urea injection tests are beryllium, molybdenum and selenium, all of which had higher levels during the urea injection tests. Nonrepresentative coal sampling may have contributed to the variation in fuel metal concentrations; however, the results may be indicative of the natural variation of trace metals concentrations in coal. The difference in anion concentration in coal between baseline and urea injection tests was -3% for fluorine and -46% for chlorine.

## TABLE 3-9
## OUTLET GAS EMISSION FACTORS AT SITE 115
## PHASE II: UREA INJECTION
## (lb/$10^{12}$ BTU UNLESS NOTED)

| Substance | Mean | 95% C.I. |
|---|---|---|
| Gas Flow, dscfm | 257,400 | |
| Fuel Flow, lb/hr | 92,918 | |
| Heating Value, Btu/lb | 12,638 | |
| Particulate, lb/$10^6$ Btu | 0.0012 | 0.0025 |
| <u>Metals</u> | | |
| Arsenic | 0.15@ | 0.10 |
| Barium | 1.1F | 2.8 |
| Beryllium | ND(0.02) | NC |
| Cadmium | ND(0.07) | NC |
| Chromium | 0.30@F | 0.19 |
| Cobalt | ND(0.23) | NC |
| Copper | 1.3F | 0.61 |
| Lead | 0.40@F | 0.05 |
| Manganese | 0.89 | 2.82 |
| Mercury | 0.41@ | 0.59 |
| Molybdenum | 0.27@F | 0.39 |
| Nickel | 0.45@F | 0.06 |
| Phosphorus | 4.6 | 9.7 |
| Selenium | ND(0.06) | NC |
| Vanadium | 0.29@F | 0.12 |
| <u>Anions</u> | | |
| Chloride | 720 | 210 |
| Fluoride | 4,800 | 720 |
| <u>Ammonia</u> | | |
| *Ammonia (Injection Rate #1)* | 4,300 | NC |
| Ammonia (Injection Rate #2) | 8,900 | |
| <u>Cyanide</u> | | |
| Cyanide | ND(9) | NC |

<u>Notes:</u>
ND( ) - Not detected at the reporting limit
NC - Not Calculated
F - Field blank greater than 50% of average uncorrected sample measurement
@ - *Species detected at less than five times the reporting limit*
The ammonia injection rates were, #1: 1.07 gpm, #2: 1.04 gpm.
[1]The cyanide emissions factor was calculated using a heat rate flow rate of 273,375 dscfm. Flow rate measurements were made during cyanide testing.

**TABLE 3-10**
**SUMMARY OF FFDC REMOVAL EFFICIENCIES**
**SITE 115 - PHASE II: UREA INJECTION**

| Substance | Removal Efficiency (%) | Uncertainty (as % Efficiency) |
|---|---|---|
| Total Particulate | 99.98 | 5.4 |
| Arsenic | 98.8 | 38 |
| Barium(2) | 99.5 | 22 |
| Beryllium(3) | >99.8 | NC |
| Cadmium(3) | >98.2 | NC |
| Chromium(2) | 99.4 | 17 |
| Cobalt(3) | >99.6 | NC |
| Copper(2) | 99.3 | 24 |
| Lead(2) | 99.1 | 50 |
| Manganese | 99.0 | 23 |
| Mercury | 77.9 | 52 |
| Molybdenum(2) | 97.7 | 9 |
| Nickel(2) | 98.5 | 22 |
| Phosphorus | 99.95 | 14 |
| Selenium(3) | >99.7 | NC |
| Vanadium(2) | 99.8 | 15 |
| | | |
| Chloride | 29.0 | 5 |
| Fluoride | 16.9 | 4 |

Notes:
NC - Not Calculated
(1) Field blank was greater than 50% of the average uncorrected sample measurement for FFDC inlet samples.
(2) Field blank was greater than 50% of the average uncorrected sample measurement for FFDC outlet samples.
(3) Beryllium, cadmium, cobalt and selenium removal efficiency may be greater than the indicated value. These elements were not detected at the FFDC outlet.
Calculation of removal efficiency confidence intervals is presented in Section 6.

# TABLE 3-11
# COMPARISON OF TRACE INORGANIC SPECIES BETWEEN PHASE I (BASELINE) AND PHASE II (UREA INJECTION)
# SITE 115

| Parameter | Fuel Input | | FFDC Inlet | | FFDC Outlet | |
|---|---|---|---|---|---|---|
| | PHASE I | PHASE II | PHASE I | PHASE II | PHASE I | PHASE II |
| | lb/$10^{12}$Btu | | | | | |
| **Trace Metals** | | | | | | |
| Arsenic | 43 | 56 | 23 | 13 | 0.75 | 0.15 |
| Barium | 37,600 | 29,700 | 234 | 192 | 1.1 | 1.1 |
| Beryllium | 20 | 48 | 9.0 | 7.5 | ND(0.02) | ND(0.02) |
| Cadmium | ND(4.5) | ND(5.3) | 2.3 | 2.0 | 0.12 | ND(0.07) |
| Chromium | 97 | 125 | 50 | 51 | 0.66 | 0.30 |
| Cobalt | 84 | 114 | 30 | 26 | ND(0.22) | ND(0.23) |
| Copper | 241 | 324 | 169 | 206 | 1.1 | 1.3 |
| Lead | 185 | 195 | 64 | 46 | 0.44 | 0.40 |
| Manganese | 379 | 458 | 195 | 88 | 1.0 | 0.89 |
| Mercury | 1.9 | 1.7 | 1.3 | 1.9 | ND(0.35) | 0.41 |
| Molybdenum | 9.0 | 44 | 11 | 12 | 0.17 | 0.27 |
| Nickel | 53 | 88 | 30 | 29 | 1.5 | 0.45 |
| Selenium | 73 | 127 | 22 | 12 | 0.36 | ND(0.06) |
| Phosphorus | 36,700 | 27,700 | 14,300 | 9,300 | 6.7 | 4.6 |
| Vanadium | 266 | 379 | 135 | 120 | 0.24 | 0.29 |
| **Anions** | | | | | | |
| Chloride | 2,000 | 1,400 | 790 | 1000 | 630 | 720 |
| Fluoride | 7,600 | NR | 4,800 | 5,800 | 4,300 | 4,800 |
| **Nitrogen Compounds** | | | | | | |
| Cyanide | NA | NA | ND(8) | ND(12) | ND(8) | ND(9) |
| Ammonia (Rate #1/#2) | NA | NA | ND(100) | 10,000/13,000 | NA | 4,300/8,900 |

ND: Not detected at the reporting limit
NA: Not analyzed
NR: Not reported

Changes in FFDC inlet concentrations generally do not correlate with changes in fuel concentration. Inlet concentrations of arsenic, manganese and selenium were >50% lower during urea injection. Other metals and anions generally were at similar levels during both test conditions.

FFDC outlet concentrations of arsenic, chromium, nickel and selenium were lower for urea injection tests than for baseline tests by >50%. Levels for other metals and anions were unchanged. Cyanide was not detected at the FFDC inlet or outlet for both phases. FFDC removal efficiencies were similar for baseline and urea injection phases.

# SECTION 4.0

## CHROMIUM AND MERCURY SPECIATION TESTS

This section presents the results of the chromium and mercury speciation tests performed during Phase II (March 1993) at baseline conditions at Site 115.

## 4.1 CHROMIUM SPECIATION TESTS

Table 4-1 presents the results of the chromium speciation tests using the EPA recirculation train. The tests were conducted to determine the fraction of total chromium emissions that is hexavalent chromium. Triplicate tests were conducted at a single point at the FFDC inlet. Tests were not conducted at the FFDC outlet because particulate emissions are too low at the outlet to determine the $Cr^{6+}/Cr_{total}$ ratio. The mechanical complexities of the recirculation train precluded a full traverse, so actual hexavalent chromium emission rates could not be measured. However, there are no data to suggest that the ratio of hexavalent to total chromium varies across the sample plane; the measured fraction can be applied to other total chromium results (e.g., from the multi-metals tests) to estimate hexavalent chromium emission rates. The EPA methodology was modified to include periodic additions of potassium hydroxide to maintain the pH above 8.5. Maintaining the pH above this level should prevent the conversion of hexavalent chromium to the trivalent form. This test series, unlike other EPRI programs, did not assess conversion from $Cr^{6+}$ to $Cr^{3+}$ through the use of an isotopically labelled spike.

Hexavalent chromium concentrations in the inlet gas ranged from 2.5 to 7.3 ug/Nm$^3$ with an average of 5.2 $\mu$g/Nm$^3$. The $Cr^{6+}/Cr_{total}$ ratio averaged 4%. Total FFDC inlet chromium emissions were 93 $\mu$g/Nm$^3$ using the recirculation train. FFDC inlet chromium emissions were 65 $\mu$g/Nm$^3$ from the Phase I baseline multi-metals tests and 64 $\mu$g/Nm$^3$ from the Phase II urea injection multi-metals tests. The total and hexavalent chromium field blank levels for the recirculation train were 50% for hexavalent chromium and 44% for total chromium of the uncorrected sample level. These field blanks were not subtracted from the results. Reagent blanks had no detectable hexavalent or total chromium.

Blank levels detected in the field blank may have influenced the $Cr^{6+}$/Cr total ratio. The uncorrected ratio is 4%. With blank correction the ratio would be 5%.

**TABLE 4-1**
**FFDC INLET CONCENTRATIONS OF**
**TOTAL AND HEXAVALENT CHROMIUM**
**EPA RECIRCULATION TRAIN METHOD EVALUATION TESTS**
**SITE 115**
**PHASE II: BASELINE**

| | Concentration, $\mu g/Nm^3$ | | | | |
|---|---|---|---|---|---|
| **Substance** | **Run 8A** | **Run 8B** | **Run 9** | **Mean** | **95% C.I.** |
| **Total Chromium** | 121 | 90.1 | 69.2 | 93.3 | 65.4 |
| **Hexavalent Chromium** | 5.74 | 2.52 | 7.25 | 5.17 | 6.04 |
| **$Cr^{6+}/Cr$, %** | 4.8 | 2.8 | 5.2 | 4.3 | |

## 4.2 MERCURY SPECIATION TESTS

Mercury emissions were first sampled with a multimetals train during a full traverse of the FFDC inlet and outlet, then again with a series of mercury speciation tests. This test series measured mercury emissions at a single point using the Brooks Rand/Frontier Geosciences solid sorbent methodology. The method is experimental and reflects the state of development of this technique.

Three samples were collected at the FFDC inlet and outlet locations using the Brooks Rand/Frontier Geosciences methodology. The sample train consisted of a glass probe, KCl/soda lime traps to collect mercury(II) and methyl mercury (species such as $CH_3HgCl$), and iodated charcoal traps to collect elemental mercury(Hg(0)). Mercury(II) and methyl mercury concentrations were determined by dissolving the KCl-impregnated traps in an acetic acid/HCl mixture, followed by aqueous ethylation, separation by gas chromatography, and detection by cold vapor atomic fluorescence spectrometry (CVAFS). Mercury(II) was detected as diethy mercury and methyl mercury as methyl ethyl mercury. Subsequent investigation by Frontier Geosciences has revealed that the method produces invalid results for methyl mercury; therefore, methyl mercury results are not presented in this report. Frontier Geosciences discovered that there is a reaction among acetate, sulfite and Hg(II) that occurs during the dissolution of the sodalime traps. This reaction has been shown to produce methyl mercury. The methyl mercury that was detected could be attributed, in whole or in part, to the Hg(II) collected in the KCL/soda lime traps. Consequently, this report combines the results for Hg(II) and methyl mercury as a sum, termed oxidized mercury.

In addition to flue gas samples, one coal and one flyash sample were analyzed by Frontier Geosciences for total mercury. Table 4-2 presents the results of the flue gas samples and associated fuel and ash analyses. Mercury concentration data from earlier multimetals tests at the FFDC inlet and outlet are included for comparison. All mercury species were detected at the inlet, but only oxidized mercury was detected at the outlet at levels $< 5$ times the reporting limit.

There are a number of concerns with the FFDC inlet results from the Frontier Geosciences train: 1) Approximately 50% of the total mercury collected by the inlet train was found in particulate collected in the probe and on the glass wool plug at the inlet of the first KCl/soda lime trap. Any vapor phase mercury trapped by carbon or other material in this particulate would not have been accurately speciated. 2) The second KCl/soda lime and charcoal traps, used for backup and to assess breakthrough, contained at least 50% of the mercury found in each pair of inlet traps. If breakthrough beyond the second trap occurred, the train would not have accurately speciated mercury. 3) Results for Run 14C were low and were not included in the average. It is probable that the low results for this test were due to sampling problems, however, a specific problem was not isolated.

A summary of mercury mass balance results is presented in Table 4-3. Mass balance results were calculated using flow rates calculated from the average F-factor and heating values for Phase II baseline samples. Mercury mass balance results from Phase I and II multi-metals

## TABLE 4-2
## FFDC INLET AND OUTLET MERCURY EVALUATION TEST RESULTS
## FRONTIER GEOSCIENCES SPECIATION METHOD
## SITE 115
## PHASE II: BASELINE

| Stream/Species | Run 14A | Run 14B | Run 14C | Mean[(1)] | 95% C.I. |
|---|---|---|---|---|---|
| FFDC Inlet, μg/Nm³ | | | | | |
| Hg(II) | 0.52 | 0.47B | 0.07@B | 0.49 | |
| Hg(0) | 0.32 | 0.53B | 0.05 | 0.42 | |
| Hg - Glass wool Plug + Probe** | 0.99 | 0.94 | 0.09 | 0.97 | |
| Mercury, total | 1.8 | 1.9 | 0.22 | 1.9 | |
| FFDC Outlet, μg/Nm³ | | | | | |
| Hg(II) | ND(0.03) | 0.04@B | 0.13 | 0.06 | |
| Hg(0) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | NC |
| Hg - Probe** | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | NC |
| Mercury, total | ND(0.05) | 0.05 | 0.14 | 0.07 | 0.15 |
| Coal, μg/g | 0.021 | | | | |
| Flyash, μg/g | 0.216 | | | | |

Notes:
ND( ) - Not detected at the reporting limit
NC: Not calculated
** - Filter Plug and Probe fraction were analyzed for total mercury only.
@ - Concentration is less than five times the reporting limit.
B - Indicates blank correction ≥ 50% of original sample value.
(1) Average FFDC Inlet result excludes Run 14C because of sampling problems for this test.

# TABLE 4-3
# MERCURY MASS BALANCE SUMMARY
# SITE 115

| Mercury Tests | Average Emission Factors, lb/10[12] Btu | | | | | Boiler/FFDC Balance,[2] % Closure | Uncertainty, % Closure | FFDC Balance,[3] % Closure | Uncertainty, % Closure |
|---|---|---|---|---|---|---|---|---|---|
| | Fuel | FFDC Inlet | Bottom Ash | Flyash | FFDC Outlet | | | | |
| Frontier Geosciences(using Phase II bottom ash result) | 1.7 | 1.4 | ND(0.24) | 1.3 | 0.06 | 87 | 2 | 94 | 4 |
| Multimetals/MIT Fuel[1] | | | | | | | | | |
| Phase I Baseline | 1.9 | 1.3 | 0.30 | 0.9 | ND(0.35) | 72 | 24 | 81 | 31 |
| Phase II Urea Injection | 1.7 | 1.9 | ND(0.24) | 1.2 | 0.41 | 103 | 43 | 85 | 41 |

Notes:
(1) These data represent the emissions from triplicate multimetals tests at the FFDC outlet and the coal collected during Phase I Baseline Testing. The mercury speciation tests were conducted during Phase II Baseline Testing.
(2) Boiler/FFDC Balance = (Outlet + Flyash + Bottom Ash)/Fuel
(3) FFDC Balance = (Outlet + Flyash)/Inlet
NC - Not calculated
ND - Not detected at the reporting limit

testing are included for comparison. Fuel and flyash mercury results agree. FFDC inlet and outlet results are higher from the multi-metals tests than the speciation tests. This resulted in a lower FFDC balance for multi-metals tests than speciation tests.

# SECTION 5.0

## DATA EVALUATION

Several procedures can be used to evaluate the information developed during a field sampling program. In the case of Site 115, three methods were used to evaluate data quality. First, the process data were examined to determine if the unit operated at normal, steady-state conditions during the sampling periods. Second, the QA/QC protocol for sampling and analytical procedures used at Site 115 (i.e., equipment calibration and leak checks, duplicates, blanks, spikes, standards, etc.) was evaluated. Site 115 QA/QC data were compared with FCEM project objectives. Third, material balances were calculated around the boiler system. Material balances involve the summation and comparison of mass flow rates in several streams, often sampled and analyzed by different methods. Closure within an acceptable range can be used as an indicator of accurate results for streams that contribute significantly to the overall inlet or outlet mass rates, such as coal, flyash and bottom ash streams.

## 5.1 PROCESS OPERATION

Process operating data were examined to ensure that operation was stable during sampling periods. Measurements were available from control room instrumentation. Process operating data were collected at least two times a day. Table 5-1 shows the key unit operating parameters and conditions for the Phase I baseline test series. The coefficient of variation (CV) was calculated for each parameter to evaluate process variability over the test program. Steady boiler operation was maintained during the Phase I test program. The unit operated at between 87 and 89% of full load during the baseline tests.

Table 5-2 presents operating parameters and unit conditions for the Phase II baseline and urea test series. The unit operated at between 88 and 91% of full load for all tests except for Run 13 during urea injection. During this run the unit operated at 98% of full load. The operation of the boiler was considered representative for baseline and urea injection tests.

## 5.2 SAMPLE COLLECTION

Several factors indicate the acceptable collection of gas samples. Key components of the sampling equipment, pitot tubes, thermocouples, dry gas meters, and sampling nozzles, were calibrated before use in the field. Dry gas meter calibrations were checked at the end of sampling. These and additional periodic equipment calibrations are on file at Carnot. The methods used to collect metals, particulate/anions and PAH samples were comparable to those

**TABLE 5-1**
**SUMMARY OF UNIT OPERATION**
**SITE 115**
**PHASE I: BASELINE**

| Test No. | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| Date | 11/17 | 11/17 | 11/18 | 11/18 | 11/19 | 11/19 | Mean | CV |
| Unit load, MW gross | 102 | 104 | 103 | 104 | 104 | 104 | 104 | 0.8% |
| Steam flow, lb/hr | 836,000 | 851,000 | 836,000 | 851,000 | 853,000 | 852,000 | 847,000 | 1.0% |
| Air flow, lb/hr | 874,000 | 895,000 | 886,000 | 901,000 | 901,000 | 884,000 | 890,000 | 1.2% |
| Fuel flow, lb/hr wet | 86,837 | 91,797 | 88,919 | 91,265 | 88,752 | 90,452 | 89,670 | 2.1% |
| $O_2$, % wet | | | | | | | | |
| FFDC Outlet | 5.5 | 5.6 | 5.5 | 5.6 | 5.5 | 5.3 | 5.7 | 2.0% |
| FFDC Inlet | 5.1 | 5.1 | 5.1 | 5.1 | 4.7 | 4.8 | 5.0 | 3.7% |

Fuel flow from plant instrumentation. FFDC Outlet and Inlet $O_2$ from single point CEM.
The coefficient of variation (CV) is the standard deviation divided by the mean.

## TABLE 5-2
## SUMMARY OF UNIT OPERATION
## SITE 115
## PHASE II: BASELINE AND UREA INJECTION

| Test No. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | 3/8/93 | 3/9/93 | 3/9/93 | 3/10/93 | 3/10/93 | 3/11/93 | 3/11/93 | 3/15/93 | Mean | CV |
| Unit load, MW gross | 104 | 104 | 103 | 103 | 104 | 106 | 115 | 103 | 105 | 3.9% |
| Steam flow, lb/hr | 854,000 | 852,000 | 850,000 | 846,000 | 855,000 | 870,000 | 951,000 | 846,000 | 866,000 | 4.1% |
| Air flow, lb/hr | 854,000 | 874,000 | 889,000 | 838,000 | 875,000 | 891,000 | 980,000 | 869,000 | 884,000 | 4.8% |
| Fuel flow, lb/hr wet | 82,161 | 83,883 | 89,276 | 88,972 | 96,098 | 93,683 | 111,822 | 84,658 | 91,319 | 10.5% |
| Urea Injection Rate, gpm | NP | NP | NP | 1.07 | 1.07 | 1.04 | 1.04 | NP | 1.06 | 1.6% |
| $O_2$, % wet | | | | | | | | | | |
| FFDC Outlet | 5.9 | 6.0 | 6.2 | 6.0 | 6.1 | 6.4 | 6.2 | 6.1 | 6.1 | 2.5% |
| FFDC Inlet | 5.6 | 5.6 | 5.8 | 5.7 | 5.7 | 6.1 | 6.1 | 5.8 | 5.8 | 3.4% |

Fuel flow from plant instrumentation. Tests 7, 8, 9 and 14 were conducted at baseline conditions only. Tests 10, 11, 12 and 13 were conducted during urea injection.
FFDC Outlet and Inlet $O_2$ from single point CEM
The coefficient of variation (CV) is the standard deviation divided by the mean.
NP - Not performed

used at other FCEM sites. The sampling runs were well documented and these flue gas samples were collected at rates between 90 and 110% isokinetic. Typical flue gas conditions during Phase I were 5.4 to 5.9% oxygen, 7 to 11% moisture, and 255 to 270 degrees with flow rates of approximately 250,000 dscfm. Flue gas conditions for Phase II were 5.7 to 6.4% oxygen, 8 to 13% moisture and 255 to 270 degrees with flow rates of approximately 255,000 dscfm. These values are representative of a coal-fired utility boiler of this size.

Sufficient data were collected using standard sampling and analysis methods to ensure acceptable data completeness and the comparability of measurements. Major differences from other FCEM programs were that benzene and toluene samples were collected according to CARB Method 410A in tedlar bags and formaldehyde samples were collected non-isokinetically according to CARB Method 430 in midget impingers containing 2,4-dinitrophenylhydrazine.

Flue gas entering the FFDC was sampled at the 6 available test ports. A total of 42 points were sampled for each isokinetic test. This sampling location does not meet EPA Method 1 requirements for minimum distances from flow disturbances. Three-dimensional velocity testing indicated that the location did meet EPA Method 1, Section 2.5 criteria of $\leq 20$ degrees resultant angle and $\leq 10$ degrees standard deviation. The resultant angle was 9.9 degrees and the standard deviation of the angles was 7.6 degrees.

There were no accessible ports on the Site 115 stack, so flue gas exiting the FFDC was sampled at the 8 available test ports. A total of 40 points were sampled for isokinetic tests. This sample location does meet the EPA Method 1 criteria for minimum distances from flow disturbances.

Collection procedures for coal samples did not completely follow ASTM methods. Coal samples were collected from each of eight coal feed pipes entering four coal pulverizers. Samples were composited to correspond to each exhaust gas test. Standard procedures for collection of coal samples including sample size, number of sample increments and timing of sample collection are contained in ASTM D2234, Standard Test Methods for Collection of a Gross Sample of Coal. Collection and compositing procedures used for Phase I and II testing at Site 115 deviated from the ASTM standard as follows: (1) Samples were collected over one or two narrow time periods during testing instead of spaced out over the test period. (2) Less than half the recommended number of sample increments were collected. (3) The size of the individual sample increments was too small. (4) Sample increments were collected from the edge of the coal pipes resulting in a possible bias toward collection of larger particles. (5) Samples were not ground to the proper size and riffled for compositing.

Flyash and bottom ash sample collection also did not strictly follow ASTM procedures. Flyash samples were collected from the bottom of each of 16 hoppers and combined in the same manner as coal. Bottom ash samples were grab samples collected once during sluicing.

Sample collection procedures are further described in Appendix A (sampling and analytical summary). Coal flow rates were measured during testing, however readings fluctuated considerably. Coal and ash flow rates used for emissions calculations were calculated from the

HHV of coal for each test. Process stream flow rates and conditions during testing are presented in Appendix D. A sample calculation is located in Section 6.0.

## 5.3 EVALUATION OF MEASUREMENT DATA QUALITY

An evaluation of the quality of the measurement data is based on quality control data obtained experimentally during sampling and analysis. Generally, the type of quality control information obtained that pertains to measurement precision, accuracy, and blank effects, is determined using various types of replicate, spiked, and blank samples. The specific characteristics evaluated depend on the type of quality control checks performed. For example, blanks may be prepared at different stages in the sampling and analysis process to isolate the source of a blank effect. Similarly, replicate samples may be generated at different stages to isolate and measure sources of variability. The QA/QC measures commonly used as part of the FCEM data assessment protocol, and the characteristic information obtained, are summarized in Table 5-3. The absence of any of these types of quality control checks from the data reports does not necessarily reflect poorly on the quality of the data, but does limit the ability to measure the various components of measurement error.

As shown in the table, different QC checks provide different types of information pertaining to the sources of inaccuracy, imprecision, or blank effects. As part of the FCEM project, measurement precision and accuracy are typically estimated from QC indicators that cover as much of the total sampling and analytical process as feasible. Precision and accuracy measurements are based primarily on the actual sample matrix. The precision and accuracy estimates obtained experimentally during the test programs are compared with data quality objectives (DQOs) established for the FCEM project.

These DQOs are not intended to be used as validation criteria, but they can be used as empirical estimates of the precision and accuracy that are expected from existing reference measurement methods. Although analytical precision and accuracy are relatively easy to quantify and control, sampling precision and accuracy are unique to each site and each sample matrix. Data that do not meet these objectives are not necessarily unacceptable. Rather, the intent is to document the precision and accuracy actually obtained; the objectives serve as benchmarks for comparison. The effects of not meeting the objectives should be considered in light of the intended use of the data.

Definition of Quality Assurance Terms

Presented below is a general discussion of considerations to be used when evaluating data and definitions of terms used to describe quality assurance indicators.

Precision is a measure of the reproducibility of laboratory analyses of the same sample. It is expressed in terms of distribution or scatter of the data, and traditionally calculated as the standard deviation or coefficient of variation (CV, standard deviation divided by the mean). For duplicate analysis, precision is expressed as the relative percent difference (RPD).

**TABLE 5-3**
**TYPES OF QUALITY CONTROL SAMPLES**

| QC Activity | Characteristic Measured |
|---|---|
| Precision | |
| Replicate samples collected over time under the same conditions | Total variability, including process or temporal, sampling and analytical. |
| Duplicate field samples collected simultaneously | Sampling plus analytical variability at the actual sample concentrations. |
| Duplicate analyses of a single sample | Analytical variability at the actual sample concentrations. |
| Matrix- or media-spiked duplicates | Sampling plus analytical variability at an established concentration. |
| Laboratory control sample duplicates | Analytical variability in the absence of sample matrix effects |
| Surrogate-spiked sample sets | Analytical variability in the sample matrix but at an established concentration. |
| Accuracy | |
| Matrix-spiked samples | Analyte recovery in the sample matrix, indicating possible matrix interferences and other effects. In a single sample, includes both random error (imprecision) and systematic error (bias) |
| Media-spiked samples | Same as matrix-spiked samples. Used where a matrix-spiked sample is not feasible, such as certain stack sampling methods. |
| Surrogate-spiked samples | Analyte recovery in the sample matrix, to the extent that the surrogate compounds are chemically similar to the compounds of interest. Primarily used as an indicator of analytical efficacy. |
| Laboratory check standards (LCS) | Analyte recovery in the absence of actual sample matrix effects. Used as an indicator of analytical control. |
| Standard Reference Material | Analyte recovery in a matrix similar to the actual samples |
| Blank Effects | |
| Field Blank | Total sampling plus analytical blank effect, including sampling equipment and reagents, sample transport and storage, and analytical reagents and equipment. |
| Trip Blank | Blank effects arising from sample transport and storage. Typically used only for volatile organic compound analyses. |
| Method Blank | Blank effects inherent in analytical method, including laboratory reagents and equipment. |
| Reagent Blank or Field Reagent Blank | Blank effects from reagents used during sampling and analysis. |

$$RPD = \frac{x_1 - x_2}{\bar{x}} x\ 100$$

Accuracy is a measure of the degree of conformity of a value generated by a specific procedure to the assumed or accepted true value; it includes both precision and bias. Bias is the persistent positive or negative deviation of the method average value from the assumed or accepted true value.

The efficacy of the analytical procedure for a given sample matrix is quantified by the analysis of spiked samples containing target or indicator analytes or other quality assurance measures, as necessary. However, all spikes, unless made to the flowing stream ahead of the sampling, produce only estimates of recovery of the analyte through all of the measurement steps occurring after the addition of the spike. A good spike recovery tells little about the true value of the sample before spiking.

Representativeness expresses the degree to which sampling data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The representativeness criterion is based on making certain that sampling locations are properly selected and that a sufficient number of samples are collected.

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sampling data should be comparable with other measurement data for similar samples collected under similar conditions. This goal is achieved using standard techniques to collect and analyze representative samples and by reporting analytical results in appropriate units. Data sets can be compared with confidence when the precision and accuracy are known.

Completeness is an expression of the number of valid measurements obtained compared with the number planned for a given study. The goal is to generate a sufficient amount of valid data.

## 5.4 STACK SAMPLING QUALITY CONTROL RESULTS

Sampling quality control was well documented in this program. It included calibration sheets for most of the equipment used, including the gas meters, portable $O_2$ meters and CEM calibration. Also on file are calibrations for temperature indicators and pitot assemblies. Gas meters are calibrated before and after sampling and can differ no more than 3% from the original meter calibration. The sampling data were evaluated and comments were made on the sampling data sheets about the sampling locations, techniques used, and specific tests comments. In general, a methodical and conservative approach was employed to collect the samples according to the specifications.

The precision of the sampling can be estimated by comparing results for various parameters of the replicate samples, notably velocity, moisture content, and gas composition. These results were fairly constant for each sample location. Comparisons of measured flow rate at each location to calculated flow rates from the unit heat rate and F-factor were made. During Phase I average FFDC inlet measured flow rates were 19% higher than calculated values. Phase I FFDC outlet measured flow rates were 10% higher than calculated. During Phase II urea injection, FFDC inlet measured flow rates were 18% higher than calculated. Phase II urea injection FFDC outlet measured flow rates were 7% higher than calculated.

The accuracy of the sampling is usually assumed from the calibration and proper operation of the equipment and from historical validation of the methods. Field blanks were used to assess any biases that may be caused by contamination of the equipment, location, or operator errors. Field blank values were not subtracted from tests results except for mercury speciation tests. Field blanks were performed for all tests except the particulate/anions, cyanide, and ammonia. Reagent blanks were collected for all tests except mercury speciation.

## 5.5 ANALYTICAL QUALITY CONTROL RESULTS: BASELINE TESTS

Table 5-4 summarizes the types of quality control data reported for the Site 115 baseline tests. The results of these analyses are summarized in Appendices G and H. Table 5-5 presents a summary of precision and accuracy measurements. Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of the sampling procedure.

Based on the quality control data evaluated, the majority of the results met the project objectives.

The following potential problems were highlighted by the quality control data:

- FFDC outlet arsenic and selenium results may be biased low. There may have been sample matrix interferences which resulted in low sample spike recoveries for ICP hydride analysis. Inlet selenium sample levels exceeded the instrument calibration range for ICP hydride analysis. Selenium was not well quantified at the FFDC inlet.

- Barium and copper reagent and field blank levels represent a large fraction of FFDC outlet sample results, and results may be biased high.

- Surrogate spike recoveries for FFDC inlet samples are low for ten of fifteen PAH compounds. Results for ideno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene were not recovery corrected, and these compounds were not well quantified at the inlet.

- Phase II toluene blank levels represent 59% of FFDC outlet sample levels and 33% of inlet sample levels. Sample results may be biased high.

## TABLE 5-4
## TYPES OF QUALITY CONTROL DATA REPORTED
## SITE 115: BASELINE TESTS

| | Precision | | | | | Accuracy | | | | Blank | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis | Replicate Runs | Duplicate Field Samples | Duplicate Laboratory Analysis | Matrix or Media Spiked Duplicate | Laboratory Control Sample Duplicate | Matrix or Media Spike | Surrogate Spike | Laboratory Control Sample | Standard Reference Material | Field Blank | Trip Blank | Laboratory Method Blank | Reagent Blank (Field) |
| FFDC Inlet and Outlet Gas | | | | | | | | | | | | | |
| Metals | ✓ | | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ | ✓ |
| Particulate | ✓ | | | | | | | | | | | | ✓ |
| Anions | ✓ | | ✓ | | | ✓ | | ✓ | | | | | ✓ |
| PAH | ✓ | | | ✓ | | ✓ | ✓ | | | ✓ | | ✓ | |
| Benzene and Toluene | ✓ | | ✓ | | | ✓ | | | | | | | |
| Formaldehyde | ✓ | | ✓ | | | ✓ | | | | ✓ | ✓ | | ✓ |
| Cyanide | ✓ | | ✓ | | | ✓ | | | | | | ✓ | ✓ |
| Radionuclides (Outlet only) | ✓ | | | | ✓ | | ✓ | ✓ | | | | ✓ | ✓ |
| Total and Hexavalent Chromium | ✓ | | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ | ✓ |
| Mercury Speciation (Brooks Rand) | ✓ | | ✓ | | | | | | | ✓ | | | |
| Coal | | | | | | | | | | | | | |
| Metals by ICP-AES, GFAAS and CVAAS | ✓ | | | | | ✓ | | ✓ | | | | ✓ | |
| Metals by INAA | ✓ | | | | | | | | ✓ | | | | |
| Chlorine | ✓ | | ✓ | | | | | | | | | | |
| Fluorine | ✓ | | ✓ | | | | | | | | | | |
| Sulfur | ✓ | | ✓ | | | | | | | | | | |
| Ultimate and Heating Value | ✓ | | ✓ | | | | | ✓ | | | | | |
| Radionuclides | ✓ | | | | ✓ | | ✓ | ✓ | | | | ✓ | |
| Mercury by CVAFS (Brooks Rand) | | | | | | | | | ✓ | | | ✓ | |
| Bottom Ash | | | | | | | | | | | | | |
| Metals | ✓ | | | | | | | ✓ | | | | ✓ | |
| Anions | ✓ | | ✓ | | | | | | | | | ✓ | |
| Radionuclides | ✓ | | ✓ | | | | ✓ | ✓ | | | | ✓ | |
| Fly Ash | | | | | | | | | | | | | |
| Metals | ✓ | | | | | | | ✓ | | | | ✓ | |
| Anions | ✓ | | ✓ | | | | | | | | | ✓ | |
| Radionuclides | ✓ | | | ✓ | | | ✓ | ✓ | | | | ✓ | |
| Mercury by CVAFS (Brooks Rand) | | | | | | | | | ✓ | | | ✓ | |

## TABLE 5-5
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## Site 115: BASELINE TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| **Metals in FFDC Outlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Arsenic | | 10% RPD | 75-125% | 0.1% RPD | 15% |
| Barium | | 10% RPD | 75-125% | 0.1% RPD | 94% |
| Beryllium | | 10% RPD | 75-125% | NC | 92% |
| Cadmium | | 10% RPD | 75-125% | 6% RPD | 102% |
| Chromium | | 10% RPD | 75-125% | 11% RPD | 97% |
| Cobalt | | 10% RPD | 75-125% | NC | 89% |
| Copper | | 10% RPD | 75-125% | 0.4% RPD | 92% |
| Lead | | 10% RPD | 75-125% | NP | MSA |
| Manganese | | 10% RPD | 75-125% | 3% RPD | 98% |
| Mercury | | 10% RPD | 75-125% | NC | 94% |
| Molybdenum | | 10% RPD | 75-125% | 1% RPD | 91% |
| Nickel | | 10% RPD | 75-125% | 2% RPD | 88% |
| Phosphorus | | 10% RPD | 75-125% | 0.5% RPD | 124% |
| Selenium | | 10% RPD | 75-125% | 9% RPD | 4% |
| Vanadium | | 10% RPD | 75-125% | | 114% |
| **Metals in FFDC Inlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Arsenic | | 10% RPD | 75-125% | NP | MSA |
| Barium | | 10% RPD | 75-125% | 2% RPD | 96% |
| Beryllium | | 10% RPD | 75-125% | 2% RPD | 92% |
| Cadmium | | 10% RPD | 75-125% | 37% RPD | 99% |
| Chromium | | 10% RPD | 75-125% | 0.5% RPD | 98% |
| Cobalt | | 10% RPD | 75-125% | 8% RPD | 107% |
| Copper | | 10% RPD | 75-125% | 2% RPD | 96% |
| Lead | | 10% RPD | 75-125% | NP | MSA |
| Manganese | | 10% RPD | 75-125% | 0.3% RPD | 94% |
| Mercury | | 10% RPD | 75-125% | 17% RPD | 99% |
| Molybdenum | | 10% RPD | 75-125% | 4% RPD | 90% |
| Nickel | | 10% RPD | 75-125% | 9% RPD | 107% |
| Phosphorus | | 10% RPD | 75-125% | 0.7% RPD | 124% |
| Selenium | | 10% RPD | 75-125% | NP | NP |
| Vanadium | | 10% RPD | 75-125% | 0.4% RPD | 95% |

(continued)

Precision for metals was measured by duplicate analyses and replicate runs. Replicate runs results are contained in Appendix F.
Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Accuracy for metals was assessed by post-digestion and pre-digestion laboratory spikes. This table is based on post-digestion laboratory spike recoveries. Additional information is contained in Appendix G.
Outlet arsenic and inlet and outlet selenium results are from ICP hydride analysis.
RPD = Relative Percent Difference
NC = Not calculated; analyte reported as not detected
MSA = Sample analysis performed by method of standard additions.
NP = Not performed.

**TABLE 5-5 (cont'd)**
**SUMMARY OF PRECISION AND ACCURACY ESTIMATES**
**SITE 115: BASELINE TESTS**

| Measured Parameter | How Measured | Objectives | | Measured | |
|---|---|---|---|---|---|
| | | Precision | Accuracy | Precision | Accuracy |
| PAH in FFDC Outlet Gas (detected species) | Precision - Matrix Spike Duplicate<br>Accuracy - Pre-extraction Surrogate Spikes | | | | |
| Naphthalene | | 50% RPD | 50-150% | NM | 70% |
| Fluorene | | 50% RPD | 50-150% | 11% RPD | 89% |
| 2-Methylnaphthalene | | 50% RPD | 50-150% | NP | NA |
| PAH in FFDC Inlet Gas (detected species) | Precision - Duplicate Analysis<br>Accuracy - Pre-extraction Surrogate Spikes | | | | |
| Naphthalene | | 50% RPD | 50-150% | NM | 52% |
| Fluorene | | 50% RPD | 50-150% | 11% RPD | 55% |
| 2-Methylnaphthalene | | 50% RPD | 50-150% | NP | NA |
| Benzene and Toluene in FFDC Outlet Gas (Phase I) | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Benzene | | 20% RPD | 70-130% | 18% RPD | 87% |
| Toluene | | 20% RPD | 70-130% | 9% RPD | 96% |
| Benzene and Toluene in FFDC Inlet Gas (Phase I) | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Benzene | | 20% RPD | 70-130% | 2% RPD | See Outlet Gas |
| Toluene | | 20% RPD | 70-130% | 8% RPD | |

Precision for PAH analyses also determined by replicate runs (Appendix F)

(continued)

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Accuracy for PAH analyses also determined by pre-sampling surrogate spikes (field spikes) and blank matrix spikes (Appendix G).

RPD = Relative Percent Difference.
NM = Not meaningful; spike level was too low to measure accurately.
NA = Not Available, method of internal standardization was used.
NP = Not Performed

## TABLE 5-5 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: BASELINE TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Benzene and Toluene in FFDC Outlet Gas (Phase II) | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Benzene | | 20% RPD | 70-130% | 24% RPD | 110% |
| Toluene | | 20% RPD | 70-130% | 14% RPD | 93% |
| Benzene and Toluene in FFDC Inlet Gas (Phase II) | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Benzene | | 20% RPD | 70-130% | 22% RPD | 120% |
| Toluene | | 20% RPD | 70-130% | 3% RPD | 91% |
| Formaldehyde in FFDC Outlet Gas | Precision - Replicate Runs<br>Accuracy - Spiked Samples | 10% RPD | 60-140% | 0.0% RPD | 107% |
| Formaldehyde in FFDC Inlet | Precision - Replicate Runs<br>Accuracy - Spiked Samples | 10% RPD | 60-140% | 8% RPD | 217% |
| Particulate, FFDC Outlet Gas | Precision - Replicate Runs<br>Accuracy - NBS Traceable Weights | | | | |
| Particulate | | 20% CV | 95-105% | 82% CV | 95-105% |
| Particulate, ESP Inlet Gas | Precision - Replicate Runs<br>Accuracy - NBS Traceable Weights | | | | |
| Particulate | | 20% CV | 95-105% | 19% CV | 95-105% |

Precision for Benzene and Toluene also determined by replicate runs (Appendix F).
Precision for Formaldehyde also assessed by replicate runs and multiple pre- and post- test reagent blanks (Appendices F and H).
Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Accuracy for Formaldehyde determined from field spikes. Trip spikes and matrix spikes were also performed (Appendix G).
Precision for Particulate tests includes FFDC allowable variance of 0.5 mg for duplicate weights.
Measured Precision for Particulate Size distribution tests expressed an average for all collection stages.
Accuracy of 95-105% assumes maximum FFDC allowable variance of 0.5 mg and 10 mg sample size. Actual use of NBS traceable weights requires 99-101% accuracy.
RPD = Relative Percent Difference
CV = Coefficient of variation. Duplicate analyses were not available.

(continued)

## TABLE 5-5 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: BASELINE TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| **Anions in FFDC Outlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 15% RPD | 80-120% | NC | 72-82% |
| Fluoride | | 15% RPD | 80-120% | 18% RPD | 97-118% |
| Sulfate | | 15% RPD | 80-120% | 1-5% RPD | 88-107% |
| **Anions in FFDC Inlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 15% RPD | 80-120% | See Outlet Gas | See Outlet Gas |
| Fluoride | | 15% RPD | 80-120% | | |
| Sulfate | | 15% RPD | 80-120% | | |
| **Radionuclides in FFDC Outlet Gas (detected isotopes)** | Precision - Replicate Laboratory Control Samples<br>Accuracy - Spiked Samples | | | | |
| Radium-226 | | 20% RPD | 50-150% | 3% RPD | 89% |
| Radium-228 | | 20% RPD | 50-150% | 11% RPD | 107% |
| **Cyanide in FFDC Outlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | 20% RPD | 75-125% | | See Inlet |
| **Cyanide in FFDC Inlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | 20% RPD | 75-125% | 15% RPD | 94% |

(continued)

Precision for Anions, Radionuclides and Cyanide also determined by replicate runs (Appendix F).
Accuracy for Anions determined from spike recovery in the filter and front half sample train fractions. Results presented here are the range of spike recoveries reported.
Accuracy for Radionuclides from internal spike recoveries.
Accuracy for Radionuclides also determined by laboratory control sample analysis (Appendix G).
RPD = Relative Percent Difference.
CV = Coefficient of variation. Duplicate analyses were not available.
NC = Not calculated, no detected values.

**TABLE 5-5 (cont'd)**
**SUMMARY OF PRECISION AND ACCURACY ESTIMATES**
**SITE 115: BASELINE TESTS**

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Chromium Recirculation Train Evaluation, FFDC Inlet | Precision - Duplicate Analyses<br>Accuracy - Spiked Samples (Cr(VI))<br>SRM WP481 (Total Cr) | | | | |
| Hexavalent chromium | | 15% RPD | 80-120% | 4% RPD | 92% |
| Total chromium | | 10% RPD | 75-125% | 3% RPD | 107% |
| | | | | Conversion: | 4% |
| Mercury Evaluation Tests, FFDC Outlet Gas | Precision - Replicate Runs<br>Accuracy - NA | | | | |
| Hg (total) | | 10% RPD | 70-130% | 84% CV | NA |
| Hg (II) | | 10% RPD | 70-130% | 102% CV | NA |
| Hg (0) | | 10% RPD | 70-130% | NC | NA |
| Mercury Evaluation Tests, FFDC Inlet Gas | Precision - Replicate Runs<br>Accuracy - NA | | | | |
| Hg (total) | | 10% RPD | 70-130% | 3% CV | NA |
| Hg (II) | | 10% RPD | 70-130% | 7% CV | NA |
| Hg (0) | | 10% RPD | 70-130% | 24% CV | NA |

(continued)

Precision for Cr and $Cr^{6+}$ also assessed from replicate runs and duplicate spike analyses.
Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Precision for inlet mercury speciation tests based on results for duplicate sample analyses.
RPD = Relative Percent Difference
NA = Not Available
NC = Not Calculated, analyte reported as not detect
CV = Coefficient of Variation. Duplicate analyses were not available.

**TABLE 5-5 (cont'd)**
**SUMMARY OF PRECISION AND ACCURACY ESTIMATES**
**SITE 115: BASELINE TESTS**

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Metals in Coal by ICP-AES and GFAAS | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Beryllium | | 20% CV | 75-125% | 20% CV | 84% |
| Cadmium | | 20% CV | 75-125% | 46% CV | 112% |
| Copper | | 20% CV | 75-125% | 2% CV | 84% |
| Cobalt | | 20% CV | 75-125% | 12% CV | 88% |
| Chromium | | 20% CV | 75-125% | 23% CV | 87% |
| Lead | | 20% CV | 75-125% | 21% CV | 102% |
| Manganese | | 20% CV | 75-125% | 34% CV | 85% |
| Molybdenum | | 20% CV | 75-125% | 87% CV | 112% |
| Nickel | | 20% CV | 75-125% | 35% CV | 86% |
| Phosphorus | | 20% CV | 75-125% | 21% CV | 107% |
| Vanadium | | 20% CV | 75-125% | 16% CV | 89% |
| Metals and Cl in Coal by INAA | Precision - Replicate Runs<br>Accuracy - Standard Reference Material NBS 1571 and 8408 (mercury) | | | | |
| Arsenic | | 20% CV | 75-125% | 16% CV | 110% |
| Barium | | 20% CV | 75-125% | 22% CV | 109% |
| Mercury | | 20% CV | 75-125% | 34% CV | 94% |
| Selenium | | 20% CV | 75-125% | 12% CV | NP |
| Chlorine | | 20% CV | 75-125% | 16% CV | NA |
| Mercury in Coal by CVAFS (Brooks Rand) | Precision - NA<br>Accuracy - Standard Reference Material NBS 1630 | 20% CV | 75-125% | NA | 73% |
| Fluorine in Coal | Precision - Duplicate Analysis<br>Accuracy - Standard Reference Material NBS 1632B | | | | |
| Fluorine | | 10% RPD | 90-110% | 8% RPD | 101% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedures. (continued)
Metals analyses by ICP-AES presented here are those used in the final calculations. Additional metals data is presented in Appendices B, G, and H.
Fluorine precision also determined by replicate runs.
Metals accuracy data is for analysis of a post-digestion sample spike.
NA = Not available
NP = Not performed
RPD = Relative Percent Difference
CV = Coefficient of variation. Duplicate analyses were not available.

**TABLE 5-5 (cont'd)**
**SUMMARY OF PRECISION AND ACCURACY ESTIMATES**
**SITE 115: BASELINE TESTS**

| Phase I Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| **Coal Composition (Phase I):** | Precision - Duplicate Analysis<br>Accuracy - Laboratory Check Standards | | | | |
| Moisture | | 10% RPD | 90-110% | 7% RPD | NA |
| Carbon | | 10% RPD | 90-110% | 0.9% RPD | NA |
| Hydrogen | | 10% RPD | 90-110% | 1% RPD | NA |
| Nitrogen | | 10% RPD | 90-110% | 3% RPD | NA |
| Sulfur | | 10% RPD | 90-110% | 0% RPD | NA |
| Ash | | 10% RPD | 90-110% | 5% RPD | 99% |
| HHV | | 10% RPD | 90-110% | 0.2% RPD | 100% |
| **Coal Composition (Phase II):** | Precision - Duplicate Analysis<br>Accuracy - Laboratory Check Standards | | | | |
| Moisture | | 10% RPD | 90-110% | 7% RPD | NA |
| Carbon | | 10% RPD | 90-110% | NA | 100% |
| Hydrogen | | 10% RPD | 90-110% | NA | 99% |
| Nitrogen | | 10% RPD | 90-110% | NA | 98% |
| Sulfur | | 10% RPD | 90-110% | NA | 99% |
| Ash | | 10% RPD | 90-110% | 0.2% RPD | NA |
| HHV | | 10% RPD | 90-110% | 0% RPD | 100% |
| **Radionuclides in Coal** | Precision - Replicate Laboratory Control Samples<br>Accuracy - Spiked Samples | | | | |
| Uranium-233 & 234 | | 20% RPD | 50-150% | 12% RPD | 44% |
| Uranium-235 | | 20% RPD | 50-150% | NP | 44% |
| Uranium-238 | | 20% RPD | 50-150% | 4% RPD | 44% |
| Radium-226 | | 20% RPD | 50-150% | 5% RPD | 97% |
| Radium-228 | | 20% RPD | 50-150% | NP | 119% |
| Lead-210 | | 20% RPD | 50-150% | NP | 69% |
| Polonium-210 | | 20% RPD | 50-150% | NA | 16% |
| Thorium-228 | | 20% RPD | 50-150% | NP | 53% |
| Thorium-230 | | 20% RPD | 50-150% | NP | 53% |
| Thorium-232 | | 20% RPD | 50-150% | 8% RPD | 53% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedures.

(continued)

Metals precision and accuracy data are for analysis of the bottom ash liquid fraction. Fly ash and bottom ash solid samples were analyzed for metals in the same batch and quality control was performed on a fly ash sample.
Metals accuracy data is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.
Radionuclides accuracy data are for internal spike recoveries. Accuracy for radionuclides also determined from laboratory control sample analysis. Radionuclides precision also estimated from replicate runs.
NA = Not available
NP = Not performed
RPD = Relative Percent Difference

## TABLE 5-5 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: BASELINE TESTS

| Phase I Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Metals in Bottom Ash | Precision - Replicate Runs<br>Accuracy - Spiked Laboratory Method Blanks | | | | |
| Arsenic | | 20% CV | 75-125% | 8% CV | 100% |
| Barium | | 20% CV | 75-125% | 9% CV | 101% |
| Beryllium | | 20% CV | 75-125% | 12% CV | 101% |
| Cadmium | | 20% CV | 75-125% | NC | 112% |
| Chromium | | 20% CV | 75-125% | 6% CV | 103% |
| Cobalt | | 20% CV | 75-125% | 13% CV | 105% |
| Copper | | 20% CV | 75-125% | 15% CV | 100% |
| Lead | | 20% CV | 75-125% | 19% CV | 115% |
| Manganese | | 20% CV | 75-125% | 11% CV | NR |
| Mercury | | 20% CV | 75-125% | 107% CV | 97% |
| Molybdenum | | 20% CV | 75-125% | NC | 101% |
| Nickel | | 20% CV | 75-125% | NC | 101% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedures. (continued)
Metals precision and accuracy data are for analysis of the bottom ash liquid fraction. Fly ash and bottom ash solid samples were analyzed for metals in the same batch and quality control was performed on a fly ash sample.
Metals accuracy data is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.
NA = Not available
NC = Not calculated, analyte reported as not detected
NP = Not performed
NR = Not reported
RPD = Relative Percent Difference
CV = Coefficient of variation. Duplicate analyses were not available.

## TABLE 5-5 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: BASELINE TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Selenium | | 20% CV | 75-125% | NC | 108% |
| Phosphorus | | 20% CV | 75-125% | 9% CV | 113% |
| Vanadium | | 20% CV | 75-125% | 12% CV | 101% |
| **Anions in Bottom Ash** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 20% RPD | 80-120% | See Flyash | See Flyash |
| Fluoride | | 20% RPD | 80-120% | | |
| Sulfur | | 20% RPD | 80-120% | | |
| **Radionuclides in Bottom Ash** | Precision - Duplicate Analyses<br>Accuracy - Spiked Samples | | | | |
| Uranium-233 & 234 | | 20% RPD | 50-150% | 13% RPD | 63% |
| Uranium-235 | | 20% RPD | 50-150% | 0.0% RPD | 63% |
| Uranium-238 | | 20% RPD | 50-150% | 9% RPD | 63% |
| Radium-226 | | 20% RPD | 50-150% | 7% RPD | 98% |
| Radium-228 | | 20% RPD | 50-150% | NP | 131% |
| Lead-210 | | 20% RPD | 50-150% | 15% RPD | 59% |
| Polonium-210 | | 20% RPD | 50-150% | 29% RPD | 21% |
| Thorium-228 | | 20% RPD | 50-150% | 10% RPD | 52% |
| Thorium-230 | | 20% RPD | 50-150% | 14% RPD | 52% |
| Thorium-232 | | 20% RPD | 50-150% | 18% RPD | 52% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of procedure sampling. (continued)

Metals precision and accuracy data are for analysis of the bottom ash liquid fraction. Fly ash and bottom ash solid samples were analyzed for metals in the same batch and quality control was performed on a fly ash sample.

Metals accuracy data is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.

Bottom ash and flyash samples were analyzed for anions in the same batch, and quality control was performed on a flyash sample.

Metals, anions and radionuclides precision also determined from replicate runs.

Radionuclides accuracy data are for internal spike recoveries. Accuracy for radionuclides also determined from laboratory control sample analysis.

NA = Not available
NC = Not calculated, sample value was not detected
RPD = Relative Percent Difference
CV = Coefficient of Variation. Duplicate analyses were not available.
NP = Not performed

## TABLE 5-5 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: BASELINE TESTS

| Measured Parameter | How Measured | Objectives | | Measured | |
|---|---|---|---|---|---|
| | | Precision | Accuracy | Precision | Accuracy |
| Metals in Flyash | Precision - Replicate Runs<br>Accuracy - Spiked Laboratory Method Blanks | | | | |
| Arsenic | | 20% CV | 75-125% | 75% CV | 81% |
| Barium | | 20% CV | 75-125% | 10% CV | 102% |
| Beryllium | | 20% CV | 75-125% | 10% CV | 112% |
| Cadmium | | 20% CV | 75-125% | NC | 113% |
| Chromium | | 20% CV | 75-125% | 10% CV | 104% |
| Cobalt | | 20% CV | 75-125% | 14% CV | 100% |
| Copper | | 20% CV | 75-125% | 21% CV | 107% |
| Lead | | 20% CV | 75-125% | 20% CV | 77% |
| Manganese | | 20% CV | 75-125% | 3% CV | 103% |
| Mercury | | 20% CV | 75-125% | 67% CV | 106% |
| Molybdenum | | 20% CV | 75-125% | 6% CV | 100% |
| Nickel | | 20% CV | 75-125% | 44% CV | 98% |
| Selenium | | 20% CV | 75-125% | 5% CV | 104% |
| Phosphorus | | 20% CV | 75-125% | 15% CV | 96% |
| Vanadium | | 20% CV | 75-125% | 21% CV | 101% |
| Anions in Flyash | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 20% RPD | 80-120% | 4% RPD | 133% |
| Fluoride | | 20% RPD | 80-120% | 0.6% RPD | 126% |
| Sulfur | | 20% RPD | 80-120% | 1% RPD | 132% |

(continued)

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of procedure sampling.
Metals sample spike recovery data for flyash only available for arsenic and lead. Accuracy reflects recovery of spiked laboratory method blank for all metals except arsenic and lead which are post-digestion sample spikes recoveries.
Metals and anions precision also assessed from replicate runs.
RPD = Relative Percent Difference.
CV = Coefficient of Variation. Duplicate analyses were not available.
NC = Not calculated, no detected values

## TABLE 5-5 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: BASELINE TESTS

| Phase I | | Objectives | | Measured | |
|---|---|---|---|---|---|
| Measured Parameter | How Measured | Precision | Accuracy | Precision | Accuracy |
| **Radionuclides in Flyash** | Precision - Replicate Laboratory Control Samples<br>Accuracy - Spiked Samples | | | | |
| Uranium-233 & 234 | | 20% RPD | 50-150% | 12% RPD | 67% |
| Uranium-235 | | 20% RPD | 50-150% | NP | 67% |
| Uranium-238 | | 20% RPD | 50-150% | 4% RPD | 67% |
| Radium-226 | | 20% RPD | 50-150% | 5% RPD | 96% |
| Radium-228 | | 20% RPD | 50-150% | NP | 141% |
| Lead-210 | | 20% RPD | 50-150% | NP | 44% |
| Polonium-210 | | 20% RPD | 50-150% | NA | 9% |
| Thorium-228 | | 20% RPD | 50-150% | NP | 55% |
| Thorium-230 | | 20% RPD | 50-150% | NP | 55% |
| Thorium-232 | | 20% RPD | 50-150% | 8% RPD | 55% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of procedure sampling.
Radionuclides accuracy data is from internal sample spike recoveries. Accuracy for radionuclides also assessed from laboratory control sample analysis
Radionuclides precision also from replicate runs.
RPD = Relative Percent Difference
NA = Not Available
NP = Not Performed

- Formaldehyde results may be biased high. Recovery for the inlet field spike was high and inlet and outlet field blank levels were one to three times sample levels.

- Polonium-210 internal spike recoveries are low for FFDC outlet, coal and ash samples. Sample results are recovery corrected.

- Hexavalent and total chromium field blank levels are 50% of hexavalent chromium sample levels and 44% of total chromium sample levels. Sample results may be biased high.

- Metals reported at significant levels in the field blank compared to outlet sample levels include arsenic, barium, copper, molybdenum, and vanadium.

A discussion of the overall measurement precision, accuracy, and blank effects for Phase I and II baseline samples is presented below for each measurement type. Complete QA/QC data are presented in Appendix G. Appendix H presents analytical and blank correction data. Table H-16 contains a summary of blank correction contributions to the sample values.

### 5.5.1 Multi-Metals

#### Precision

The precision of metals analyses of flue gas samples can be estimated by the results of duplicate laboratory analyses. The precision data on duplicate analyses of one inlet and one outlet sample were compared to the data quality objective of 10% RPD. Cadmium and mercury (in the permanganate impingers) in the inlet sample exceeded the DQO with RPDs of 37% and 25%, respectively. For the FFDC outlet sample, only chromium exceeds the DQO with 11% RPD.

Precision of flue gas metals was also calculated based on replicate runs. This measure of precision should be more variable than duplicate analyses due to the added variability in process operation and sampling. The precision data on replicate runs were compared to a typical objective of 20% CV.

FFDC inlet and outlet metals results for most elements did not meet the CV objective. The coefficient of variation for the inlet ranges from 4-84%. Only copper, selenium and phosphorus meet the objective. The coefficient of variation for outlet samples ranged from 4-79%, indicating greater variability than expected. Only lead, molybdenum and phosphorus meet the 20% CV objective.

Duplicate metals analysis results for coal and ash were not available and precision was based on replicate runs. Precision results were compared to the 20% CV objective.

Results for coal samples analyzed by ICP-AES and GFAAS do not meet the objective for Cd, Cr, Pb, Mn, Mo, Ni and P with CV values ranging from 21% for phosphorus to 87% for molybdenum. Coal sample results for INAA analysis meet the objective for all but barium at 22% CV and mercury at 34% CV.

Bottom ash samples were split into solid and liquid fractions for Phase I, and analyzed separately. Precision results for the liquid fraction are acceptable for all elements except mercury at 107% CV. This high CV is because two of the three mercury sample results were not detected values. Bottom ash solid samples and flyash samples were analyzed together and quality control was performed on a flyash sample.

Flyash precision results do not meet the <20% CV objective for arsenic, copper, mercury, nickel and vanadium. CV values range from 21% for copper and vanadium to 67% for mercury.

Accuracy

The accuracy of the flue gas metals analyses is based on sample spike recoveries. A spike recovery objective of 75-125% is specified by the multi-metals method. One inlet and one outlet sample were spiked after digestion and before analysis. Typically, if recovery of a particular element was not ±25% of nominal, the laboratory attempted to analyze the sample using either an alternate instrumental technique or by the Method of Standard Additions (MSA).

For the spiked outlet sample, the recovery objective was not met for arsenic at 15% and selenium at 4%, both analyzed by ICP-AES with hydride generation (ICP hydride). The remaining metals met the objective with recoveries of 88% to 124%.

A predigestion spike was added to a blank sample to demonstrate that there were no losses or gains from the digestion procedure. Predigestion spike recoveries were acceptable for all elements including arsenic and selenium by ICP hydride. This indicates that poor post-digestion spike recoveries were due to sample matrix interferences. The laboratory also had problems with ICP hydride analysis of inlet samples as indicated by poor calibration and blank check results. Additionally, sample concentration levels exceeded the calibration range and results for diluted samples were not acceptable. An inlet selenium sample spike was not performed.

Accuracy of coal metals analyses was estimated from spiked samples for ICP-AES and GFAAS analyses and from standard reference materials 1571 and 8408 for INAA analysis. ICP-AES and GFAAS analysis recoveries for post-digestion sample spikes all meet the 75-125% objective ranging from 84-112%. NIST standard analysis results also met the objective ranging from 94-112%.

The accuracy of metals in bottom ash and flyash was not estimated in the sample matrix. Spiked laboratory blanks were calculated and were acceptable at 97-113% for bottom ash (liquid fraction) and 96-113% for flyash.

Blank Effects

Barium, chromium, copper, lead, manganese, mercury, molybdenum and vanadium were detected in the reagent blank. Sample results for these metals were reagent blank corrected. For the FFDC inlet gas, no blank correction contribution exceeded 50%. For the FFDC outlet gas, blank correction contribution exceeded 50% for barium at 71%, copper at 59% and molybdenum at 94%.

Laboratory preparation blank levels are low or not detected for all elements. Field blank levels are the same or slightly higher than sample levels for all elements except chromium, manganese and nickel. Sample results for barium and copper may show a slight high bias.

Laboratory blank levels for coal metals ICP-AES and GFAAS analyses were low or not detected. Blank correction contribution ranged from 0-13%.

No elements were detected in bottom ash or flyash laboratory blanks.

Conclusions

Outlet arsenic and selenium sample spike recoveries from ICP hydride analysis are low due to sample matrix interferences and sample results may be biased low. No sample spiking was performed on inlet selenium samples for ICP-hydride analysis, however, calibration and blank check results were high and sample results exceeded the instrument calibration range. Inlet selenium results are semi-quantitative.

Flue gas field blank levels are similar to FFDC outlet sample levels, however, barium and copper sample results are significantly affected, and may be biased high.

### 5.5.2 Polycyclic Aromatic Hydrocarbons

Precision

Precision for PAH flue gas sample analysis is based on duplicate blank matrix spikes. A DQO of <50% RPD was set for PAH precision due to high relative uncertainties inherent in the analysis of extremely trace species. The spike level for naphthalene was too low to provide meaningful data. Duplicate results for other PAH were acceptable ranging from 0 through 11%.

Precision for detected PAH was also estimated from replicate runs. Precision ranges from 8-70% and is acceptable for all species except 2-methylnapthalene at the inlet.

Accuracy

The accuracy of the PAH analysis is assessed by the recovery of labelled surrogate compounds added to each sample before extraction. Acceptable recovery for surrogates is 50-150%.

Recoveries are acceptable for outlet samples ranging from 34-97%. Only benzo(a)pyrene does not meet the recovery objective on two of three samples. Inlet sample recoveries for ten of fifteen PAH are below the objective in two of three samples. Recoveries for indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene are 2-8% and sample results for these compounds were not recovery corrected. These compounds may not have been well quantified in FFDC inlet samples.

Blank Effects

Laboratory blanks contain approximately 50% of naphthalene levels and sample results were blank corrected. The 2-methylnapthalene field blanks contain 60% of inlet levels and 500% of outlet levels. 2-methylnapthalene inlet and outlet sample results are low, less than five times the reporting limit.

Conclusions

PAH analysis results are acceptable except for low internal spike recoveries for 10 of 15 species at the inlet. Sample results for ideno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene are not recovery corrected because internal spike recoveries were only 2-8% on all samples and these compounds may not have been well quantified. 2-methyl napthalene field blank levels are five times FFDC outlet sample levels, however sample results are near the detection limit and are not significantly affected.

### 5.5.3 Benzene and Toluene

Benzene and toluene samples were collected during Phase I. Because inlet sample results were lower than outlet results the tests were repeated as part of Phase II baseline testing.

Precision

Analytical precision for FFDC inlet and outlet gas benzene and toluene is based on RPDs for duplicate inlet and outlet sample analysis. All RPD values for Phase I benzene and toluene and Phase II toluene met the <20% DQO. Phase II benzene RPDs slightly exceed the objective at 22% for an inlet sample and 34% for an outlet sample.

Precision was also assessed for replicate runs. Phase I benzene and toluene precision results exceed the <20% objective ranging from 3-62% CV. Phase II precision results for benzene and toluene range from 2% to 49% CV.

Accuracy

Benzene and toluene analytical accuracy is based on recoveries of a spiked sample. After sample analysis, a known volume of sample was spiked with a known volume of benzene and toluene standard gas. This standard was used to measure potential matrix effects and assess the accuracy of the analysis. Phase I spike recoveries met the 70-130% recovery objective for benzene and toluene at 87% and 96%, respectively. Phase II spike recoveries ranged from 91-120% and were also acceptable.

Blank Effects

Pre-test tedlar bag blank sample results were 0.045 ppb benzene and 0.29 ppb toluene for Phase I samples. Sample results were not blank corrected and blank values were only 1-13% of sample values. Blank results for Phase II were 0.14 ppb for benzene and 12.8 ppb for toluene. These levels are 4-6% of benzene sample levels and 33-59% of toluene sample levels.

Conclusion

Analytical precision and accuracy results for Phase I and II FFDC inlet and outlet gas benzene and toluene samples are acceptable. Blank levels are low on both an absolute and relative basis for Phase I benzene and toluene samples and Phase II benzene samples. Phase II toluene blank levels are high, representing 33% of inlet values and 59% of outlet values. Phase II FFDC toluene results may be biased high.

5.5.4 Formaldehyde

Precision

Precision for FFDC inlet and outlet formaldehyde analysis is based on RPDs for duplicate samples. Duplicate analysis was performed on one FFDC inlet sample and one inlet and outlet field blank. Only the inlet field blank duplicate exceeded the <10% objective at 13% RPD. Precision for inlet and outlet formaldehyde samples was also estimated from replicate runs. Results were 15% CV for inlet samples and 48% CV for outlet samples.

Accuracy

Accuracy for formaldehyde analysis is based on sample spike recoveries. Spike recovery of an inlet sample was 101% and spike recovery of an outlet sample was 108%. Both of these recoveries meet the 60-140% DQO.

Accuracy was also assessed by trip and field spike recoveries. The trip spike recovery was 140%. Inlet and outlet field spike recoveries were 217% and 107%. The inlet sample field spike recovery does not meet the recovery objective.

Blank Effects

The trip blank was 21% of the average inlet sample and 17% of the average outlet sample. Field blank concentrations represent 30-300% of sample levels. Blank and sample levels are variable and sample results were not blank corrected.

Conclusions

Formaldehyde analytical quality assurance results are acceptable except for a high inlet location field spike recovery. Field blank levels are variable and one to three times sample levels. Sample results may be biased high.

5.5.5 Total Solid Particulate

Precision

Precision for FFDC inlet and outlet gas particulate samples is based on the average CV for replicate runs. Inlet precision was 19%. Outlet precision was 82%. The outlet precision exceeds the <20% objective; however, differences between replicate runs are large only on a relative basis and not on an absolute basis.

Accuracy

EPA Method 5 gravimetric procedures were used. These procedures generally have laboratory accuracy of 95% to 105%, and overall accuracy of 85-115%.

Blank Effects

No particulate was measured in the acetone reagent blank, so no blank corrections were necessary.

Conclusions

FFDC outlet sample precision was high because of low particulate loading. Other particulate analysis quality assurance results are acceptable.

5.5.6 Anions

Precision

Precision for FFDC inlet and outlet gas anions analysis is based on RPDs for duplicate samples. The objective for anions IC analysis was <15% RPD. All results meet this objective except fluoride on an inlet filter at 18% RPD.

Precision for replicate runs is high for inlet phosphate samples at 59% and for outlet chloride samples at 41% and outlet fluoride samples at 55% which is typical of low concentration levels.

Precision for chlorine in coal by INAA is 16% CV based on replicate runs, which meets the <20% CV objective. Precision for fluorine and sulfur in coal is based on duplicate sample analysis and both meet the objective of <10% RPD.

Precision for anions in bottom ash and flyash is estimated from duplicate analyses. Bottom ash and flyash samples were analyzed together and quality control was performed on a flyash sample. The duplicate results range from 0.6 to 4% RPD and meet the <10% RPD objective.

Accuracy

The accuracy of FFDC inlet and outlet gas anions analyses was estimated from spiked samples. All FFDC inlet and outlet recoveries met the 80-120% objective, except for chloride recovery for an inlet filter at 72%.

Accuracy results for chlorine and sulfur in coal by INAA analysis were not available. Accuracy for fluorine is 101% for SRM NBS 1632B and meets the 90-110% recovery objective.

Accuracy for anions in bottom ash and flyash was assessed from spiked samples. Bottom ash and flyash samples were analyzed together, and quality control was performed on a flyash sample. Spike recoveries range from 126-133% and slightly exceed the 80-120% recovery objective.

Blank Effects

Fluoride and phosphate were not detected in any of the flue gas reagent blank fractions. Chloride was detected in the 3% peroxide blank and results were reagent blank corrected. Sulfate was detected in the filter and 3% peroxide blanks and results were reagent blank corrected. Blank correction contribution for sulfate and chloride is minimal for both inlet and outlet samples. Anions were not detected in bottom ash and flyash laboratory blanks.

Conclusions

Quality assurance results for anions in flue gas, coal and ash samples are generally acceptable.

### 5.5.7 Radionuclides

Precision

Precision for FFDC outlet flue gas, coal and flyash sample radionuclides analyses is based on replicate laboratory control samples. Results for a laboratory control sample analyzed with each set of samples were compared to the mean values from the previous 30 laboratory control samples (LCS) analyzed. The objective for laboratory control sample replicates is <20% RPD.

Precision results for FFDC outlet samples meet the objective for all isotopes except uranium-238 at 40% RPD and one radium-228 LCS at 22% RPD. Results for a second radium-228 LCS were acceptable at 11% RPD. Precision for detected isotopes based on replicate runs was 3% for radium-226 and 12% for radium-228, both below the 50% CV objective.

Precision for coal and flyash LCS replicates met the objective for all isotopes. Precision from replicate runs ranged from 19-87% for coal with uranium-235, polonium-210 and thorium-232 exceeding the <50% CV objective. Precision for flyash from replicate runs ranged from 7-64% with only uranium-235 exceeding the objective of 64%.

Bottom ash precision was estimated from duplicate sample analyses. Results meet the <20% RPD objective for all isotopes except polonium at 29% RPD. Precision was also estimated from replicate runs and ranged from 0.5-56%. Only lead-210 at 21% CV and polonium-210 at 56% CV exceed the limit.

Accuracy

Analytical accuracy for flue gas, coal and ash radionuclide analysis is assessed by recoveries for internal spikes added to samples prior to preparation for analysis. Alternate isotopes were used for uranium, polonium and thorium. Carriers were used for the other isotopes. The data quality objective for internal recoveries is 50-150%.

Internal recoveries for FFDC outlet flue gas samples ranged from 24-115% and met the objective for all isotopes except polonium with 20% average recovery.

Internal recoveries for coal samples meet the objective for all but uranium at 44% and polonium at 15%. Bottom ash and flyash internal recoveries are all acceptable except for polonium at 21% and 9% respectively.

Radionuclides accuracy was also assessed from laboratory control samples. All FFDC outlet, coal and ash LCS results meet the 80-120% objective.

Blank Effects

Reagent blank levels are similar to sample levels for all isotopes in FFDC outlet exhaust gas samples. All blank and sample levels are near or below the reporting limit. Coal and ash laboratory blank levels are low or not detected. Sample results are not blank corrected.

Conclusions

Internal spike recoveries for polonium-210 are low in FFDC outlet, coal and ash samples. Sample results are recovery corrected. FFDC outlet reagent blank levels are similar to sample levels; however, both are near or below the reporting limit for all isotopes.

### 5.5.8 Cyanide

Precision

Precision of cyanide analysis is based on the RPD for duplicate samples. Precision is 15% RPD for an FFDC inlet gas sample and meets the <20% objective.

Accuracy

Accuracy for cyanide analysis is based on sample spike recoveries. Recovery for the spiked inlet sample was 94% which meets the 75-125% objective.

Blank Effects

Cyanide was not detected in either the laboratory preparation blank or the reagent blank. All sample results were at or near the detection limit.

Conclusions

Cyanide analytical quality assurance results are acceptable.

### 5.5.9 Chromium and Mercury Speciation Tests

Total and Hexavalent Chromium

Precision

Hexavalent chromium precision was assessed from duplicate sample analysis. Total chromium precision was assessed from duplicate laboratory control samples. Results for both meet precision objectives at 4% and 3% RPD respectively.

Precision of hexavalent and total chromium samples was also estimated for replicate runs. Precision is 47% CV for hexavalent chromium and 28% for total chromium.

Accuracy

Accuracy for hexavalent chromium was estimated from spiked sample results. Total chromium accuracy was estimated from results for standard reference material NBS WP481. Recoveries are 91.5% and 107% respectively, and both meet the 75-125% recovery objective. Radioactive spiking to assess conversion of Cr(VI) to Cr(III) was not performed for this test program.

Blank Effects

Laboratory and reagent blanks had no detectable hexavalent or total chromium. Field blank levels were 50% of sample levels for hexavalent chromium and 44% of sample levels for total chromium.

Conclusions

Field blanks represent 50% of hexavalent chromium sample levels and 44% of total chromium sample levels, indicating a possible high bias to sample results. This does not significantly affect the Cr(VI)/total Cr ratio. Cr(VI) to Cr(III) conversion was not assessed for this program.

Mercury Speciation Tests

Precision

Precision for FFDC inlet and outlet mercury speciation tests is based on replicate runs. Inlet precision is based on results for two sample runs and ranges from 3%-24% CV. Outlet sample precision ranges from 84-102% CV which is high because of sample levels near the reporting limit. Only one coal and one ash replicate were analyzed so precision could not be assessed.

Accuracy

Accuracy data for flue gas inlet and outlet samples are not available. Coal and ash accuracy are based on results for NBS standards and met the 75-125% recovery objective.

Blank Effects

Two field blanks consisting of two soda lime and two iodated carbon traps each were collected along with the samples. The front and back traps were analyzed individually and an average per cartridge blank level was determined. Blank correction was made by subtracting twice the average blank level from the combined results for front and back sample traps. This resulted in overcorrection when the back trap sample result was lower than the average field blank result.

Blank correction contribution was high relative to sample levels averaging 40% of inlet levels and 70% of outlet levels. A probe blank was also analyzed, but was not subtracted from sample results. Probe blank levels were low or not detected.

A laboratory blank was analyzed with coal and ash samples, and sample results were blank corrected. Laboratory blank levels represent only a small fraction of coal and ash sample levels.

Conclusions

Precision for FFDC outlet mercury speciation samples is high for all detected species ranging from 62-132%. Concentration levels for all species are near the reporting limit. The procedure used to blank correct sample results was different than PISCES conventions and over-corrected results for some samples.

### 5.5.10 Coal Composition

Precision

Precision for coal composition is based on RPDs for duplicate samples. RPDs range from 0-3% for Phase I samples and 0-7% for Phase II samples. All meet the <10% objective.

Accuracy

Accuracy for the coal composition is based on recoveries for laboratory check standards. Recoveries for Phase I moisture carbon, hydrogen, nitrogen and sulfur were not available. Recoveries for ash and higher heating value were 99% and 100%, respectively. Recoveries for Phase II composition results ranged from 98-100%. Results for moisture and ash were not available.

Blank Effects

Blank analysis is not required for the coal ultimate analysis.

Conclusions

Quality assurance results for coal composition are acceptable.

## 5.6 BASELINE MATERIAL BALANCE RESULTS

At Site 115, four key streams were used to define the material balance: coal, bottom ash, flyash, and FFDC outlet gas. Table 5-6 lists all of the possible streams for solid removal from the boiler, along with information on whether or not they were sampled.

The material balance was calculated in $lb/10^{12}$ Btu to eliminate uncertainties associated with exhaust gas and fuel flow measurements.

Stream concentrations, and the bias and precision errors associated with those measurements, were entered into a statistical error propagation model to estimate the uncertainty in the overall material balance closure. A detailed discussion of this statistical error propagation analysis is presented in Section 6.0.

**TABLE 5-6**
**EXIT STREAMS FROM SITE 115**

| Stream | Operational Time Frame | Sampling Time Frame |
|---|---|---|
| FFDC Exhaust Gas | Continuous | 4-6 hours |
| Bottom Ash | Sootblowing, batch dump and sluicing as needed | One sample collected twice per day during each post test sluicing. |
| Fly Ash | Baghouse cleaning and batch dump as needed | Collected from each of 12 hoppers and composited into one sample twice per day after each post test/baghouse cleaning |

Closure is defined as the rate of outlet to inlet mass. A 100% closure indicates perfect agreement of the measured inlet and outlet mass flow rates. Closures of 70-130% have been set as a goal for the FCEM project. This range reflects the typical level of analytical uncertainty. Closures outside this range may indicate measurement problems in one or more of the sample matrices or a systematic bias imposed by the experimental design.

Flow Rates

Outlet exhaust gas flow rates were consistent with unit load and heat rate calculated flow rates, and have a high confidence level. Inlet exhaust gas flow rates were not consistent with heat rate calculated flow rates and were not used. Outlet flow rates were corrected based on inlet $O_2$ concentrations. Measured fuel flow rates also had a high degree of uncertainty. Calculated flow rates were used for mass balance calculations. Flyash and bottom ash flow rates could not be measured and were calculated from fuel flow rates. The fuel and ash flow rate calculations are presented in Appendix D.

Table 5-7 presents material balance results for Phase I baseline tests and the uncertainty level calculated from error propagation analysis. The table shows results fell into five groups: two volatile elements within the target range (mercury, sulfur), five volatile elements outside the target range (arsenic, chlorine, fluorine, phosphorus and selenium), two non-volatile elements within the target range (lead, manganese), eight non-volatile elements outside the target range (barium, beryllium, chromium, cobalt, copper, molybdenum, nickel and vanadium), and two radionuclides within the target range (radium-226, radium-228). Closure for cadmium was not calculated because it was not detected in the FFDC outlet gas, coal or ash.

**TABLE 5-7**
**MATERIAL BALANCES**
**SITE 115**
**PHASE I - BASELINE**

| Substance | Out/In, % | Uncertainty, % Closure |
|---|---|---|
| Arsenic(5) | 62 | 24 |
| Barium(5) | 31 | 4 |
| Beryllium(1) | 60 | 4 |
| Cadmium(2) | NC | NC |
| Chlorine | 40 | 8 |
| Chromium | 53 | 8 |
| Cobalt(1) | 41 | 4 |
| Copper(5) | 67 | 7 |
| Fluorine(3) | 59 | 18 |
| Lead | 89 | 14 |
| Manganese | 130 | 26 |
| Mercury(1) | 72 | 24 |
| Molybdenum(3)(5) | 256 | 128 |
| Nickel(3) | 50 | 17 |
| Phosphorus(1) | 66 | 9 |
| Selenium(3) | 37 | 3 |
| Sulfur | 84 | 4 |
| Vanadium(5) | 68 | 10 |
| Radium-226(4) | 104 | 8 |
| Radium-228(4) | 84 | 21 |

NC - Not calculated
(1) Beryllium, cobalt and mercury not detected at FFDC outlet
(2) Cadmium not detected in fuel or ash
(3) Fluorine, molybdenum, nickel and selenium not detected in bottom ash
(4) Only results for radionuclides detected in FFDC outlet gas are presented.
(5) Field blank was greater than 50% of the average uncorrected sample measurement for FFDC outlet samples.

The FFDC outlet gas results account for only a small fraction of the total amount of all elements leaving the system. Therefore, FFDC outlet results have very little effect on the overall material balance.

The calculated uncertainties are due primarily to uncertainties in coal and ash samples and secondarily to uncertainties in the exhaust gas samples. Calculated uncertainties do not include uncertainties associated with coal and ash sample collection. Uncertainties are low for for all elements except molybdenum, which is high because of poor agreement in coal analysis results.

The poor closures for several elements and low uncertainties indicate a systematic problem in sampling and/or analysis procedures for one or more of the streams. While there were no specific sampling or analysis problems which contributed to the poor closures, there are three potential sources of problems which were not quantified: 1) Coal, bottom ash and flyash samples were collected in a manner that could yield results not representative of actual sample concentrations. 2) Collection of FFDC inlet samples was difficult because of the large amounts of particulate in the gas stream and high negative pressure. This location did not meet EPA Method 1 criteria. 3) Analysis of FFDC inlet samples was difficult because of the large amounts of particulate collected. Most of the test methods used are designed for outlet emissions sampling, and had to be modified for inlet sampling.

## 5.7 ANALYTICAL QUALITY ASSURANCE RESULTS: UREA INJECTION TESTS

Table 5-8 summarizes the types of quality control data reported for the Site 115 urea injection tests. The results of these analyses are summarized in Appendices I and J. Table 5-9 presents a summary of precision and accuracy measurements. Quality assurance results for ammonia samples were not available.

Based on the quality control data evaluated, the majority of the results met the project objectives.

The following potential problems were highlighted by the quality control data:

- FFDC outlet and inlet sample spike recoveries were low for most elements
- The field blank concentration was greater than 50% of the average sample concentration for molybdenum and sodium at the FFDC inlet and for barium, chromium, copper, molybdenum, lead, manganese, nickel, calcium and sodium at the FFDC outlet.

### 5.7.1 Multi-Metals

Precision

Precision for metals in FFDC inlet and outlet gas is based on RPDs for duplicate samples. An objective of 10% was set for metals precision. The selenium inlet gas result exceeded the objective at 28%. Precision results for the remaining FFDC inlet gas metals met the objective with RPDs ranging from 0.2% to 6.1%. For FFDC outlet gas, all RPDs met the

# TABLE 5-8
# TYPES OF QUALITY CONTROL DATA REPORTED
# SITE 115: UREA INJECTION TESTS

| | Precision | | | | Accuracy | | | | Blank | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis | Replicate Runs | Duplicate Field Samples | Duplicate Laboratory Analysis | Matrix or Media Spiked Duplicate | Matrix or Media Spike | Surrogate Spike | Laboratory Control Sample | Standard Reference Material | Field Blank | Trip Blank | Laboratory Method Blank | Reagent Blank (Field) |
| FFDC Inlet and Outlet Gas | | | | | | | | | | | | |
| Metals | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | ✓ |
| Particulate | ✓ | | | | | | | | | | | ✓ |
| Anions | ✓ | | ✓ | | ✓ | | ✓ | | | | | ✓ |
| Cyanide | ✓ | | | ✓ | ✓ | | | | | | ✓ | ✓ |
| Coal | | | | | | | | | | | | |
| Metals by ICP-AES, GFAAS and CVAAS | ✓ | | | | ✓ | | ✓ | | | | ✓ | |
| Metals by INAA | ✓ | | ✓ | | | | | ✓ | | | | |
| Chlorine | ✓ | | ✓ | | | | | | | | | |
| Fluorine | ✓ | | ✓ | | | | | | | | | |
| Sulfur | ✓ | | ✓ | | | | | | | | | |
| Ultimate and Heating Value | ✓ | | ✓ | | | | ✓ | | | | | |
| Bottom Ash | | | | | | | | | | | | |
| Metals | ✓ | | | | | | | | | | ✓ | |
| Anions | ✓ | | ✓ | | ✓ | | | | | | ✓ | |
| Fly Ash | | | | | | | | | | | | |
| Metals | ✓ | | | | ✓ | | | | | | ✓ | |
| Anions | ✓ | | ✓ | | | | | | | | ✓ | |

## TABLE 5-9
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## Site 115: UREA INJECTION TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Metals in FFDC Outlet Gas | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Arsenic | | 10% RPD | 75-125% | 61% RPD | 92% |
| Barium | | 10% RPD | 75-125% | 0.4% RPD | 73% |
| Beryllium | | 10% RPD | 75-125% | NC | 73% |
| Cadmium | | 10% RPD | 75-125% | NC | 56% |
| Chromium | | 10% RPD | 75-125% | 3% RPD | 59% |
| Cobalt | | 10% RPD | 75-125% | NC | 56% |
| Copper | | 10% RPD | 75-125% | 1% RPD | 76% |
| Lead | | 10% RPD | 75-125% | NP | MSA |
| Manganese | | 10% RPD | 75-125% | 0.8% RPD | 59% |
| Mercury ($HNO_3$) | | 10% RPD | 75-125% | NC | 99% |
| Mercury ($KMnO_4$) | | 10% RPD | 75-125% | NC | 99% |
| Molybdenum | | 10% RPD | 75-125% | 1% RPD | 63% |
| Nickel | | 10% RPD | 75-125% | 19% RPD | 55% |
| Phosphorus | | 10% RPD | 75-125% | 121% RPD | 67% |
| Selenium | | 10% RPD | 75-125% | NC | 91% |
| Vanadium | | 10% RPD | 75-125% | 14% RPD | 63% |
| Calcium | | 10% RPD | 75-125% | 2% RPD | 54% |
| Sodium | | 10% RPD | 75-125% | 0.5% RPD | 88% |

Precision for metals was measured by duplicate analyses and replicate runs. Replicate runs results are contained in Appendix F. (continued)
Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Accuracy for metals was assessed by post-digestion and pre-digestion laboratory spikes. This table is based on post-digestion laboratory spike recoveries. Additional information is contained in Appendix I.
Outlet arsenic and selenium results are from ICP hydride analysis.
RPD = Relative Percent Difference
NC = Not calculated; analyte reported as not detected
MSA = Sample analysis performed by method of standard additions.

# TABLE 5-9 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## Site 115: UREA INJECTION TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| **Metals in FFDC Inlet Gas** | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Arsenic | | 10% RPD | 75-125% | 0.6% RPD | 59% |
| Barium | | 10% RPD | 75-125% | 1% RPD | 69% |
| Beryllium | | 10% RPD | 75-125% | 0.4% RPD | 71% |
| Cadmium | | 10% RPD | 75-125% | 3% RPD | 59% |
| Chromium | | 10% RPD | 75-125% | 2% RPD | 68% |
| Cobalt | | 10% RPD | 75-125% | 3% RPD | 48% |
| Copper | | 10% RPD | 75-125% | 0.2% RPD | 85% |
| Lead | | 10% RPD | 75-125% | 4% RPD | 60% |
| Manganese | | 10% RPD | 75-125% | 2% RPD | 60% |
| Mercury ($HNO_3$) | | 10% RPD | 75-125% | 2% RPD | 112% |
| Mercury ($KMnO_4$) | | 10% RPD | 75-125% | NC | 98% |
| Molybdenum | | 10% RPD | 75-125% | 0.1% RPD | 54% |
| Nickel | | 10% RPD | 75-125% | 6% RPD | 50% |
| Phosphorus | | 10% RPD | 75-125% | 3% RPD | 141% |
| Selenium | | 10% RPD | 75-125% | 28% RPD | 68% |
| Vanadium | | 10% RPD | 75-125% | 2% RPD | 69% |
| Calcium | | 10% RPD | 75-125% | 4% RPD | 48% |
| Sodium | | 10% RPD | 75-125% | 1% RPD | 83% |

(continued)

Precision for metals was measured by duplicate analyses and replicate runs. Replicate runs results are contained in Appendix F.
Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Accuracy for metals was assessed by post-digestion and pre-digestion laboratory spikes. This table is based on post-digestion laboratory spike recoveries. Additional information is contained in Appendix I.
RPD = Relative percent difference
NC = Not calculated; analyte reported as not detected

**TABLE 5-9 (cont'd)**
**SUMMARY OF PRECISION AND ACCURACY ESTIMATES**
**SITE 115: UREA INJECTION TESTS**

| Measured Parameter | How Measured | Objectives | | Measured | |
|---|---|---|---|---|---|
| | | Precision | Accuracy | Precision | Accuracy |
| Particulate, FFDC Outlet Gas | Precision - Replicate Runs<br>Accuracy - NBS Traceable Weights | | | | |
| Particulate | | 20% CV | 95-105% | 91% CV | 95-105% |
| Particulate, ESP Inlet Gas | Precision - Replicate Runs<br>Accuracy - NBS Traceable Weights | | | | |
| Particulate | | 20% CV | 95-105% | 21% CV | 95-105% |

(continued)

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure.
Precision for particulate tests includes allowable variance of 0.5 mg for duplicate weights.
Measured precision for particulate size distribution tests expressed an average for all collection stages.
Accuracy of 95-105% assumes maximum allowable variance of 0.5 mg and 10 mg sample size. Actual use of NBS traceable weights requires 99-101% accuracy.
CV = Coefficient of variation. Duplicate analyses were not available.

**TABLE 5-9 (cont'd)**
**SUMMARY OF PRECISION AND ACCURACY ESTIMATES**
**SITE 115: UREA INJECTION TESTS**

| Measured Parameter | How Measured | Objectives | | Measured | |
|---|---|---|---|---|---|
| | | Precision | Accuracy | Precision | Accuracy |
| Anions in FFDC Outlet Gas | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 15% RPD | 80-120% | See Inlet Gas | See Inlet Gas |
| Fluoride | | 15% RPD | 80-120% | | |
| Sulfate | | 15% RPD | 80-120% | | |
| Anions in FFDC Inlet Gas | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 15% RPD | 80-120% | NC | 82-98% |
| Fluoride | | 15% RPD | 80-120% | 0.2% RPD | 102-113% |
| Sulfate | | 15% RPD | 80-120% | 0.9% RPD | 72-95% |
| Cyanide in FFDC Outlet Gas | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | 20% RPD | 75-125% | 4% RPD | 92% |
| Cyanide in FFDC Inlet Gas | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | 20% RPD | 75-125% | See outlet | See outlet |

(continued)

Precision for anions and cyanide also determined by replicate runs (Appendix F).
Accuracy for anions determined from spike recovery in the filter and 3% peroxide sample train fractions. Results presented here are the range of spike recoveries reported.
RPD = Relative percent difference
NC = Not calculated, no detected values

TABLE 5-9 (cont'd)
SUMMARY OF PRECISION AND ACCURACY ESTIMATES
SITE 115: UREA INJECTION TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| Metals in Coal by ICP-AES and GFAAS | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Beryllium | | 20% CV | 75-125% | 43% CV | 84% |
| Cadmium | | 20% CV | 75-125% | NC | 112% |
| Chromium | | 20% CV | 75-125% | 41% CV | 91% |
| Cobalt | | 20% CV | 75-125% | 13% CV | 91% |
| Copper | | 20% CV | 75-125% | 10% CV | 84% |
| Lead | | 20% CV | 75-125% | 23% CV | 102% |
| Manganese | | 20% CV | 75-125% | 25% CV | 85% |
| Molybdenum | | 20% CV | 75-125% | 35% CV | 88% |
| Nickel | | 20% CV | 75-125% | 0% CV | 86% |
| Phosphorus | | 20% CV | 75-125% | 2% CV | NP |
| Vanadium | | 20% CV | 75-125% | 21% CV | 89% |
| Calcium | | 20% CV | 75-125% | 26% CV | 59% |
| Sodium | | 20% CV | 75-125% | 47% CV | 83% |
| Metals and Cl in Coal by INAA | Precision - Replicate Runs<br>Accuracy - Standard Reference Material NBS 1571 and 8408 (mercury) | | | | |
| Arsenic | | 20% CV | 75-125% | 23% CV | 110% |
| Barium | | 20% CV | 75-125% | 3% CV | 109% |
| Mercury | | 20% CV | 75-125% | 84% CV | 102% |
| Selenium | | 20% CV | 75-125% | 55% CV | NP |
| Chlorine | | 20% CV | 75-125% | 4% CV | NP |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedures. (continued)

Metals analyses by ICP-AES and GFAAS presented here are those used in the final calculations. Additional metals data is presented in Appendices B, I, and J.

Metals ICP-AES and GFAAS accuracy data is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.

NP = Not performed
NC = Not calculated, analyte reported as not detected
CV = Coefficient of variation. Duplicate analyses were not available.

# TABLE 5-9 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: UREA INJECTION TESTS

| Measured Parameter | How Measured | Objectives Precision | Objectives Accuracy | Measured Precision | Measured Accuracy |
|---|---|---|---|---|---|
| **Coal Composition:** | Precision - Duplicate Analysis<br>Accuracy - Laboratory Check Standards | | | | |
| Moisture | | 10% RPD | 90-110% | 7% RPD | NA |
| Carbon | | 10% RPD | 90-110% | NA | 100% |
| Hydrogen | | 10% RPD | 90-110% | NA | 99% |
| Nitrogen | | 10% RPD | 90-110% | NA | 98% |
| Sulfur | | 10% RPD | 90-110% | NA | 99% |
| Ash | | 10% RPD | 90-110% | 0.2% RPD | NA |
| HHV | | 10% RPD | 90-110% | 0.0% RPD | 100% |
| **Metals in Bottom Ash** | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Arsenic | | 20% CV | 75-125% | 43% CV | NP |
| Barium | | 20% CV | 75-125% | 29% CV | 120% |
| Beryllium | | 20% CV | 75-125% | 13% CV | 92% |
| Cadmium | | 20% CV | 75-125% | NC | 104% |
| Chromium | | 20% CV | 75-125% | 6% CV | 98% |
| Cobalt | | 20% CV | 75-125% | 17% CV | 98% |
| Copper | | 20% CV | 75-125% | 17% CV | 100% |
| Lead | | 20% CV | 75-125% | 69% CV | NP |
| Manganese | | 20% CV | 75-125% | 25% CV | 100% |
| Mercury | | 20% CV | 75-125% | NC | NP |
| Molybdenum | | 20% CV | 75-125% | NC | 97% |
| Nickel | | 20% CV | 75-125% | 17% CV | 100% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedures. (continued)
Bottom ash metals accuracy data is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.

NA = Not available
NC = Not calculated, analyte reported as not detected
NP = Not performed
RPD = Relative percent difference
CV = Coefficient of variation. Duplicate analyses were not available.

## TABLE 5-9 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: UREA INJECTION TESTS

| Measured Parameter | How Measured | Objectives | | Measured | |
|---|---|---|---|---|---|
| | | Precision | Accuracy | Precision | Accuracy |
| Selenium | | 20% CV | 75-125% | NC | MSA |
| Phosphorus | | 20% CV | 75-125% | 20% CV | 114 |
| Vanadium | | 20% CV | 75-125% | 13% CV | 98 |
| Calcium | | 20% CV | 75-125% | 37% CV | 136% |
| Sodium | | 20% CV | 75-125% | 18% CV | 108 |
| Anions in Bottom Ash | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 20% RPD | 80-120% | 2% RPD | 90% |
| Fluoride | | 20% RPD | 80-120% | NC | 111% |
| Sulfur | | 20% RPD | 80-120% | 2% RPD | 92% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of sampling procedure. (continued)

Bottom ash metals accuracy data is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.

Bottom ash metals and anions precision also determined from replicate runs.

NA = Not available
NC = Not calculated, sample value was not detected
RPD = Relative percent difference
CV = Coefficient of variation. Duplicate analyses were not available
MSA = Sample analysis performed by method of standard additions

## TABLE 5-9 (cont'd)
## SUMMARY OF PRECISION AND ACCURACY ESTIMATES
## SITE 115: UREA INJECTION TESTS

| Measured Parameter | How Measured | Objectives | | Measured | |
|---|---|---|---|---|---|
| | | Precision | Accuracy | Precision | Accuracy |
| Metals in Flyash | Precision - Replicate Runs<br>Accuracy - Spiked Samples | | | | |
| Arsenic | | 20% CV | 75-125% | 49% CV | NP% |
| Barium | | 20% CV | 75-125% | 28% CV | 101% |
| Beryllium | | 20% CV | 75-125% | 9% CV | 90% |
| Cadmium | | 20% CV | 75-125% | NC | 117% |
| Chromium | | 20% CV | 75-125% | 15% CV | 98% |
| Cobalt | | 20% CV | 75-125% | 5% CV | 96% |
| Copper | | 20% CV | 75-125% | 5% CV | 99% |
| Lead | | 20% CV | 75-125% | 17% CV | NP |
| Manganese | | 20% CV | 75-125% | 6% CV | 98% |
| Mercury | | 20% CV | 75-125% | 50% CV | NP |
| Molybdenum | | 20% CV | 75-125% | 31% CV | 96% |
| Nickel | | 20% CV | 75-125% | 20% CV | 98% |
| Selenium | | 20% CV | 75-125% | NC | MSA |
| Phosphorus | | 20% CV | 75-125% | 5% CV | 105% |
| Vanadium | | 20% CV | 75-125% | 12% CV | 98% |
| Calcium | | 20% CV | 75-125% | 2% CV | 101% |
| Sodium | | 20% CV | 75-125% | 16% CV | 101% |
| Anions in Flyash | Precision - Duplicate Analysis<br>Accuracy - Spiked Samples | | | | |
| Chloride | | 20% RPD | 80-120% | NC | 127% |
| Fluoride | | 20% RPD | 80-120% | 7% RPD | 96% |
| Sulfur | | 20% RPD | 80-120% | 3% RPD | 96% |

Accuracy as used in this table reflects laboratory recovery and does not reflect the accuracy of procedure sampling.

Metals accuracy for flyash is for analysis of a post-digestion sample spike. Metals accuracy also assessed by analysis of a spiked laboratory method blank.

RPD = Relative percent difference
NP = Not performed
CV = Coefficient of variation. Duplicate analyses were not available
NC = No calculated, sample value not detected
MSA = Sample analysis performed by method of standard additions

objective except for arsenic (61%), lead (13%), nickel (19%), phosphorous (121%), and vanadium (14%).

Precision for flue gas metals was also estimated from replicate runs. For inlet samples precision ranged from 14-99% CV. As, Ba, Ca, Cu, Pb, Mn, Hg, Na, Ni and Se exceeded the objective of <20%. For outlet samples precision ranged from 4-12%. Only copper, lead, nickel and vanadium meet the objective.

Precision for coal and ash metals samples was estimated based on replicate runs. Duplicate sample results were not available. Precision for coal samples ranged from 0-84% CV. Arsenic, beryllium, chromium, lead, manganese, molybdenum, vanadium, calcium and sodium exceed the <20% precision objective.

Precision for bottom ash samples ranges from 6-69% CV. Arsenic, barium, lead, manganese and calcium exceed the <20% objective.

Precision for flyash samples ranged from 5-50% CV. Arsenic, barium, mercury and molybdenum exceed the <20% objective.

Accuracy

The accuracy of metals analysis in flue gas was estimated from spiked samples. A spike recovery of 75-125% is specified by the multi-metals method. For the inlet sample only copper, mercury, and sodium meet the objective. For the outlet sample only arsenic, copper, mercury, selenium and sodium meet the objective. All other recoveries, except inlet phosphorus sample at 141%, are below the objective ranging from 48-73%.

Predigestion blank spike analysis was also performed for flue gas metals and recoveries are also low. Only arsenic, mercury and selenium meet the recovery objective. Other recoveries are below the objective except molybdenum at 138%. The recoveries for the other elements range from 47-70%.

Accuracy for metals in coal by ICP/AES and GFAAS was assessed from post-digestion sample spike recoveries. Recoveries ranged from 59-112% and all met the 75-125% recovery objective except calcium at 59%.

Accuracy for INAA analysis of coal was assessed from SRMs NBS 1571 and 8408 (mercury). Results ranged from 102-110%, all within the recovery objective.

The accuracy of metals in bottom ash and flyash was not estimated in the sample matrix. Spiked laboratory blank recoveries were evaluated and all met the 75-125% recovery objective.

Blank Effects

Arsenic, barium, chromium, copper, lead, manganese, molybdenum, nickel, calcium and sodium were detected in the multimetals reagent blank. Sample levels of all these elements except chromium and copper were reagent blank corrected. All of these elements except nickel were also detected in the laboratory blank, most at similar or lower levels than the reagent blank. Barium and sodium were higher in the laboratory blank than in the reagent blank. Laboratory blank levels of chromium were more consistent with outlet sample results. Sample results were corrected for chromium laboratory blank levels. Copper sample results were not blank corrected. Both reagent and laboratory blank levels were higher than outlet sample results.

Blank correction contribution was greater than 50% for arsenic, barium, chromium, lead, manganese, molybdenum and nickel in outlet gas samples.

FFDC inlet field blank levels are higher than reagent blank levels for several elements, but represent greater than 50% of the average uncorrected sample level for only molybdenum and sodium. FFDC outlet field blank levels represent greater than 50% of the average uncorrected sample level for barium, chromium, copper, molybdenum, lead, manganese, nickel, calcium and sodium.

Calcium and sodium were detected in the laboratory blank for coal analysis and sample results were blank corrected. The blank correction contribution was 5% for calcium and 34% for sodium.

Barium and sodium were detected in the laboratory blank for bottom ash analysis and sample results were blank corrected with minimal blank correction contribution. No elements were detected in the flyash laboratory blank.

Conclusions

Spike recoveries for FFDC inlet and outlet samples were low for most elements on one or both samples except for arsenic, copper, mercury and sodium, which were acceptable. Blank spike recoveries also were consistently low for most of the same elements. Only arsenic, mercury and selenium met the recovery objective.

FFDC inlet and outlet copper results are not blank corrected because blank levels were higher than outlet sample levels. These sample results may be biased high. FFDC inlet field blank levels of molybdenum and sodium represent greater than 50% of sample levels. FFDC outlet field blank levels are greater than 50% of outlet sample levels for barium, chromium, copper, molybdenum, lead, manganese, nickel, calcium and sodium. FFDC inlet and outlet results for these elements may be biased high.

### 5.7.2 Particulate

Precision

Precision for particulate samples was 21% CV for FFDC inlet samples and 91% CV for FFDC outlet samples based on replicate runs. The outlet precision exceeds the <20% precision objective; however, differences between replicate runs are high on a relative basis but low on an absolute basis.

Accuracy

EPA Method 5 procedures for gravimetric analysis were used. These procedures generally have a laboratory accuracy of 95% to 105% and an overall accuracy of 85% to 115%.

Blank Effects

Acetone reagent blanks were subtracted from the front-half particulate catch. The acetone blank level of 0.0055 mg/ml met the DQO of <0.008 mg/ml.

Conclusions

Outlet particulate precision was high due to low particulate loading. Other particulate analysis quality assurance results are acceptable.

### 5.7.3 Anions

Precision

Precision for FFDC inlet and outlet anions analyses is based on duplicate analysis of the filter and peroxide fraction of an inlet sample. The precision objective of 15% RPD was met for all anions. Precision for chlorine in coal by INAA was 4% CV for replicate runs. Sulfur precision results were not available. Precision for anions in bottom ash and flyash was estimated from duplicate sample analysis and all results are below the 20% objective.

Accuracy

Accuracy for FFDC inlet and outlet anions analyses was estimated from sample spike recoveries. Recoveries were determined for both the filter and peroxide fraction of an inlet sample. Chloride and fluoride met the 80-120% recovery objective in both the filter and peroxide fraction. Phosphate and sulfate recoveries were low in the filter at 42% and 72%.

Accuracy results for chlorine in coal were not available. Accuracy for sulfur was 99% based on results for a laboratory check standard. Accuracy for anions in bottom ash and flyash was assessed from spiked samples. Bottom ash results met the recovery objective of 80-120%.

Flyash results for fluoride, phosphate and sulfur met the objective, but chloride recovery was slightly high at 127%.

Blank Effects

Chloride was detected in the flue gas 3% peroxide reagent blank and sample results were blank corrected. Sulfate was detected in the filter and 3% peroxide reagent blanks, and sample results were blank corrected.

There were no detected anions in bottom ash or flyash laboratory blanks.

Conclusions

Quality assurance data are acceptable. Anion measurements appear to be accurate and consistent.

### 5.7.4 Cyanide

Precision

Precision for cyanide analysis is based on duplicate matrix spike recoveries. The precision of 4.2% RPD meets the <20% objective.

Accuracy

Accuracy for cyanide analysis is based on sample spike recovery. The recovery for a spiked sample was 92% which meets the recovery objective of 75-125%.

Blank Effects

Cyanide was not detected in the laboratory preparation blank or reagent blank. No blank corrections were made to the results.

Conclusions

Cyanide analytical quality assurance results are acceptable.

### 5.7.5 Coal Composition

Precision

Precision for coal composition is based on RPDs for duplicate samples. RPD values meet the <20% precision objective ranging from 0-7%.

Accuracy

Accuracy for coal composition is based on recoveries for laboratory check standard analysis. Recoveries range from 98-100%.

Blank Effects

Blank analysis is not required for coal composition.

Conclusions

Quality assurance results for coal composition are acceptable.

## 5.8 MATERIAL BALANCE RESULTS: UREA INJECTION TESTS

The material balance definitions and techniques used for Phase I baseline tests were also used for Phase II urea injection tests.

Table 5-10 presents the material balance results and uncertainty intervals calculated from the error propagation analysis. Twelve of the sixteen elements for which material balances are presented met the closure objective of 70-130%. One volatile element (fluorine) and three nonvolatile elements (barium, beryllium and molybdenum) had closures less than 70%.

As for Phase I, the FFDC outlet gas results have little effect on the overall mass balance. The calculated uncertainties are due primarily to uncertainties in coal and ash samples and secondarily to uncertainties in exhaust gas samples. Calculated uncertainties also do not include uncertainties associated with coal and ash sample collection, and difficulties in sampling and analysis of FFDC inlet samples due to large amounts of particulate, neither of which could be quantified. For elements with closures outside the target range there are no specific sampling or analytical problems which contributed to the low closures.

## 5.9 COMPARISON OF BASELINE AND UREA INJECTION MATERIAL BALANCES

Material balance closures are better for urea injection than for baseline tests for 14 of 18 elements. Of the 13 elements outside the target range for the baseline mass balance, arsenic, chlorine, chromium, cobalt, copper, nickel, phosphorus and vanadium are within the target range for the urea injection mass balance. For arsenic, chromium, cobalt, copper, nickel and vanadium, better closures for urea injection appear to be due to higher bottom ash and flyash levels. For chlorine and phosphorus, lower fuel levels appear to have resulted in better closures. Barium, beryllium and fluorine closures are outside the target range for both phases.

**TABLE 5-10**
**MATERIAL BALANCES**
**SITE 115**
**PHASE II: UREA INJECTION**

| Substance | Out/In, % | Uncertainty, % Closure |
|---|---|---|
| Arsenic | 119 | 30 |
| Barium[6] | 26 | 2 |
| Beryllium[1] | 39 | 10 |
| Cadmium[2] | NC | NC |
| Chlorine[3] | 71 | 5 |
| Chromium[6] | 85 | 21 |
| Cobalt[1] | 76 | 6 |
| Copper[6] | 81 | 5 |
| Fluorine[4] [7] | 68 | 3 |
| Lead[6] | 103 | 16 |
| Manganese | 107 | 16 |
| Mercury[4] | 103 | 49 |
| Molybdenum[4][6] | 55 | 16 |
| Nickel[6] | 102 | 9 |
| Phosphorus | 107 | 3 |
| Selenium[5] | NC | NC |
| Sulfur | 103 | 11 |
| Vanadium[6] | 105 | 13 |

NC - Not calculated
(1) Beryllium, cobalt and selenium not detected at FFDC outlet.
(2) Cadmium not detected in FFDC outlet gas, fuel or ash.
(3) Chlorine not detected in flyash.
(4) Fluorine, mercury and molybdenum not detected in bottom ash.
(5) Selenium not detected in FFDC outlet gas or ash.
(6) Field blank was greater than 50% of the average uncorrected sample measurement for ESP outlet samples.
(7) Phase II fluorine results for coal were not reported; Phase I coal results were used for mass balance calculations.

# SECTION 6.0

## EXAMPLE CALCULATIONS

This section presents the methodology and sample calculations used to develop the results presented in Sections 3.0, 4.0 and 5.0. Specifically, the calculation of stream flow rates, unit-energy-based results, and confidence intervals are discussed.

## 6.1 STREAM FLOW RATES

Appendix D presents information about the stream flow rates measured or calculated at Site 115 during the sampling period.

FFDC outlet gas flow rates were measured using an S-type pitot tube. FFDC inlet gas flow rates were calculated by correcting the measured outlet flow rate to the measured $O_2$ concentration. Although inlet flue gas flow rates were measured directly during sampling, the calculated inlet flow rate is considered to be more representative of this sampling location. An example calculation of inlet flow rate for Test 1-Mtls in Table 3-2 is as follows:

| | | |
|---|---|---|
| Outlet measured flowrate (from Test 1-Mtls) | = | 245,732 dscfm |
| Outlet $O_2$ | = | 5.57% |
| Inlet $O_2$ | = | 5.66% |

$$\begin{aligned}\text{Inlet flowrate} &= \text{Outlet measured flowrate} \times (20.9 - \text{Outlet } O_2)/(20.9 - \text{Inlet } O_2)\\ &= 245{,}732 \times (20.9 - 5.57)/(20.9 - 5.66)\\ &= 247{,}183 \text{ dscfm}\end{aligned}$$

Fuel flow rates were measured by plant instrumentation; however, readings fluctuated considerably and fuel flow rates were calculated from the higher heating value of the coal for mass emissions calculations. Bottom ash and flyash flow rates could not be measured and were calculated in lb/hr from measured coal flow rates, and in lb/$10^6$ Btu using calculated coal flow rates. An example of coal and ash flow rate calculations for Phase I Baseline Test 1 is as follows:

| | | |
|---|---|---|
| Coal HHV | = | 12507 Btu/lb |
| Coal ash (average) | = | 9.94 % |
| FFDC inlet ash (particulate) flow rate | = | 5.96 lb/$10^6$ Btu |
| FFDC outlet ash (particulate) flow rate | = | 0.0005 lb/$10^6$ Btu |
| Flyash LOI | = | 5.77 % |

Bottom ash LOI = 0.74%

Coal flow rate = $10^6$/Coal HHV
= $10^6$/12507
= 79.95 lb/$10^6$ Btu

The total amount of ash generated by the coal is calculated using the average percent of ash found in the coal:

Total ash flow rate = Coal flow rate x (average Coal ash(%)/100)
= 79.95 x (9.94/100)
= 7.95

The bottom ash flow rate is calculated as the difference between the total ash flow rate and the ash (particulate) flow rate measured at the FFDC inlet. The FFDC inlet ash flow rate is corrected for differences in carbon/sulfate content between inlet ash (flyash) and bottom ash using loss on ignition (LOI) results:

Bottom ash flow rate = total ash flow rate - (FFDC inlet ash flow rate x (1-flyash LOI/100) x (1 + bottom ash LOI/100))
= 7.95 - (5.96 x (1- .0577) x (1+ .0074))
= 2.35 lb/$10^6$ Btu

The flyash flow rate is calculated as the difference between FFDC inlet and outlet flowrates:

Flyash flow rate = FFDC inlet ash flow rate - FFDC outlet ash flow rate
= 5.96 - 0.0005
= 5.96 lb/$10^6$ Btu

## 6.2 MEANS AND CONFIDENCE INTERVALS FOR STREAM CONCENTRATIONS

The mean concentrations and 95% confidence intervals (CIs) about the mean were calculated for each target substance in the streams sampled. The means were calculated according to the conventions listed in Section 3.0. The equations used to calculate the 95% confidence intervals are presented in Appendix F. The error propagation equations used to calculate uncertainties for FFDC removal efficiency and mass balance results are also presented in Appendix F.

Example calculations for baseline naphthalene in the FFDC outlet gas are presented here. These results were shown in Table 3-3.

The concentration data (in $\mu g/Nm^3$) given for naphthalene in Table 3-3 are:

| Run 2 | Run 4 | Run 6 |
|---|---|---|
| 0.423 | 0.255 | 0.338 |

The mean is calculated from the individual run totals:

Mean = (0.423 + 0.255 + 0.338)/3

= 0.339

The sample standard deviation of the individual run totals is calculated:

$$S_{pi} = \sqrt{[(.423-.339)^2 + (.255-.339)^2 + (.338-.339)^2]/2}$$

$$= 0.084$$

The standard deviation of the average is calculated according to the equation in Appendix F for N = 3:

$$S_{\overline{pi}} = 0.084/\sqrt{3}$$

$$= 0.049$$

The bias error is found by root-sum-squaring the product of the bias error and the sensitivity from each run (see Appendix F). According to the conventions listed in Section 3.0, no bias error is assigned to values above reporting limits, whereas a bias error of one-half the reporting limit is assigned to values below reporting limits. The sensitivity of the mean to each run in this case is 1/3. An additional bias of 10% of the sample value or 0.0339 is introduced because of the difference in particle collection from ideal conditions during isokinetic tests.

$$\beta_r = \sqrt{((1/3 \times 0)^2 + (1/3 \times 0)^2 + (1/3 \times 0)^2)^2 + (0.0339)^2}$$

$$= \sqrt{(0)^2 + (0.0339)^2}$$

$$= 0.0339$$

The total uncertainty in the result is found from:

$$U_r = \sqrt{\beta_r^2 + (t \times S_{\overline{pi}})^2}$$

$$= \sqrt{(0.0339)^2 + (4.3 \times 0.049)^2}$$

$$= 0.21$$

Thus, the result is reported as $0.34 \pm 0.21$ μg/Nm³.

For FFDC removal efficiencies the uncertainty as % efficiency is calculated from the following standard error propagation equations:

$$FFDC\ inlet\ value = A \pm \delta A \ where\ \delta A = Sp/\sqrt{N}$$

$$FFDC\ outlet\ value = B \pm \delta B$$

$$FFDC\ inlet - outlet = C \pm \sqrt{(\delta A)^2 + (\delta B)^2}$$

$$FFDC\ efficiency = \frac{FFDC_{inlet} - FFDC_{outlet}}{FFDC_{inlet}}$$

$$= efficiency \pm \sqrt{\left(\frac{(\delta A)^2 + (\delta B)^2}{C}\right)^2 + \left(\frac{\delta A}{A}\right)^2} * efficiency$$

Using the example of baseline FFDC removal efficiency for copper, the following calculations were performed:

| | Mean | Sp | $Sp/\sqrt{N}$ |
|---|---|---|---|
| FFDC inlet, μg/Nm³ | 220 | 26.3 | 15.2 |
| FFDC outlet, μg/Nm³ | 1.42 | 0.35 | 0.20 |

$$ESP\ inlet - outlet = 218.6 \pm \sqrt{(15.2)^2 + (0.20)^2} = 218.6 \pm 15.2$$

$$ESP\ efficiency = \frac{inlet - outlet}{inlet} = .9936 \pm \sqrt{\left(\frac{15.2}{218.6}\right)^2 + \left(\frac{15.2}{220}\right)^2} * .9936$$

$$= .9936 \pm 0.098$$

or the FFDC efficiency was 99.4 ± 9.8% efficient.

For mass balance results, the uncertainty as % closure is calculated similarly to FFDC efficiency using standard error propagation equations

$$\text{Closure} = E\left(\frac{OUT}{IN}\right) = \frac{A + B + C}{D}, \text{ where:}$$

A = FFDC Outlet
B = Bottom Ash Out
C = Fly Ash Out
D = Fuel Input

where δA, δB, δC and δD are the uncertainties in these measurements, $\left(\frac{S_p}{\sqrt{N}}\right)$, and all values are in lb/$10^{12}$ Btu. The uncertainty in the outputs $(A + B + C)$ is calculated as:

$$\delta(A+B+C+) = \sqrt{(\delta A)^2 + (\delta B)^2 + (\delta C)^2}$$

and the uncertainty in the output/input is calculated as:

$$\delta E = E \times \sqrt{\left(\frac{\delta(A+B+C)}{A+B+C}\right)^2 + \left(\frac{\delta D}{D}\right)^2}$$

Using the example of mass balance uncertainty for baseline manganese, the uncertainty is calculated from the data in Appendix F as:

$$\delta(A + B + C) = \sqrt{\left(\frac{0.48}{\sqrt{3}}\right)^2 + \left(\frac{10.7}{\sqrt{3}}\right)^2 + \left(\frac{15.8}{\sqrt{3}}\right)^2} = 11.0\ lb/10^{12}\ Btu$$

$$E \pm \delta E = \frac{493}{379} \pm \sqrt{\left(\frac{11.0}{493}\right)^2 + \left(\frac{74.7/\sqrt{3}}{379}\right)^2}$$

$$= 130\% \pm 26\%$$

## 6.3 UNIT ENERGY EMISSION FACTORS

In addition to the gas-phase concentrations, unit-energy-based emission factors expressed as $lb/10^{12}$ Btu have been developed for each target substance. These values were determined by calculating the concentration of a substance in the flue gas ($lb/ft^3$) and multiplying by the fuel F-factor and $O_2$ correction, according to EPA Method 19.

The equation used for trace species emissions is:

$$lb/10^{12}\ Btu = \mu g/m^3 \times m^3/35.31\ ft^3 \times lb/454g \times F\text{-}factor\ @\ 0\%\ O_2,\ dscf/MMBtu$$

$$\times\ 20.9/(20.9\ -\ \%\ O_2) \times 10^{-6}\ g/\mu g \times 10^6\ \frac{MMBtu}{10^{12} Btu}$$

The 95% confidence intervals for emission factors were calculated according to the equations presented in Appendix F. For each parameter (concentration, unit heat rate, and unit load) the mean, standard deviation, number of points, and bias estimates were used to calculate the combined uncertainty in the mean emission factors.

# SECTION 7.0

## GLOSSARY

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| Btu | British Thermal Unit |
| CAAA | Clean Air Act Amendments of 1990 |
| CI | Confidence Interval |
| CV | Coefficient of Variation |
| DL | Detection Limit |
| DQO | Data Quality Objective |
| dscfm | Dry Standard Cubic Feet per Minute (1atm, 68°F) |
| EPA | U.S. Environmental Protection Agency |
| EPAREC/ICP | EPA Recirculation train for total Chromium with ICP-AES Analysis |
| EPAREC/IC-PCR | EPA Recirculation Train for Hexavalent Chromium with Analysis by Ion Chromatography with Post Column Reaction |
| ESP | Electrostatic Precipitator |
| FCEM | Field Chemical Emissions Monitoring |
| FD | Forced Draft |
| GC/MS | Gas Chromatography with Mass Spectrometer |
| GPM | Gallons Per Minute |
| GRAV | Gravimetric Analysis |
| HHV | Higher Heating Value |
| HPLC | High Pressure Liquid Chromatography |
| HRGC/HRMS | High Resolution Gas Chromatography/High Resolution Mass Spectrometry |
| HRGC/LRMS-SIM | High Resolution Gas Chromatography/Low Resolution Mass Spectrometry with Selected Ion Monitoring |
| IC | Ion Chromatography |
| ICP-AES | Inductively Coupled Plasma Atomic Emission Spectroscopy |
| ID | Induced Draft |
| LECO-CHN | Leco Carbon, Hydrogen, Nitrogen Analyzer |
| LECO-SC132 | Leco Sulfur Analyzer |
| LCS | Laboratory Check Standards |
| MMBtu | Million British Thermal Units |
| MW | Megawatt |
| NC | Not Calculated |
| ND | Not Detected |
| NIST | National Institute of Standards and Technology |
| $Nm^3$ | Dry Normal Cubic Meter (0°C, 1atm) |
| NM | Not Measurable |

| | |
|---|---|
| NP | Not Performed |
| NR | Not Reported |
| PAH | Polycyclic Aromatic Hydrocarbons |
| PISCES | Power Plant Integrated Systems Chemical Emission Study |
| QA/QC | Quality Assurance/Quality Control |
| RPD | Relative Percent Difference |
| RPDM | Relative Percent Difference from the Mean |
| SL/AAS | Sequential Leaching/Atomic Absorption Spectroscopy |
| UOM | Unit of Measure |

# APPENDIX A

# SAMPLING AND ANALYTICAL SUMMARY

This appendix presents the methods used to collect, preserve and analyze each type of sample collected at Site 115. Summary tables presented include the following:

| | |
|---|---|
| A-1 | Reference Table for Sampling Methods |
| A-2 | FFDC Inlet and Outlet Test Schedule and Sampling Comments |
| A-3 | Sampling Train Configurations for FFDC Inlet and Outlet Samples |
| A-4 | Sampling and Analytical Methods for FFDC Inlet and Outlet Samples |
| A-5 | Sampling and Analysis Schedule for Coal and Ash Samples |
| A-6 | Analytical Methods for Coal Samples |
| A-7 | Analytical Methods for Flyash and Bottom Ash Samples |
| A-8 | Sample Handling and Preparation Procedures |
| A-9 | 3-D Velocity Summary for the FFDC Inlet Sampling Location |

Descriptions of the exhaust gas sampling trains and coal and ash sample collection methods follow the summary tables.

## TABLE A-1
## REFERENCE TABLE FOR SAMPLING METHODS
## SITE 115

| Stream | Target Substances | Collection Method |
|---|---|---|
| FFDC Inlet and Outlet | Metals: As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, P, Pb, Se, V, Ca, Na | EPA Multi-metals |
| | Polycyclic Aromatic Hydrocarbons | CARB 429 |
| | Benzene, Toluene | CARB 410A(bags) |
| | Formaldehyde | CARB 430 |
| | Particulate, SO2, Cl-, F- | EPA 5, 6/8, CARB 421 |
| | Radionuclides (FFDC outlet only) | EPA 114 |
| | Cyanide | CARB 426 |
| | Ammonia | BA ST-1B |
| | Mercury Speciation<br>Hg(II)<br>Hg(0) | Frontier Geosciences(KCl/soda lime and iodated carbon cartridges) |
| | Total Chromium and Hexavalent Chromium (FFDC inlet only) | EPA Recirculation Method |
| Coal | Metals, anion precursors, composition, heating value, radionuclides | Composited Grab Samples |
| Flyash, Bottom Ash, Sluice Water Blanks | Metals, anions, radionuclides | Composited Grab Samples |

Note: The above list includes all substances analyzed in both Phase I and Phase II. Some substances were not collected during both phases. For more detailed information, see Appendix A-2.

# TABLE A-2
# FFDC INLET AND OUTLET TEST SCHEDULE AND SAMPLING COMMENTS
# SITE 115

| TEST NO. | DATE | TIME | DESCRIPTION | COMMENTS |
|---|---|---|---|---|
| **Phase I - Baseline, November 1992:** | | | | |
| 1-MTLS-IN | 11/17/92 | 0828/1340 | Metals | isokinetic/multipoint, FFDC inlet |
| 1-MTLS-OUT | 11/17/92 | 0830/1257 | Metals | isokinetic/multipoint, FFDC outlet |
| 1-PM/AN-OUT | 11/17/92 | 0905/1337 | Particulate/Anions/Radionuclides | isokinetic/multipoint, FFDC outlet |
| 1-PM/AN-IN | 11/17/92 | 0906/1334 | Particulate/Anions | isokinetic/multipoint, FFDC inlet |
| 2-PAH-OUT | 11/17/92 | 1520/1944 | Polycyclic Aromatic Hydrocarbons | isokinetic/multipoint, FFDC outlet |
| 2-PAH-IN | 11/17/92 | 1521/1948 | Polycyclic Aromatic Hydrocarbons | isokinetic/multipoint, FFDC inlet |
| 2A-NH3-IN | 11/17/92 | 1630 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 2B-NH3-IN | 11/17/92 | 1738 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 2C-NH3-IN | 11/17/92 | 1847 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 2A-VOC-IN | 11/17/92 | 1825/1845 | Benzene and Toluene | tedlar bag leaked after collection; not analyzed |
| 2A-VOC-OUT | 11/17/92 | 1825/1845 | Benzene and Toluene | sample not analyzed |
| 2B-VOC-IN | 11/17/92 | 1848/1908 | Benzene and Toluene | nonisokinetic/multipoint, FFDC inlet |
| 2B-VOC-OUT | 11/17/92 | 1848/1908 | Benzene and Toluene | nonisokinetic/single point, FFDC outlet |
| 2C-VOC-IN | 11/17/92 | 1910/1930 | Benzene and Toluene | nonisokinetic/multipoint, FFDC inlet |
| 2C-VOC-OUT | 11/17/92 | 1910/1930 | Benzene and Toluene | nonisokinetic/single point, FFDC outlet |
| 2D-VOC-IN | 11/17/92 | 1935/1955 | Benzene and Toluene | tedlar bag leaked after collection; not analyzed |
| 2D-VOC-OUT | 11/17/92 | 1935/1955 | Benzene and Toluene | sample not analyzed |
| 3-MTLS-IN | 11/18/92 | 0801/1226 | Metals | isokinetic/multipoint, FFDC inlet |
| 3-MTLS-OUT | 11/18/92 | 0801/1241 | Metals | isokinetic/multipoint, FFDC outlet |
| 3-PM/AN-OUT | 11/18/92 | 0853/1320 | Particulate/Anions/Radionuclides | isokinetic/multipoint, FFDC outlet |
| 3-PM/AN-IN | 11/18/92 | 0853/1323 | Particulate/Anions | isokinetic/multipoint, FFDC inlet |
| 3A-VOC-IN | 11/18/92 | 0900/0920 | Benzene and Toluene | nonisokinetic/multipoint, FFDC inlet |
| 3A-VOC-OUT | 11/18/92 | 0900/0920 | Benzene and Toluene | nonisokinetic/single point, FFDC outlet |
| 4-PAH-OUT | 11/18/92 | 1448/1902 | Polycyclic Aromatic Hydrocarbons | isokinetic/multipoint, FFDC outlet |
| 4-PAH-IN | 11/18/92 | 1451/1939 | Polycyclic Aromatic Hydrocarbons | isokinetic/multipoint, FFDC inlet |
| 4A-FORM-OUT | 11/18/92 | 1541/1642 | Formaldehyde | nonisokinetic/single point, FFDC outlet |
| 4A-FORM-IN | 11/18/92 | 1541/1648 | Formaldehyde | nonisokinetic/multipoint, FFDC inlet |
| 4B-FORM-IN | 11/18/92 | 1708/1815 | Formaldehyde | nonisokinetic/multipoint, FFDC inlet |
| 4B-FORM-OUT | 11/18/92 | 1708/1815 | Formaldehyde | nonisokinetic/single point, FFDC outlet |
| 4C-FORM-IN | 11/18/92 | 1829/1934 | Formaldehyde | nonisokinetic/multipoint, FFDC inlet |
| 4C-FORM-OUT | 11/18/92 | 1830/1930 | Formaldehyde | nonisokinetic/single point, FFDC outlet |
| 5-MTLS-IN | 11/19/92 | 0746/1210 | Metals | isokinetic/multipoint, FFDC inlet |
| 5-MTLS-OUT | 11/19/92 | 0748/1211 | Metals | isokinetic/multipoint, FFDC outlet |
| 5-PM/AN-OUT | 11/19/92 | 0832/1239 | Particulate/Anions/Radionuclides | isokinetic/multipoint, FFDC outlet |
| 5-PM/AN-IN | 11/19/92 | 0834/1302 | Particulate/Anions | isokinetic/multipoint, FFDC inlet |
| 6-PAH-IN | 11/19/92 | 1445/1907 | Polycyclic Aromatic Hydrocarbons | isokinetic/multipoint, FFDC inlet |
| 6-PAH-OUT | 11/19/92 | 1520/1944 | Polycyclic Aromatic Hydrocarbons | isokinetic/multipoint, FFDC outlet |
| 6A-CN-IN | 11/19/92 | 1551/1638 | Cyanide | isokinetic/singlepoint, FFDC inlet |
| 6A-CN-OUT | 11/19/92 | 1551/1638 | Cyanide | isokinetic/singlepoint, FFDC outlet |
| 6B-CN-OUT | 11/19/92 | 1730/1800 | Cyanide | isokinetic/singlepoint, FFDC outlet |
| 6B-CN-IN | 11/19/92 | 1730/1809 | Cyanide | isokinetic/singlepoint, FFDC inlet |
| 6C-CN-OUT | 11/19/92 | 1846/1916 | Cyanide | isokinetic/singlepoint, FFDC outlet |
| 6C-CN-IN | 11/19/92 | 1846/1918 | Cyanide | isokinetic/singlepoint, FFDC inlet |

(continued)

# TABLE A-2 (continued)
# FFDC INLET AND OUTLET TEST SCHEDULE AND SAMPLING COMMENTS
# SITE 115

| TEST NO. | DATE | TIME | DESCRIPTION | COMMENTS |
|---|---|---|---|---|
| **Phase II - Baseline, March 1992:** | | | | |
| 8A-Cr-IN | 03/09/93 | 850/1050 | Hexavalent and Total Chromium | isokinetic/single point, FFDC inlet |
| 8B-Cr-IN | 03/09/93 | 1125/1325 | Hexavalent and Total Chromium | isokinetic/single point, FFDC inlet |
| 8A-VOC-IN | 03/09/93 | 1155/1225 | Benzene and toluene | sample not analyzed |
| 8A-VOC-OUT | 03/09/93 | 1155/1225 | Benzene and toluene | nonisokinetic/single point, FFDC outlet |
| 8B-VOC-IN | 03/09/93 | 1243/1313 | Benzene and toluene | nonisokinetic/multipoint, FFDC inlet |
| 8B-VOC-OUT | 03/09/93 | 1243/1313 | Benzene and toluene | nonisokinetic/single point, FFDC outlet |
| 9-Cr-IN | 03/09/93 | 1620/1820 | Hexavalent and Total Chromium | isokinetic/single point, FFDC inlet |
| 9A-VOC-IN | 03/09/93 | 1605/1635 | Benzene and toluene | nonisokinetic/multipoint, FFDC inlet |
| 9A-VOC-OUT | 03/09/93 | 1605/1635 | Benzene and toluene | nonisokinetic/single point, FFDC outlet |
| 9B-VOC-IN | 03/09/93 | 1651/1721 | Benzene and toluene | nonisokinetic/multipoint, FFDC inlet |
| 9B-VOC-OUT | 03/09/93 | 1651/1721 | Benzene and toluene | sample not analyzed |
| 14A-HG-OUT | 03/15/93 | 900/1100 | Mercury Speciation | non-isokinetic/single point, FFDC inlet |
| | 03/15/93 | 900/1103 | Mercury Speciation | non-isokinetic/single point, FFDC inlet |
| 14B-HG-OUT | 03/15/93 | 1115/1315 | Mercury Speciation | non-isokinetic/single point, FFDC inlet |
| | 03/15/93 | 1119/1319 | Mercury Speciation | non-isokinetic/single point, FFDC inlet |
| 14C-HG-IN | 03/15/93 | 1331/1531 | Mercury Speciation | non-isokinetic/single point, FFDC inlet |
| | 03/15/93 | 1331/1531 | Mercury Speciation | non-isokinetic/single point, FFDC inlet |
| **Phase II - Urea Injection, March 1992:** | | | | |
| | 03/10/93 | 806/1224 | Metals | isokinetic/multipoint, FFDC outlet |
| | 03/10/93 | 806/1235 | Metals | isokinetic/multipoint, FFDC inlet |
| 10A-NH3-IN | 03/10/93 | 945/1220 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 10-PM/AN-IN | 03/10/93 | 946/1428 | Particulate/Anions | isokinetic/multipoint, FFDC inlet |
| 10-PM/AN-OUT | 03/10/93 | 950/1412 | Particulate/Anions | isokinetic/multipoint, FFDC outlet |
| 10B-NH3-IN | 03/10/93 | 1253 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 10-NH3-OUT | 03/10/93 | 1316 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 11-MTLS-IN | 03/10/93 | 1526/2002 | Metals | isokinetic/multipoint, FFDC inlet |
| 11-MTLS-OUT | 03/10/93 | 1526/2001 | Metals | isokinetic/multipoint, FFDC outlet |
| 11-PM/AN-OUT | 03/10/93 | 1613/2001 | Particulate/Anions | isokinetic/multipoint, FFDC outlet |
| 11-PM/AN-IN | 03/10/93 | 1614/2000 | Particulate/Anions | isokinetic/multipoint, FFDC inlet |
| 12-MTLS-OUT | 03/11/93 | 900/1312 | Metals | isokinetic/multipoint, FFDC outlet |
| 12-MTLS-IN | 03/11/93 | 901/1344 | Metals | isokinetic/multipoint, FFDC inlet |
| 12A-NH3-IN | 03/11/93 | 935 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 12-PM/AN-OUT | 03/11/93 | 944/1403 | Particulate/Anions | isokinetic/multipoint, FFDC outlet |
| 12-PM/AN-IN | 03/11/93 | 952/1431 | Particulate/Anions | isokinetic/multipoint, FFDC inlet |
| 12A-NH3-OUT | 03/11/93 | 1013 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 12B-NH3-OUT | 03/11/93 | 1040 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 12C-NH3-OUT | 03/11/93 | 1132 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 12D-NH3-OUT | 03/11/93 | 1217 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 12E-NH3-OUT | 03/11/93 | 1304 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 12F-NH3-OUT | 03/11/93 | 1355 | Ammonia | nonisokinetic/single point, secondary FFDC outlet location |
| 12B-NH3-IN | 03/11/93 | 1410 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 13A-NH3-IN | 03/11/93 | 1552 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 13A-CN-OUT | 03/11/93 | 1610/1640 | Cyanide | isokinetic/singlepoint, FFDC outlet |
| 13A-CN-IN | 03/11/93 | 1610/1652 | Cyanide | isokinetic/singlepoint, FFDC inlet |
| 13B-NH3-IN | 03/11/93 | 1613 | Ammonia | nonisokinetic/multipoint, secondary FFDC inlet location |
| 13B-CN-OUT | 03/11/93 | 1722/1752 | Cyanide | isokinetic/singlepoint, FFDC outlet |
| 13B-CN-IN | 03/11/93 | 1722/1801 | Cyanide | isokinetic/singlepoint, FFDC inlet |
| 13C-CN-OUT | 03/11/93 | 1826/1856 | Cyanide | isokinetic/singlepoint, FFDC outlet |
| 13C-CN-IN | 03/11/93 | 1826/1921 | Cyanide | isokinetic/singlepoint, FFDC inlet |

115A2.XLS
5:04 PM
2/22/94

# TABLE A-3
# SAMPLING TRAIN CONFIGURATIONS FOR FFDC INLET AND OUTLET SAMPLES
# SITE 115

| Sample Train | Nozzle | Probe | Filter | Filter Holder | Sample Line | Impinger Contents | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | #1 | #2 | #3 | #4 | #5 |
| EPA Multi-Metals | Glass | Teflon/Glass | Method 5 ultrapure 110 mm filter (with a cyclone for the inlet) | Method 5 glass | Teflon | 100 ml 5% $HNO_3$/ 10% $H_2O_2$ | 100 ml 5% $HNO_3$/ 10% $H_2O_2$ | Empty | 100 ml 4% $KMnO_4$/ 10% $H_2SO_4$ | 300-400g silica gel |
| Semi-VOST CARB 429 | Glass | Teflon/Glass | Method 5 toluene-rinsed 110 mm filter (with a cyclone for the inlet) | Method 5 glass | Teflon to XAD-2 resin column | Empty-stub stem | 100 ml organic free DI $H_2O$ | Empty | 300-400g silica gel | N/A |
| Benzene/Toluene CARB 410A | N/A | Teflon | N/A | N/A | Teflon | Sample collected over 30 minutes into Tedlar bag | | | | |
| Solid Particulate/ Anions/ Radionuclides | Glass | Teflon/Glass | Method 5 fiberglass 110 mm filter (with a cyclone for the inlet) | Method 5 glass | Teflon | 100 ml $NaHCO_3$/ $Na_2CO_3$ | 100 ml $NaHCO_3$/ $Na_2CO_3$ | 100 ml 3% $H_2O_2$ | 100 ml 3% $H_2O_2$ | 300-400g silica gel |
| | | | | | | Midget Impingers | | | | |
| Formaldehyde | N/A | Glass | 47 mm in-stack fiberglass filter | Method 17 stainless steel | Teflon | 10 ml DNPH | 10 ml DNPH | Empty | 10-20 ml silica gel | N/A |
| Cyanide | N/A | Glass | 47 mm in-stack fiberglass filter | Method 17 stainless steel | Teflon | 100 ml 0.1N NaOH | 100 ml 0.1N NaOH | Empty | 300-400g silica gel | N/A |
| Ammonia | N/A | Glass | | | Teflon | 0.1N $H_2SO_4$ | | | | |
| Mercury speciation | N/A | Glass | | | Teflon | KCl/sodalime and iodated carbon traps | | | | |
| Cr/$Cr^{6+}$ | Glass | Teflon with recirculating peristaltic pump teflon line | N/A | N/A | Teflon | 250 ml 0.1N NaOH (Teflon-coated glass Impinger) | 75 ml 0.1N NaOH (Teflon Impinger - 2 in Series) | Empty | 100 ml 0.1N $HNO_3$ (glass impinger) | 300-400g silica gel |

N/A = Not Applicable

## TABLE A-4
## SAMPLING AND ANALYTICAL METHODS FOR FFDC INLET AND OUTLET SAMPLES
## SITE 115

| Parameter | No. of Replicates | Duration of Test (Minutes) | Sampling Rate | Collection and Preparation Reference Method | Measurement Principle | Analytical Reference Method | Method Detection Limit | Comments |
|---|---|---|---|---|---|---|---|---|
| <u>Metals:</u> | 3 | Inlet: 252<br>Outlet: 240 | Inlet: 0.7 m3/hr<br>Outlet: 1.1 m3/hr | EPA Multimetals | | | | Method of standard additions (MSA) used when interferences or low spike recoveries occur. |
| Arsenic | | | | | ICP-AES Hydride | EPASW846 6010/7061 | 0.08 ug/Nm3 | ICP-AES or GFAAS(MSA) used for inlet |
| Barium | | | | | ICP-AES | EPASW846 6010 | 0.2 ug/Nm3 | |
| Beryllium | | | | | ICP-AES | EPASW846 6010 | 0.03 ug/Nm3 | |
| Cadmium | | | | | ICP-AES | EPASW846 6010 | 0.08 ug/Nm3 | |
| Chromium | | | | | ICP-AES | EPASW846 6010 | 0.2 ug/Nm3 | |
| Cobalt | | | | | ICP-AES | EPASW846 6010 | 0.3 ug/Nm3 | |
| Copper | | | | | ICP-AES | EPASW846 6010 | 0.2 ug/Nm3 | |
| Lead | | | | | GFAAS(MSA) | EPA SW846 7421 | 0.5 ug/Nm3 | ICP-AES or GFAAS(MSA) used for inlet |
| Manganese | | | | | ICP-AES | EPASW846 6010 | 0.2 ug/Nm3 | |
| Mercury | | | | | CVAAS | EPASW846 7470 | 0.5 ug/Nm3 | |
| Molybdenum | | | | | ICP-AES | EPASW846 6010 | 0.2 ug/Nm3 | |
| Nickel | | | | | ICP-AES | EPASW846 6010 | 0.6 ug/Nm3 | |
| Phosphorus | | | | | ICP-AES | EPASW846 6010 | 1.7 ug/Nm3 | |
| Selenium | | | | | ICP-AES Hydride | EPASW846 6010/7741 | 0.08 ug/Nm3 | ICP-AES or ICP-AES hydride used for inlet |
| Vanadium | | | | | ICP-AES | EPASW846 6010 | 0.2 ug/Nm3 | |
| Calcium | | | | | ICP-AES | EPASW846 6010 | 8 ug/Nm3 | |
| Sodium | | | | | ICP-AES | EPASW846 6010 | 8 ug/Nm3 | |
| <u>Polycyclic Aromatic Hydrocarbons:</u> | 3 | Inlet: 252<br>Outlet: 240 | Inlet: 0.7 m3/hr<br>Outlet: 1.1 m3/hr | CARB 429 | HRGC/LRMS-SIM | CARB 429 | | All fractions combined for analysis. Used isotope dilution where isotopically |
| 2-Methylnaphthalene | | | | | | | 0.013 ug/Nm3 | labeled standards were available. |
| 7,12-Dimethylbenz(a)anthracene | | | | | | | 0.005 ug/Nm3 | Used method of internal standardization |
| 3-Methylcholanthrene | | | | | | | 0.006 ug/Nm3 | for 2-Methylnapthalene, 3-Methylcholanthrene, |
| Acenaphthylene | | | | | | | 0.009 ug/Nm3 | and 7,12-Dimethylbenz(a)anthracene. |
| Acenaphthene | | | | | | | 0.013 ug/Nm3 | |
| Anthracene | | | | | | | 0.025 ug/Nm3 | |
| Benz(a)anthracene | | | | | | | 0.016 ug/Nm3 | |
| Benzo(a)pyrene | | | | | | | 0.015 ug/Nm3 | |
| Benzo(b)fluoranthene | | | | | | | 0.010 ug/Nm3 | |
| Benzo(g,h,i)perylene | | | | | | | 0.034 ug/Nm3 | |
| Benzo(k)fluoranthene | | | | | | | 0.014 ug/Nm3 | |
| Chrysene | | | | | | | 0.016 ug/Nm3 | |
| Dibenzo(a,h)anthracene | | | | | | | 0.047 ug/Nm3 | |
| Fluoranthene | | | | | | | 0.025 ug/Nm3 | |
| Fluorene | | | | | | | 0.013 ug/Nm3 | |
| Indeno(1,2,3-cd)pyrene | | | | | | | 0.040 ug/Nm3 | |
| Naphthalene | | | | | | | 0.025 ug/Nm3 | |
| Phenanthrene | | | | | | | 0.13 ug/Nm3 | |
| Pyrene | | | | | | | 0.025 ug/Nm3 | |

Notes:
Metals and PAH samples were collected at the FFDC inlet and outlet isokinetically using a complete traverse of the duct.

(continued)

# TABLE A-4 (continued)
## SAMPLING AND ANALYTICAL METHODS FOR FFDC INLET AND OUTLET SAMPLES
## SITE 115

| Parameter | No. of Replicates | Duration of Test (Minutes) | Sample Rate | Collection and Preparation Reference Method | Measurement Principle | Analytical Reference Method | Method Detection Limit | Comments |
|---|---|---|---|---|---|---|---|---|
| Volatile Organics: | 3 | 30 | 0.2 l/min | CARB 410A | GC/MS | EPA TO-14 | | |
| Benzene | | | | | | | 0.9 ug/Nm3 | Collected in Tedlar bags |
| Toluene | | | | | | | 1.0 ug/Nm3 | |
| Formaldehyde | 3 | 60 | 0.06 ft3/min. | CARB 430 | HPLC | CARB 430 | 4.2 ug/Nm3 | Collect in midget impingers |
| Solid Particulate: | 3 | Inlet: 252<br>Outlet: 240 | Inlet: 0.7 m3/hr<br>Outlet: 1.1 m3/hr | EPA 5/17 | Filtration/Gravimetric | EPA 5 | 0.0002 gr/dscf | |
| Anions: | 3 | Inlet: 252<br>Outlet: 240 | Inlet: 0.7 m3/hr<br>Outlet: 1.1 m3/hr | | | | | Combined with particulate train |
| Sulfate | | | | EPA 6/8 | Ion chromatography | EPA 300.0 | 0.05 ug/m3 | |
| Chloride | | | | CARB 421 | Ion chromatography | EPA 300.0 | 0.06 ug/m3 | Cl confirmed by mercuric nitrate titration |
| Fluoride | | | | CARB 421 | Ion chromatography | EPA 300.0 | 0.02 ug/m3 | |
| Phosphate | | | | — | Ion chromatography | EPA 300.0 | 0.41 ug/m3 | Also measured P in metals train |
| Radionuclides: | 3 | Inlet: 252<br>Outlet: 240 | Inlet: 0.7 m3/hr<br>Outlet: 1.1 m3/hr | EPA 114 | Alpha Spectrometry | EPA 114 | 0.06-0.75 pCi/Nm3 | Analyzed from the front half of the Phase I FFDC outlet particulate/anions train only |
| Uranium-233&234, 238 | | | | | | | | |
| Radium-226, 228 | | | | | | | | |
| Polonium-210 | | | | | | | | |
| Lead-210 | | | | | | | | |
| Thorium-228, 230, 232 | | | | | | | | |
| Cyanide | 3 | 30 | 0.9 m3/hr | CARB 426 | Colorimetry | CARB 426 | 13 ug/m3 | |

(continued)

Notes:
① Inlet =252 minutes, Outlet = 240 minutes.
VOC and formaldehyde samples were collected at the FFDC inlet and outlet nonisokinetically. Sampling was at a single point at the outlet and at 6 points at the inlet. Cyanide samples were collected isokinetically at a single point at inlet and outlet. Particulate/anions/radionuclides samples were collected at the FFDC inlet and outlet isokinetically using a complete traverse of the duct.

## TABLE A-4 (continued)
## SAMPLING AND ANALYTICAL METHODS FOR FFDC INLET AND OUTLET SAMPLES
## SITE 115

| Parameter | No. of Replicates | Duration of Test (Minutes) | Sample Rate | Collection and Preparation Reference Method | Measurement Principle | Analytical Reference Method | Method Detection Limit | Comments |
|---|---|---|---|---|---|---|---|---|
| Ammonia | Various | 5 | 0.25 ft3/min. | | ISE | EPA 350.3 | 1 ppm | |
| Mercury Speciation | 3 | 120 | 0.01 ft3/min. | Frontier Geosciences | | N. Bloom* | | |
| Hg(II) | | | | | CVAFS | | 0.02 ug/Nm3 | |
| Hg(0) | | | | | CVAFS | | 0.01 ug/Nm3 | |
| Total Hg | | | | | | | 0.05 ug/Nm3 | |
| Chromium Speciation | 3 | 120 | 0.7 m3/hr | EPA Recirculation Method | | | | FFDC inlet only |
| Total Cr | | | | | GFAAS | EPA SW846 7191 | 0.2 ug/Nm3 | |
| Hexavalent Cr | | | | | IC/PCR | EPA Recirculation Method | 0.1 ug/Nm3 | Used preconcentration column to improve detection limit for hexavalent chromium |
| O2, CO2 | in conjunction with all tests by EPA method 3A | | | | | | | |
| Velocity, Moisture | in conjunction with all isokinetic tests by EPA Methods 2 and 4 | | | | | | | |

Notes:
Ammonia samples were collected nonisokinetically at 4-6 points at the FFDC inlet and a single point at the FFDC outlet. Mercury speciation samples were collected nonisokinetically at a single point at the FFDC inlet and outlet.
Chromium speciation samples were collected isokinetically at a single point at the FFDC inlet.
*Ref.: Bloom N.S. and Fitzgerald, W.F., Determination of Volatile Mercury Species at the Picogram Level by Low Temperature Gas Chromatography with Cold Vapor Atomic Fluorescence Detection, Anal. Chim. Acta., 208, 151, 1988.

**TABLE A-5**
**SAMPLING AND ANALYSIS SCHEDULE FOR COAL AND ASH SAMPLES**
**SITE 115**

| TEST NO. | DATE | TIME | COMMENTS |
|---|---|---|---|
| **Phase I - Baseline:** | | | |
| 1-COAL | 11/17/92 | 1110 | Samples from 1-COAL and 2-COAL were composited and analyzed |
| 2-COAL | 11/17/92 | 1820 | for metals, radionuclides, Cl, F, S, and Composition |
| 3-COAL | 11/18/92 | 1035 | Samples from 3-COAL and 4-COAL were composited and analyzed |
| 4-COAL | 11/18/92 | 1750 | for metals, radionuclides, Cl, F, S, and Composition |
| 5-COAL | 11/19/92 | 1220 | Samples from 5-COAL and 6-COAL were composited and analyzed |
| 6-COAL | 11/19/92 | 1700 | for metals, radionuclides, Cl, F, S, and Composition |
| 1-FLYASH | 11/17/92 | 1530 | Samples from 1-FLYASH and 2-FLYASH were composited and |
| 2-FLYASH | 11/17/92 | 2050 | analyzed for metals, radionuclides,Cl-, F-, SO4 2-, and LOI |
| 3-FLYASH | 11/18/92 | 1500 | Samples from 3-FLYASH and 4-FLYASH were composited and |
| 4-FLYASH | 11/18/92 | 2045 | analyzed for metals, radionuclides,Cl-, F-, SO4 2-, and LOI |
| 5-FLYASH | 11/19/92 | 1415 | Samples from 5-FLYASH and 6-FLYASH were composited and |
| 6-FLYASH | 11/19/92 | 2015 | analyzed for metals, radionuclides,Cl-, F-, SO4 2-, and LOI |
| 1-BOT ASH | 11/17/92 | 1515 | Samples from 1-BOT ASH and 2-BOT ASH were composited and |
| 2-BOT ASH | 11/17/92 | 2025 | analyzed for metals, radionuclides,Cl-, F-, SO4 2-, and LOI |
| 3-BOT ASH | 11/18/92 | 1430 | Samples from 3-BOT ASH and 4-BOT ASH were composited and |
| 4-BOT ASH | 11/18/92 | 2030 | analyzed for metals, radionuclides,Cl-, F-, SO4 2-, and LOI |
| 5-BOT ASH | 11/19/92 | 1430 | Samples from 5-BOT ASH and 6-BOT ASH were composited and |
| 6-BOT ASH | 11/19/92 | 2015 | analyzed for metals, radionuclides,Cl-, F-, SO4 2-, and LOI |
| 1-SLUICE WTR | 11/17/92 | 1500 | Samples from 1-SLUICE WTR and 2-SLUICE WTR were composited |
| 2-SLUICE WTR | 11/17/92 | 2005 | and analyzed for metals, radionuclides,Cl-, F-, and SO4 2- for blank correction of bottom ash results. |
| 3-SLUICE WTR | 11/18/92 | 1445 | Samples from 3-SLUICE WTR and 4-SLUICE WTR were composited |
| 4-SLUICE WTR | 11/18/92 | 1940 | and analyzed for metals, radionuclides,Cl-, F-, and SO4 2- for blank correction of bottom ash results. |
| 5-SLUICE WTR | 11/19/92 | 1330 | Samples from 5-SLUICE WTR and 6-SLUICE WTR were composited |
| 6-SLUICE WTR | 11/19/92 | 1840 | and analyzed for metals, radionuclides,Cl-, F-, and SO4 2- for blank correction of bottom ash results. |

(continued)

## TABLE A-5 (continued)
## SAMPLING AND ANALYSIS SCHEDULE FOR COAL AND ASH SAMPLES
## SITE 115

| TEST NO. | DATE | TIME | COMMENTS |
|---|---|---|---|
| **Phase II - Baseline:** | | | |
| 7-COAL | 03/08/93 | 1430 | Analyzed for composition and HHV |
| 8-COAL | 03/09/93 | 1100 | Samples from 8-Coal and 9-Coal were composited and analyzed for |
| 9-COAL | 03/09/93 | 1730 | composition |
| 14-COAL | 03/15/93 | 1200 | Analyzed for Total Hg (Frontier Geosciences), composition and HHV |
| 14-FLY ASH | 03/15/93 | 1545 | Analyzed for Total Hg (Frontier Geosciences) |
| **Phase II - Urea injection:** | | | |
| 10-COAL | 03/10/93 | 1130 | Analyzed for metals, Cl, S, F, and composition |
| 11-COAL | 03/10/93 | 2030 | Analyzed for metals, Cl, S, F, and composition |
| 12-COAL | 03/11/93 | 1130 | Analyzed for metals, Cl, S, F, and composition |
| 13-COAL | 03/11/93 | 1715 | Not analyzed |
| 10-FLY ASH | 03/10/93 | 1425 | Analyzed for metals, Cl-, F-, SO4 2- and LOI |
| 11-FLY ASH | 03/10/93 | 2030 | Analyzed for metals, Cl-, F-, SO4 2- and LOI |
| 12-FLY ASH | 03/11/93 | 1445 | Analyzed for metals, Cl-, F-, SO4 2- and LOI |
| 10-BOT ASH | 03/10/93 | 1525 | Analyzed for metals, Cl-, F-, SO4 2- and LOI |
| 11-BOT ASH | 03/10/93 | 2100 | Analyzed for metals, Cl-, F-, SO4 2- and LOI |
| 12-BOT ASH | 03/11/93 | 1345 | Analyzed for metals, Cl-, F-, SO4 2- and LOI |
| 10-SLUICE WTR (BLANK) | 03/10/93 | 1300 | Collected for blank correction of bottom ash results for metals, Cl-, F-, and SO4 2- |
| 11-SLUICE WTR (BLANK) | 03/10/93 | 2045 | Collected for blank correction of bottom ash results for metals, Cl-, F-, and SO4 2- |
| 12-SLUICE WTR (BLANK) | 03/11/93 | 1130 | Collected for blank correction of bottom ash results for metals, Cl-, F-, and SO4 2- |

115A5.XLS
9:56 AM
1/11/94

**TABLE A-6**
**ANALYTICAL METHODS FOR COAL SAMPLES**
**SITE 115**

| Parameter | Measurement Principle | Reference Method | Method Detection Limit | Comments |
|---|---|---|---|---|
| Composition: | | | | |
| Carbon | CHN Analyzer | LECO CHN/600 | 0.1 % | |
| Hydrogen | CHN Analyzer | LECO CHN/600 | 0.1 % | |
| Nitrogen | CHN Analyzer | LECO CHN/600 | 0.01 % | |
| Oxygen | Difference | – | 0.1 % | |
| Moisture | Gravimetric | ASTM D-5142 | 0.01 % | |
| Ash | Gravimetric | ASTM D-5142 | 0.01 % | |
| Heating Value | Calorimetry | ASTM-D1989 | 10 Btu/lb | |
| Anion precursors: | | | | |
| Chlorine | INAA | – | 0.1 ug/g | Also by ASTM D-2361 |
| Fluorine | Ion-selective electrode | ASTM D-3761 | 10 ug/g | |
| Sulfur | LECO SC-132 | ASTM D-4239 | 0.01 % | |
| Metals: | | | | |
| Arsenic | INAA | – | 0.0003 ug/g | Also by EPA SW846 7060 |
| Barium | INAA | – | 0.1 ug/g | Also by EPA SW846 6010 |
| Beryllium | ICP-AES | EPA SW846 6010 | 0.02 ug/g | |
| Cadmium | ICP-AES | EPA SW846 6010 | 0.01 ug/g | |
| Chromium | ICP-AES | EPA SW846 6010 | 0.1 ug/g | |
| Cobalt | ICP-AES | EPA SW846 6010 | 0.2 ug/g | |
| Copper | ICP-AES | EPA SW846 6010 | 0.1 ug/g | |
| Lead | GFAAS | EPA SW846 7420 | 0.4 ug/g | |
| Manganese | ICP-AES | EPA SW846 6010 | 0.2 ug/g | |
| Mercury | INAA | – | 0.0001 ug/g | Also by EPA SW846 7470 |
| Molybdenum | ICP-AES | EPA SW846 6010 | 0.1 ug/g | |
| Nickel | ICP-AES | EPA SW846 6010 | 0.3 ug/g | |
| Phosphorus | ICP-AES | EPA SW846 6010 | 5 ug/g | |
| Selenium | INAA | – | 0.0001 ug/g | Also by EPA SW846 7740 |
| Vanadium | ICP-AES | EPA SW846 6010 | 0.1 ug/g | |
| Calcium | ICP-AES | EPA SW846 6010 | 5 ug/g | |
| Sodium | ICP-AES | EPA SW846 6010 | 5 ug/g | |
| Radionuclides: Isotopic Uranium; Ra-226,-228; isotopic Thorium; Po-210; Pb-210 | Alpha Spectrometry | EPA 114 | 0.01-0.7 pCi/g | |

TABLE A-7
ANALYTICAL METHODS FOR
FLYASH AND BOTTOM ASH SAMPLES
SITE 115

| | | | Method Detection Limit, ug/g | | | |
|---|---|---|---|---|---|---|
| Parameter | Measurement Principle | Reference Method | Phase I | | Phase II | Comments |
| Flyash Anions | | | | | | |
| Chloride | IC | EPA 300.0 | 5 | | 50 | |
| Fluoride | ISE | EPA 340.2 | 3 | | 3 | |
| Phosphate | IC | EPA 300.0 | 20 | | 200 | |
| Sulfate | IC | EPA 300.0 | 25 | | 50 | |
| Flyash Metals | | | | | | |
| Arsenic | GFAAS | EPA SW846 7060 | 1.7 | | 4 | |
| Barium | ICP-AES | EPA SW846 6010 | 0.5 | | 2 | |
| Beryllium | ICP-AES | EPA SW846 6010 | 0.1 | | 0.4 | |
| Cadmium | ICP-AES | EPA SW846 6010 | 0.25 | | 1 | |
| Chromium | ICP-AES | EPA SW846 6010 | 0.5 | | 2 | |
| Cobalt | ICP-AES | EPA SW846 6010 | 0.9 | | 4 | |
| Copper | ICP-AES | EPA SW846 6010 | 0.5 | | 2 | |
| Lead | GFAAS | EPA SW846 7420 | 3.7 | | 3.4 | |
| Manganese | ICP-AES | EPA SW846 6010 | 0.7 | | 3 | |
| Mercury | CVAAS | EPA SW846 7471 | 0.1 | | 0.1 | |
| Molybdenum | ICP-AES | EPA SW846 6010 | 0.7 | | 3 | |
| Nickel | ICP-AES | EPA SW846 6010 | 1.6 | | 6 | |
| Phosphorus | ICP-AES | EPA SW846 6010 | 5 | | 20 | |
| Selenium | GFAAS | EPA SW846 7740 | 2.5 | | 5.7 | |
| Vanadium | ICP-AES | EPA SW846 6010 | 0.5 | | 2 | |
| Calcium | ICP-AES | EPA SW846 6010 | – | | 100 | |
| Sodium | ICP-AES | EPA SW846 6010 | – | | 100 | |
| Flyash Radionuclides: Isotopic Uranium; Ra-226,-228 isotopic Thorium; Po-210; Pb-210 | Alpha Spectrometry | EPA 114 | 0.1-1.8 pCi/g | | – | |
| Flyash Loss on Ignition | Gravimetric | ASTM C25 | | | Not Available | |
| Bottom Ash Anions* | | | | | | |
| Chloride | IC | EPA 300.0 | 25 | | 50 | |
| Fluoride | ISE | EPA 340.2 | 15 | | 3 | |
| Phosphate | IC | EPA 300.0 | 100 | | 20 | |
| Sulfate | IC | EPA 300.0 | 25 | | 50 | |
| Bottom Ash Metals* | | | Solid | Liquid** | | |
| Arsenic | GFAAS | EPA SW846 7060 | 2.5 | 0.005 | 4.3 | |
| Barium | ICP-AES | EPA SW846 6010 | 0.5 | 0.01 | 1 | |
| Beryllium | ICP-AES | EPA SW846 6010 | 0.1 | 0.002 | 0.2 | |
| Cadmium | ICP-AES | EPA SW846 6010 | 0.25 | 0.005 | 0.5 | |
| Chromium | ICP-AES | EPA SW846 6010 | 0.5 | 0.01 | 1 | |
| Cobalt | ICP-AES | EPA SW846 6010 | 0.9 | 0.018 | 2 | |
| Copper | ICP-AES | EPA SW846 6010 | 0.5 | 0.01 | 1 | |
| Lead | GFAAS | EPA SW846 7420 | 1.8 | 0.003 | 2.6 | |
| Manganese | ICP-AES | EPA SW846 6010 | 0.7 | 0.015 | 2 | |
| Mercury | CVAAS | EPA SW846 7471 | 0.1 | 0.002 | 0.1 | |
| Molybdenum | ICP-AES | EPA SW846 6010 | 0.7 | 0.014 | 1 | |
| Nickel | ICP-AES | EPA SW846 6010 | 1.6 | 0.032 | 3 | |
| Phosphorus | ICP-AES | EPA SW846 6010 | 5 | 0.1 | 10 | |
| Selenium | GFAAS | EPA SW846 7740 | 2.5 | 0.005 | 22 | |
| Vanadium | ICP-AES | EPA SW846 6010 | 0.5 | 0.01 | 1 | |
| Calcium | ICP-AES | EPA SW846 6010 | – | – | 50 | |
| Sodium | ICP-AES | EPA SW846 6010 | – | – | 50 | |
| Bottom Ash Radionuclides*: Isotopic Uranium; Ra-226,-228 isotopic Thorium; Po-210; Pb-210 | Alpha Spectrometry | EPA 114 | 0.1-5.1 pCi/g | | | |
| Bottom Ash Loss on Ignition | Gravimetric | ASTM C25 | | | Not Available | |

Notes:
* Sluice water blank detection limits are the same as for the bottom ash liquid fraction.
** Phase I bottom ash solid and liquid fractions were analyzed separately for metals. Phase II were not.

## TABLE A-8
## SAMPLING HANDLING AND PREPARATION PROCEDURES
## SITE 115

| Sample Type | Parameter | Sample Fraction Description | Sample Containers | Sample Handling and Preservation | Laboratory Preparation Procedure |
|---|---|---|---|---|---|
| Exhaust Gas Samples | Metals | Filter<br>Front half nitric peroxide rinse | Petri dish<br>500 ml acid washed amber HDPE Nalgene | Seal<br>Seal and mark liquid level | Parr Bomb HF/$HNO_3$, digestion combine with filter. Parr Bomb digestion |
| | PAH | Filter | *Hexane-rinsed foil lined petri dish* | *Seal, Store at ≤ 4°C* | Soxhlett extraction |
| | | XAD-2 column | -- | Wrap with foil to keep XAD-2 from exposure to light.<br>Store at ≤ 4°C | Soxhlett extraction |
| | | Front-half organic rinse | 500 ml organic free amber glass bottle with teflon lined lid | Seal and mark liquid level<br>Store at ≤ 4°C | Soxhlett extraction |
| | | Back-half organic rinse | 500 ml organic free amber glass bottle with teflon lined lid | Seal and mark liquid level<br>Store at ≤ 4°C | Soxhlett extraction |
| | | Back-half water impinger rinse | 500 ml organic free amber glass bottle with teflon lined lid | Seal and mark liquid level<br>Store at ≤ 4°C | Soxhlett extraction |
| | | | | All fractions: Sample to be extracted within 7 days of sampling; analysis to be performed within 40 days. Ship at conclusion of PAH tests. | |
| | VOC<br>Benzene, Toluene | *Exhaust gas sample* | *10 l Tedlar bag with teflon fittings or equivalent* | *Seal;* store away from light; ship immediately after testing; analysis within 72 hours. | None |
| | Formaldehyde | DNPH solution and lime rinse | Organic free DI $H_2O$ washed 40 ml glass sample vials with teflon lined lid | Seal and mark liquid level. Store at ≤ 4°C. Analyze within 7 days. Ship at conclusion of formaldehyde tests. | Extraction |
| | Particulate | Filter<br>Front half acetone rinse | Petri dish<br>500 ml amber glass lined bath with teflon lined lid | Seal<br>Seal and mark liquid levels | Dry at 105°C, desiccate[1]<br>Evaporate at ambient temperature, desiccate[1] |

[1] Split for anions and radionuclides (Phase I outlet only) analysis. Reconstitute in water for anions analysis; acid digestion and fusion or precipitation for radionuclides.

(continued)

# TABLE A-8 (continued)
# SAMPLING HANDLING AND PREPARATION PROCEDURES
# SITE 115

| Sample Type | Parameter | Sample Fraction Description | Sample Containers | Sample Handling and Preservation | Laboratory Preparation Procedure |
|---|---|---|---|---|---|
| | Anions | $Na_2CO_3/NaHCO_3$ impinger rinse | 1000 ml Nalgene HDPE bottle | Seal and mark liquid levels | none |
| | | 3% $H_2O_2$ impinger rinse | 1000 ml Nalgene HDPE bottle | Seal and mark liquid levels | none |
| | Mercury/ Brooks Rand/ Frontier Geosciences | Probe wash | Glass probe | Seal | BrCl in HCl and $H_2O$ rinse |
| | | KCl/soda line cartridge | Teflon cartridge | Seal | Dissolve in Acetic Acid |
| | | soda/charcoal cartridge | Teflon cartridge | Seal | Digest in $HNO_3/H_2SO_4$ |
| | | | | All fractions: Ship at conclusion of Hg testing | |
| | Total Chromium Hexavalent Chromium | Filtered KOH impinger and probe rinse | 1000 ml acid washed HDPE Nalgene bottle | Check total pH $\geq$ 8.5 Seal and mark liquid level | None for $Cr^{6+}$, concentrated and acid digestion for Cr total |
| | | Nitric acid impinger rinse | 500 ml acid washed HDPE Nalgene bottle | Seal and mark liquid level | Concentrate and acid digestion for Cr |
| | | Filtrant (filter) | Petri dish | Seal | KOH extraction for $Cr^{6+}$ Acid digestion for Cr total |
| | | Nitric acid train rinse | 500 ml acid wash HDPE nalgene bottle | Seal and mark liquid level | Concentrate and acid digestion for Cr total |
| | | | | All fractions: ship at conclusion of Cr testing | |

(continued)

# TABLE A-8 (continued)
# SAMPLING HANDLING AND PREPARATION PROCEDURES
# SITE 115

| Sample Type | Parameter | Sample Fraction Description | Sample Containers | Sample Handling and Preservation | Laboratory Preparation Procedure |
|---|---|---|---|---|---|
| Coal | Ultimate, HHV, anion precursors | 1000 g composite | 500 ml acid washed amber nalgene | Seal | None |
| | Metals | 500 g composite | 500 ml acid washed amber nalgene | Seal | Ash and acid digest for ICP-AES, GFAAS, or AA by ASTM D3683 or modified EPA 3050; Parr Oxygen bomb for Hg; Transfer to teflon INAA vessel for INAA analysis. |
| | Radionuclides | 200 g composite | 500 ml acid washed amber nalgene | Seal | Acid digest and fusion or precipitation depending on isotope. |
| Flyash, Bottom Ash | Metals | 200g composite | 500 ml acid washed amber HDPE Nalgene bottle | Seal | Acid digest for ICP-AES, GFAAS or AA by ASTM D3683 and modified EPA 3050; Parr Bomb for Hg |
| | Anions | 200g composite | 500 ml acid washed amber HDPE Nalgene bottle | Seal | |
| | Radionuclides | 200g composite | 500 ml acid washed amber Nalgene | Seal | Acid digest and fusion or precipitation depending on isotope. |
| | LOI | 200g composite | 500 ml HDPE Nalgene bottle | Seal | |
| Sluice Water Blanks | Metals | 200 ml | 250 ml acid washed amber Nalgene | Seal and mark liquid level | Reduce volume, acid digest for ICP-AES GFAAS or AA by EPA 3050; Parr Bomb for Hg |
| | Anions | 200 ml | 250 ml acid washed amber Nalgene | Seal and mark liquid level | |
| | Radionuclides | 200 ml | 250 ml acid washed amber Nalgene | Seal and mark liquid level | Acid digest and fusion or precipitation depending on isotope. |

# TABLE A-9
# 3D VELOCITY SUMMARY: FFDC INLET
# SITE 115

| Sample Port/Point | Resultant Angle, degrees | Sample Port/Point | Resultant Angle, degrees |
|---|---|---|---|
| A7 | 7.0 | D7 | 4.2 |
| A6 | 4.1 | D6 | 3.2 |
| A5 | 0.8 | D5 | 3.2 |
| A4 | 1.3 | D4 | 3.2 |
| A3 | 16.0 | D3 | 6.1 |
| A2 | 43.2 | D2 | 12.1 |
| A1 | 8.1 | D1 | 14.0 |
| B7 | 0.8 | E7 | 14.0 |
| B6 | 8.0 | E6 | 1.5 |
| B5 | 9.0 | E5 | 1.2 |
| B4 | 0.8 | E4 | 1.2 |
| B3 | 30.8 | E3 | 1.2 |
| B2 | 0.8 | E2 | 2.3 |
| B1 | 8.7 | E1 | 9.1 |
| C7 | 2.2 | F7 | 5.1 |
| C6 | 8.0 | F6 | 2.3 |
| C5 | 0.8 | F5 | 1.5 |
| C4 | 0.8 | F4 | 2.3 |
| C3 | 0.8 | F3 | 2.3 |
| C2 | 0.8 | F2 | 1.2 |
| C1 | 3.1 | F1 | 1.2 |

**RESULTS:**

| | | | |
|---|---|---|---|
| Yaw Angle: | 9.4 degrees | Velocity:* | 48.62 fps (ft/sec.) |
| Pitch Angle: | 1.2 degrees | Axial Velocity: | 47.45 fps |
| Resultant Angle: | 9.9 degrees | | |
| Standard Deviation: | 7.6 degrees | | |

Note: All results are averages for the test.
* Velocity in the direction of flow.

**Coal and Ash Collection Procedures**

Coal

Coal samples were collected from each of eight feed hoppers (two per pulverizer) once during each exhaust gas test (twice per day). A flat metal spoon was used to scoop coal from a narrow opening between the pipe to the hopper and the hopper itself. Two samples were collected from each hopper for a total of 16 samples. These samples were composited and transferred to several 500 ml containers. For Phase I testing, samples were combined to form a daily composite sample for each type of analysis performed. For Phase II, separate samples were analyzed for each exhaust gas test. Fuel consumption rates were recorded along with other boiler operating conditions. Fuel flows for each test were calculated from hourly volumetric feeder counter readings which were multiplied by the average monthly calculated lbs/revolution provided by the plant.

Flyash

The baghouse was cleaned and the ash hoppers were cleared before and after each exhaust gas test. Flyash samples were collected at the end of each exhaust gas test, after the baghouse was cleaned, but before the ash hoppers were cleared. Samples were removed from the bottom of each of twelve hoppers through an access pipe using a length of plastic pipe. These samples were composited prior to transfer to several 500 ml containers. For Phase I testing samples were combined to form a daily composite sample for each type of analysis performed. For Phase II, separate samples were analyzed for each exhaust gas test. The ash handling system did not allow direct measurement of the flyash mass flow rate, so it was calculated based on the difference between exhaust gas particulate levels at the inlet and outlet of the baghouse.

Bottom Ash

Soot blowing and bottom ash sluicing was performed before and after each exhaust gas test. Bottom ash was sluiced with river water from the boiler hoppers to the ash pit water box located below the furnace and above the ash grinder. Bottom ash sluice samples were collected during each post-test sluice by shoveling a mix of ash and water from the ash pit water box into sample jars. Samples of the water used for sluicing were also collected at this time for blank correction. As with coal and flyash, daily composite samples were analyzed for Phase I, and separate samples for each exhaust gas test were analyzed for Phase II. The bottom ash flowrate also could not be measured directly and was calculated based on inlet particulate flowrates and bottom ash loss on ignition (LOI)

**FFDC Inlet and Outlet Sample Collection and Analysis Procedures**

Combined Metals Train

Multimetals samples were collected during Phase I at baseline conditions and during Phase II during urea injection. Triplicate FFDC inlet and outlet multimetals samples were collected isokinetically using a heated filter to trap particulate, a series of impingers containing 5% $HNO_3$/10% $H_2O_2$ for gas phase metals and 4% $KMnO_4$/10% $H_2SO_4$ for mercury. A cyclone was used with the inlet train to collect excess particulate. Sample fractions were recovered and decomposed with acid by the EPA Method to solubilized target metals and remove organic interferences. Whenever possible, precautions were taken to prevent losses of volatile metals. The front half of the sample train, including the filter, was digested using conventional Parr Bomb techniques. An aliquot of this fraction and the $HNO_3/H_2O_2$ impinger fraction were removed prior to acid digestion, and combined for mercury analysis. The remainder of the sample fractions were concentrated and combined for analysis to achieve the lowest possible detection limits. Analysis for most metals was by ICP-AES. GFAAS and ICP-AES with hydride generation were used to achieve lower detection limits for arsenic and selenium. The aliquots reserved for mercury analysis and an aliquot of the $KMnO_4$ fraction were analyzed by CVAAS.

Quality control for multimetals included analysis of reagent and inlet and outlet field blanks, a blank matrix spike duplicate, duplicate sample analysis, and post-digestion sample spike analysis. If spike recoveries were poor, samples were analyzed using the method of standard additions (MSA) or an alternate technique.

**Semi-Volatile Organics -PAH**

PAH samples were collected during Phase I at baseline conditions. Triplicate samples were collected at the FFDC inlet and outlet in a modified method 5 train according to CARB Method 429 - September 12, 1989 version. Samples were collected isokinetically through a heated filter followed by an XAD-2 sorbent module in a water-cooled condenser. The sorbent module was followed by an impinger train to collect moisture and any species that might pass through the resin. A cyclone was used at the FFDC inlet to collect excess particulate.

After sampling, the sample train components were rinsed in triplicate with organic free methanol, toluene and methylene chloride, and the rinses were collected for analysis. The impinger contents were recovered and solvent extracted. The resin, solvent rinses, sample filters and organic impinger extract were combined, sohxlet extracted and cleaned up prior to analysis by HRGC/LRMS-SIM.

Prior to release to the field, each XAD-2 resin trap was spiked with deuterated standards to assess field losses or gains. The standards used were benzo(e)pyrene-$d_{12}$ and terphenyl $d_{14}$. In addition, sixteen surrogate PAH standards were added to each sample prior to the extraction step to provide recovery corrected results. Deuterated standards were not available for 2-Methylnapthalene,3-Methylcholanthrene,or7,12-Dimethylbenzo(a)anthracene; the method of internal standardization was used for these species. Two aliquots of XAD-2 resin were spiked with native PAH compounds and analyzed with the samples to further assess analytical precision and accuracy. Inlet and outlet field blank trains and a laboratory method blank were also analyzed with samples.

**Benzene and Toluene**

Benzene and toluene samples were collected during Phase I and Phase II at baseline conditions. Tedlar bag exhaust gas samples were collected nonisokinetically at the midpoint of each of four ports at the FFDC inlet and simultaneously at a single point at the FFDC outlet. Samples were collected according to CARB Method 410A and analyzed by EPA Method TO-14 using GC/MS. Duplicate analysis was performed on one inlet and one outlet sample. After sample analysis one inlet and one outlet sample were spiked with benzene and toluene and reanalyzed to assess recovery.

Formaldehyde

Formaldehyde samples were collected during Phase I at baseline conditions. Triplicate samples were collected non-isokinetically at the midpoint of each of four ports at the FFDC inlet and simultaneously at a single point at the FFDC outlet by CARB Method 430. Exhaust gas was drawn through midget impingers containing an acidic 2,4 dinitrophenylhydrazine (DNPH) solution to capture formaldehyde. The analysis for formaldehyde was performed by reverse phase HPLC with UV Detection. The DNPH collection solution was analyzed before use in the field to verify that it contained no significant levels of formaldehyde. All sample vials were kept cold and sealed before and after collection. Three inlet and three outlet field blanks were collected by attaching blank vials of DNPH to the sampling equipment and recovering it the same way as a sample. In this way, blank DNPH solution was exposed to the ambient air and the sampling equipment for the same period of time as samples. Inlet and outlet field spikes containing 5.0 $\mu$g of formaldehyde were prepared, exposed to sampling conditions using the same procedure as for field blanks and analyzed along with a trip blank and a trip spike (neither of which were opened). One sample was analyzed in duplicate. One inlet and one outlet sample were split and spiked with formaldehyde prior to analysis.

Total Solid Particulate/ Anions/ Radionuclides

Particulate and anions were collected isokinetically at the FFDC inlet and outlet. Solid particulate was collected and analyzed according to EPA Method 5 during Phase I at baseline conditions and Phase II during urea injection. Anions were collected in conjunction with the particulate samples using impingers containing a sodium carbonate/sodium bicarbonate solution to collect chloride, fluoride and phosphate by CARB Method 421 and hydrogen peroxide to collect $SO_2$ by EPA Method 6/8. The solid particulate fraction of the outlet samples (Phase I only) was analyzed for radionuclides by EPA Method 114 using alpha spectrometry. All sample fractions were analyzed for anions by EPA Method 300.0 using ion chromatography. Confirmational titration analysis by EPA Method 325.3 was performed on Phase I hydrogen peroxide fractions and Phase II hydrogen peroxide and carbonate/bicarbonate fractions.

Quality assurance activities for particulate samples included analysis of NBS traceable weights and an acetone blank. Quality assurance activities for anions samples included analysis of reagent blanks and duplicate and spiked samples. Quality assurance for radionuclides included analysis of laboratory and reagent blanks and a laboratory control sample, and internal spiking of all samples. Sample results are all recovery-corrected.

Cyanide

Cyanide samples were collected during Phase I baseline conditions and during Phase II urea injection. Samples were collected isokinetically at the midpoint of each of four ports at the FFDC inlet and simultaneously at a single point at the FFDC outlet by a modified CARB Method 426. An in-stack glass fiber filter was used to collect solid particulate but was not analyzed, because cyanide exists as HCN in the exhaust gas. Impingers containing 0.1 N NaOH were used to collect the gaseous cyanide. The pH of the sample was measured after analysis to ensure it was still >10, and the sample was checked for the presence of oxidizing agents which would decompose cyanide. Prior to colorimetric analysis, samples were treated to remove interferences and distilled. Laboratory and reagent blanks, a sample duplicate and a sample spike were analyzed along with the samples.

Ammonia

For Phase I baseline ammonia samples were collected at an FFDC inlet location 15 feet downstream of the primary inlet location at the midpoint of each of six ports. For Phase II urea injection, ammonia samples were collected from a single point in each of four ports located 50 feet downstream of the primary FFDC inlet sampling location, and at a single point 20 feet downstream of the primary FFDC outlet sampling location. Samples were collected in midget impingers containing 0.1 N $H_2SO_4$, and analyzed by EPA Method 350.3 using ISE.

$O_2$ and $CO_2$

For Phase I testing, $O_2$ and $CO_2$ were measured with a six point grid at the FFDC inlet and at a single point at the FFDC outlet by EPA Method 100 using a Continuous Emissions Monitoring System. This system was used in conjunction with all tests to provide $O_2$ and $CO_2$ data for molecular weight and dilution calculations. For Phase II testing, $O_2$ and $CO_2$ were measured with a 12 point grid at the economizer outlet and used for FFDC inlet $O_2$ and $CO_2$ concentrations. $O_2$ was measured at the FFDC outlet using portable $O_2$ meters during each isokinetic test, and these portable $O_2$ values were used for calculations. $CO_2$ was calculated by correcting FFDC outlet single point CEM measurements to portable $O_2$ measurements.

Three Dimensional Velocity Testing

The FFDC inlet sampling location did not meet the dimensional criteria specified by EPA Method 1, so three dimensional velocity testing was conducted during Phase I. A United Sensor Three Dimensional Directional Probe was used to traverse 42 points at the inlet location. The 3-D probe measures yaw and pitch angles, as well as total and static pressures, and allows for very accurate gas flow measurements.

Each probe has five measuring holes in its tip. A centrally located pressure hole measures pressure P1, while two lateral pressure holes measure pressures P2 and P3. If the probe is rotated manually until P2 and P3 are identical as a readout on the manometer, the yaw angle of flow is then indicated by the number of degrees rotated.

When the yaw angle has been determined, an additional differential pressure P4 - P5 is measured by pressure holes located above and below the total pressure (P1) hole. Pitch angle is determined by calculating (P4 - P5)/(P1 - P2) and using the calibration data for the individual probe and interpolating between the bracketing data. At any particular pitch angle, the velocity pressure coefficient (Pt - Ps)/(P1 -P2) can also be interpolated from the calibration data and Pt - Ps and Ps calculated.

Velocity and Moisture

Stack gas velocity and moisture content were measured by EPA Methods 2 and 4 in conjunction with every isokinetic test.

Hexavalent and Total Chromium

Hexavalent and total chromium samples were collected during Phase II at baseline conditions. Total and hexavalent chromium samples were collected isokinetically at a single point at the FFDC inlet using a recirculating train by the EPA draft method. To eliminate the possibility of $Cr^{6+}$ reduction between the nozzle and impingers, liquid from the first impinger was continuously recirculated to the probe trip. There were six impingers in this train. The first four were teflon, the last two were glass.

Impinger 1, 2 and 3: 0.1 N NaOH
Impinger 4: Empty
Impinger 5: 0.1 N $HNO_3$
Impinger 6: Silica Gel

5N NaOH was added to the first impinger as necessary to keep the solution pH above 8.5. The sample train was purged with nitrogen and the NaOH impinger contents were filtered immediately after sampling. The NaOH impinger solution was analyzed for $Cr^{6+}$ by ion chromatography with a post-column reactor (IC/PCR). Total chromium was measured in the filter and 0.1 N $HNO_3$ fractions of the train by GFAAS.

Mercury Speciation

A series of tests using a developmental mercury speciation method were performed during Phase II at baseline conditions. Mercury speciation samples were collected non-isokinetically at a single point simultaneously at the FFDC inlet and outlet using a sample train developed by Nick Bloom of Frontier Geosciences (formerly Brooks Rand). A series of KCl/ sodalime and iodated charcoal traps were used to collect and separate oxidized mercury (Hg(II), MMHg) from elemental mercury (Hg(0)). The KCl/sodalime traps were digested in acetic acid and analyzed for MMHg by GC/CVAFS and for Hg(II) by cold vapor atomic fluorescence spectroscopy (CVAFS). The iodated charcoal traps were digested in an acid mixture and analyzed for Hg(0) by CVAFS. At the inlet sampling location, there was a large buildup of particulate matter on the glass wool packing at the inlet of the first KCl/sodalime trap, and this particulate and glass wool were analyzed separately for total Hg. Field blank trains were collected and analyzed, and sample results were blank corrected.

# APPENDIX B

## FCEM SITE 115 INDIVIDUAL STREAM CONCENTRATIONS

This appendix presents the Site 115 sampling results that were used to calculate the emissions and mass balances presented in this report. Provided here are results for the following streams: FFDC inlet and outlet gases, coal, flyash, and furnace bottom ash.

The following data flags are used in this table:

| | |
|---|---|
| @ | Concentration is less than five times the reporting limit |
| E | Estimated analyte result |
| NA | Not analyzed |
| ND< | Not detected at less than the reporting limit |
| B | Blank correction exceeded 50% of uncorrected result |

## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 1 | | Run 3 | | Run 5 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Outlet Gas, B.L., Metals | Arsenic | ICP-AES HYDRIDE | ug/Nm3 | | 0.47 | | 1.79 | | 0.65 | | 0.97 |
| Outlet Gas, B.L., Metals | Barium | ICP-AES | ug/Nm3 | | 2.23B | | 0.56B | | 1.57B | | 1.45 |
| Outlet Gas, B.L., Metals | Beryllium | ICP-AES | ug/Nm3 | ND< | 0.03 | ND< | 0.03 | ND< | 0.03 | ND< | 0.03 |
| Outlet Gas, B.L., Metals | Cadmium | ICP-AES | ug/Nm3 | | 0.28@ | | 0.14@ | ND< | 0.08 | | 0.15 |
| Outlet Gas, B.L., Metals | Chromium | ICP-AES | ug/Nm3 | | 0.72 | | 0.70 | | 1.12 | | 0.85 |
| Outlet Gas, B.L., Metals | Cobalt | ICP-AES | ug/Nm3 | ND< | 0.28 | ND< | 0.28 | ND< | 0.26 | ND< | 0.28 |
| Outlet Gas, B.L., Metals | Copper | ICP-AES | ug/Nm3 | | 1.64 | | 1.59 | | 1.02 | | 1.42 |
| Outlet Gas, B.L., Metals | Lead | GFAAS | ug/Nm3 | | 0.61 | | 0.56@ | | 0.52@B | | 0.56 |
| Outlet Gas, B.L., Metals | Manganese | ICP-AES | ug/Nm3 | | 1.34 | | 1.87 | | 0.65@ | | 1.29 |
| Outlet Gas, B.L., Metals | Mercury | CVAAS | ug/Nm3 | ND< | 0.28 | ND< | 0.45 | ND< | 0.39 | ND< | 0.45 |
| Outlet Gas, B.L., Metals | Molybdenum | ICP-AES | ug/Nm3 | | 0.22B | | 0.22B | | 0.21B | | 0.22 |
| Outlet Gas, B.L., Metals | Nickel | ICP-AES | ug/Nm3 | | 19.5 | | 2.5@ | | 1.3@ | | 1.9 |
| Outlet Gas, B.L., Metals | Selenium | ICP-AES HYDRIDE | ug/Nm3 | | 0.42 | | 0.73 | | 0.26 | | 0.47 |
| Outlet Gas, B.L., Metals | Phosphorus | ICP-AES | ug/Nm3 | | 8.07 | | 8.66 | | 9.15 | | 8.63 |
| Outlet Gas, B.L., Metals | Vanadium | ICP-AES | ug/Nm3 | | 0.36@ | | 0.17@B | | 0.39@ | | 0.31 |
| Outlet Gas, B.L., Particulate | Particulate, total | GRAV | mg/Nm3 | | 0.7 | | 4.7 | | 2.1 | | 2.5 |
| Outlet Gas, B.L., Anions | Chloride | IC/TITRATION | ug/Nm3 | | 1,056 | | 947 | | 431 | | 811 |
| Outlet Gas, B.L., Anions | Fluoride | IC | ug/Nm3 | | 8,094 | | 6,418 | | 2,164 | | 5,559 |

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# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 2 | | Run 4 | | Run 6 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Outlet Gas, B.L., PAH | Naphthalene | HRGC/LRMS-SIM | ug/Nm^3 | | 0.42@ | | 0.25@ | | 0.34@ | | 0.34 |
| Outlet Gas, B.L., PAH | Acenaphthylene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.011 | ND< | 0.009 | ND< | 0.008 | ND< | 0.011 |
| Outlet Gas, B.L., PAH | Acenaphthene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.014 | ND< | 0.009 | ND< | 0.015 | ND< | 0.015 |
| Outlet Gas, B.L., PAH | Fluorene | HRGC/LRMS-SIM | ug/Nm^3 | | 0.014@ | | 0.011@ | ND< | 0.013 | ND< | 0.013 |
| Outlet Gas, B.L., PAH | Phenanthrene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.13 | ND< | 0.11 | ND< | 0.14 | ND< | 0.14 |
| Outlet Gas, B.L., PAH | Anthracene | HRGC/LRMS-SIM | ug/Nm^3 | | 0.012@ | ND< | 0.014 | ND< | 0.006 | ND< | 0.014 |
| Outlet Gas, B.L., PAH | Fluoranthene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.029 | ND< | 0.024 | ND< | 0.023 | ND< | 0.029 |
| Outlet Gas, B.L., PAH | Pyrene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.029 | ND< | 0.024 | ND< | 0.023 | ND< | 0.029 |
| Outlet Gas, B.L., PAH | Benz(a)anthracene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.018 | ND< | 0.016 | ND< | 0.014 | ND< | 0.018 |
| Outlet Gas, B.L., PAH | Chrysene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.018 | ND< | 0.015 | ND< | 0.014 | ND< | 0.018 |
| Outlet Gas, B.L., PAH | Benzo(b)fluoranthene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.007 | ND< | 0.008 | ND< | 0.014 | ND< | 0.014 |
| Outlet Gas, B.L., PAH | Benzo(k)fluoranthene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.013 | ND< | 0.011 | ND< | 0.018 | ND< | 0.018 |
| Outlet Gas, B.L., PAH | Benzo(a)pyrene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.011 | ND< | 0.026 | ND< | 0.008 | ND< | 0.026 |
| Outlet Gas, B.L., PAH | Indeno(1,2,3-cd)pyrene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.033 | ND< | 0.047 | ND< | 0.039 | ND< | 0.047 |
| Outlet Gas, B.L., PAH | Dibenzo(a,h)anthracene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.039 | ND< | 0.056 | ND< | 0.045 | ND< | 0.056 |
| Outlet Gas, B.L., PAH | Benzo(g,h,i)perylene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.030 | ND< | 0.038 | ND< | 0.034 | ND< | 0.038 |
| Outlet Gas, B.L., PAH | 2-Methylnaphthalene | HRGC/LRMS-SIM | ug/Nm^3 | | 0.063@ | | 0.020@ | | 0.022@ | | 0.035 |
| Outlet Gas, B.L., PAH | 7,12-Dimethylbenz(a)anthracene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.007 | ND< | 0.006 | ND< | 0.003 | ND< | 0.007 |
| Outlet Gas, B.L., PAH | 3-Methylcholanthrene | HRGC/LRMS-SIM | ug/Nm^3 | ND< | 0.007 | ND< | 0.006 | ND< | 0.006 | ND< | 0.007 |

| Stream | Substance | Method | UOM | Run 2B | Run 2C | Run 3A | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, B.L., VOC | Benzene | GC/MS | ug/Nm3 | 2.4@ | 3.1@ | 4.7 | 3.4 |
| Outlet Gas, B.L., VOC | Toluene | GC/MS | ug/Nm3 | 180.2 | 95.0 | 126.3 | 133.8 |

| Stream | Substance | Method | UOM | Run 4A | Run 4B | Run 4C | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, B.L., Form | Formaldehyde | HPLC | ug/Nm^3 | 14.5 | 33.4 | 16.9 | 21.6 |

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# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 6A | | Run 6B | | Run 6C | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Outlet Gas, B.L., Cyanide | Cyanide | Colorimetric | ug/Nm3 | | 8.9@ | ND< | 4.4 | ND< | 9.8 | ND< | 9.8 |

| Stream | Substance | Method | UOM | | Run 1 | | Run 3 | | Run 5 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Outlet Gas, B.L., Radio. | Uranium-233 & -234 | Alpha Spect. | pCi/Nm^3 | ND< | 0.06 | ND< | 0.06 | | 0.05 | ND< | 0.06 |
| Outlet Gas, B.L., Radio. | Uranium-235 | Alpha Spect. | pCi/Nm^3 | ND< | 0.06 | ND< | 0.06 | | 0.05 | ND< | 0.06 |
| Outlet Gas, B.L., Radio. | Uranium-238 | Alpha Spect. | pCi/Nm^3 | ND< | 0.06 | ND< | 0.06 | ND< | 0.05 | ND< | 0.06 |
| Outlet Gas, B.L., Radio. | Radium-226 | Alpha Spect. | pCi/Nm^3 | | 0.11 | | 0.11 | | 0.11 | | 0.11 |
| Outlet Gas, B.L., Radio. | Radium-228 | Alpha Spect. | pCi/Nm^3 | | 0.80 | | 0.96 | | 0.76 | | 0.84 |
| Outlet Gas, B.L., Radio. | Lead-210 | Alpha Spect. | pCi/Nm^3 | ND< | 0.75 | ND< | 0.73 | | 0.22 | ND< | 0.75 |
| Outlet Gas, B.L., Radio. | Polonium-210 | Alpha Spect. | pCi/Nm^3 | | 0.06 | ND< | 0.06 | ND< | 0.05 | ND< | 0.06 |
| Outlet Gas, B.L., Radio. | Thorium-228 | Alpha Spect. | pCi/Nm^3 | ND< | 0.23 | ND< | 0.34 | ND< | 0.16 | ND< | 0.34 |
| Outlet Gas, B.L., Radio. | Thorium-230 | Alpha Spect. | pCi/Nm^3 | ND< | 0.17 | ND< | 0.06 | ND< | 0.16 | ND< | 0.17 |
| Outlet Gas, B.L., Radio. | Thorium-232 | Alpha Spect. | pCi/Nm^3 | ND< | 0.06 | ND< | 0.11 | ND< | 0.11 | ND< | 0.11 |

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## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1 | Run 3 | Run 5 | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Total Metals | Arsenic | GFAAS | ug/Nm3 | 33.5 | 19.4 | 37.0 | 30.0 |
| Inlet Gas, B.L., Total Metals | Barium | ICP-AES | ug/Nm3 | 237.5 | 88.4 | 588.2 | 304.7 |
| Inlet Gas, B.L., Total Metals | Beryllium | ICP-AES | ug/Nm3 | 6.7 | 14.4 | 14.1 | 11.7 |
| Inlet Gas, B.L., Total Metals | Cadmium | ICP-AES | ug/Nm3 | 2.46 | 2.72 | 3.70 | 2.96 |
| Inlet Gas, B.L., Total Metals | Chromium | ICP-AES | ug/Nm3 | 36.7 | 84.8 | 73.6 | 65.0 |
| Inlet Gas, B.L., Total Metals | Cobalt | ICP-AES | ug/Nm3 | 21.6 | 50.4 | 44.4 | 38.8 |
| Inlet Gas, B.L., Total Metals | Copper | ICP-AES | ug/Nm3 | 248.8 | 197.2 | 214.2 | 220.0 |
| Inlet Gas, B.L., Total Metals | Lead | GFAAS | ug/Nm3 | 147.3 | 36.3 | 65.0 | 82.9 |
| Inlet Gas, B.L., Total Metals | Manganese | ICP-AES | ug/Nm3 | 148.6 | 310.0 | 299.7 | 252.8 |
| Inlet Gas, B.L., Total Metals | Mercury | CVAAS | ug/Nm3 | 2.42 | 1.49 | 1.26 | 1.72 |
| Inlet Gas, B.L., Total Metals | Molybdenum | ICP-AES | ug/Nm3 | 7.8 | 15.5 | 18.5 | 14.0 |
| Inlet Gas, B.L., Total Metals | Nickel | ICP-AES | ug/Nm3 | 19.4 | 50.4 | 48.1 | 39.3 |
| Inlet Gas, B.L., Total Metals | Selenium | ICP-AES HYDRIDE | ug/Nm3 | 23.5 | 34.1 | 29.6 | 29.1 |
| Inlet Gas, B.L., Total Metals | Phosphorus | ICP-AES | ug/Nm3 | 17,867 | 19,009 | 18,889 | 18,588 |
| Inlet Gas, B.L., Total Metals | Vanadium | ICP-AES | ug/Nm3 | 100.3 | 213.1 | 214.6 | 176.0 |
| Inlet Gas, B.L., PM | Particulate, total | GRAV | mg/Nm3 | 7,705.8 | 7,835.9 | 5,306.7 | 6,949.5 |
| Inlet Gas, B.L., Anions | Chloride | IC/TITRATION | ug/Nm3 | 1,017 | 1,091 | 988 | 1,032 |
| Inlet Gas, B.L., Anions | Fluoride | IC | ug/Nm3 | 7,223 | 5,679 | 5,711 | 6,204 |

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APPENDIX B
SITE 115 DATA USED IN CALCULATIONS
PHASE I: BASELINE TESTS
NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 2 | | Run 4 | | Run 6 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., PAH | Naphthalene | HRGC/LRMS-SIM | ug/Nm3 | | 0.306@ | | 0.235@ | | 0.402@ | | 0.314 |
| Inlet Gas, B.L., PAH | Acenaphthylene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.012 | ND< | 0.011 | ND< | 0.033 | ND< | 0.033 |
| Inlet Gas, B.L., PAH | Acenaphthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.014 | ND< | 0.012 | ND< | 0.012 | ND< | 0.014 |
| Inlet Gas, B.L., PAH | Fluorene | HRGC/LRMS-SIM | ug/Nm3 | | 0.015@ | | 0.013@ | | 0.015@ | | 0.014 |
| Inlet Gas, B.L., PAH | Phenanthrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.142 | ND< | 0.140 | ND< | 0.183 | ND< | 0.183 |
| Inlet Gas, B.L., PAH | Anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.019 | ND< | 0.010 | ND< | 0.019 | ND< | 0.019 |
| Inlet Gas, B.L., PAH | Fluoranthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.030 | ND< | 0.033 | ND< | 0.030 | ND< | 0.033 |
| Inlet Gas, B.L., PAH | Pyrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.031 | ND< | 0.034 | ND< | 0.030 | ND< | 0.034 |
| Inlet Gas, B.L., PAH | Benz(a)anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.019 | ND< | 0.021 | ND< | 0.040 | ND< | 0.040 |
| Inlet Gas, B.L., PAH | Chrysene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.019 | ND< | 0.020 | ND< | 0.037 | ND< | 0.037 |
| Inlet Gas, B.L., PAH | Benzo(b)fluoranthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.011 | ND< | 0.024 | ND< | 0.030 | ND< | 0.030 |
| Inlet Gas, B.L., PAH | Benzo(k)fluoranthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.021 | ND< | 0.096 | ND< | 0.069 | ND< | 0.096 |
| Inlet Gas, B.L., PAH | Benzo(a)pyrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.056 | ND< | 0.077 | ND< | 0.011 | ND< | 0.077 |
| Inlet Gas, B.L., PAH | Indeno(1,2,3-cd)pyrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.030 | ND< | 0.029 | ND< | 0.029 | ND< | 0.030 |
| Inlet Gas, B.L., PAH | Dibenzo(a,h)anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.037 | ND< | 0.037 | ND< | 0.037 | ND< | 0.037 |
| Inlet Gas, B.L., PAH | Benzo(g,h,i)perylene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.037 | ND< | 0.029 | ND< | 0.029 | ND< | 0.037 |
| Inlet Gas, B.L., PAH | 2-Methylnaphthalene | HRGC/LRMS-SIM | ug/Nm3 | | 0.041@ | | 0.026@ | | 0.015@ | | 0.027 |
| Inlet Gas, B.L., PAH | 7,12-Dimethylbenz(a)anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.025 | ND< | 0.004 | ND< | 0.047 | ND< | 0.047 |
| Inlet Gas, B.L., PAH | 3-Methylcholanthrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.149 | ND< | 0.007 | ND< | 0.146 | ND< | 0.149 |

| Stream | Substance | Method | UOM | | Run 2B | | Run 2C | | Run 3A | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., VOC | Benzene | GC/MS | ug/Nm3 | | 2.1@ | ND< | 0.9 | | 1.6@ | | 0.5 |
| Inlet Gas, B.L., VOC | Toluene | GC/MS | ug/Nm3 | | 15.5 | | 5.8 | | 5.8 | | 9.1 |

| Stream | Substance | Method | UOM | Run 4A | Run 4B | Run 4C | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Form | Formaldehyde | HPLC | ug/Nm3 | 17.4 | 18.6 | 22.8 | 19.6 |

| Stream | Substance | Method | UOM | | Run 6A | | Run 6B | | Run 6C | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Cyanide | Cyanide | Colorimetric | ug/Nm3 | ND< | 10.0 | ND< | 9.8 | | 11.0@ | ND< | 10.0 |

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# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 1/2 11/17 | | Run 3/4 11/18 | | Run 5/6 11/19 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal, B.L., Metals | Beryllium | ICP-AES | mg/Kg | | 0.21 | | 0.24 | | 0.23 | | 0.22 |
| Coal, B.L., Metals | Cadmium | ICP-AES | mg/Kg | | 0.09 | ND< | 0.05 | ND< | 0.05 | ND< | 0.05 |
| Coal, B.L., Metals | Chromium | ICP-AES | mg/Kg | | 0.8 | | 1.3 | | 1.1 | | 1.1 |
| Coal, B.L., Metals | Cobalt | ICP-AES | mg/Kg | | 0.8 | | 1.0 | | 1.0 | | 0.90 |
| Coal, B.L., Metals | Copper | ICP-AES | mg/Kg | | 2.7 | | 2.8 | | 2.7 | | 2.7 |
| Coal, B.L., Metals | Lead | GFAAS | mg/Kg | | 2.1 | | 2.5 | | 1.6 | | 2.1 |
| Coal, B.L., Metals | Manganese | ICP-AES | mg/Kg | | 3.4 | | 5.9 | | 3.4 | | 4.2 |
| Coal, B.L., Metals | Molybdenum | ICP-AES | mg/Kg | ND< | 0.1 | ND< | 0.1 | | 0.2@ | | 0.1 |
| Coal, B.L., Metals | Nickel | ICP-AES | mg/Kg | | 0.4@ | | 0.8@ | | 0.5@ | | 0.6 |
| Coal, B.L., Metals | Phosphorus | ICP-AES | mg/Kg | | 510 | | 350 | | 370 | | 410 |
| Coal, B.L., Metals | Vanadium | ICP-AES | mg/Kg | | 2.6 | | 3.5 | | 2.8 | | 3.0 |
| | | | | | | | | | | | |
| Coal, B.L., Metals | Arsenic | INAA | mg/Kg | | 0.55 | | 0.40 | | 0.49 | | 0.48 |
| Coal, B.L., Metals | Barium | INAA | mg/Kg | | 350 | | 525 | | 383 | | 419 |
| Coal, B.L., Metals | Mercury | INAA | mg/Kg | | 0.025 | | 0.026 | | 0.013 | | 0.021 |
| Coal, B.L., Metals | Selenium | INAA | mg/Kg | | 0.75 | | 0.77 | | 0.93 | | 0.82 |
| | | | | | | | | | | | |
| Coal, B.L., Anion Precursors | Chlorine | INAA | mg/Kg | | 19 | | 22 | | 26 | | 22 |
| Coal, B.L., Anion Precursors | Fluorine | ISE | mg/Kg | | 79 | | 89 | | 85 | | 84 |
| | | | | | | | | | | | |
| Coal, B.L., Ultimate | Moisture | ASTM D5142 | % | | 11.14 | | 11.11 | | 11.34 | | 11.20 |
| Coal, B.L., Ultimate | Carbon | CHN Analyzer | % | | 70.99 | | 71.90 | | 69.94 | | 70.94 |
| Coal, B.L., Ultimate | Hydrogen | CHN Analyzer | % | | 4.76 | | 5.12 | | 5.07 | | 4.98 |
| Coal, B.L., Ultimate | Oxygen | Difference | % | | | | 10.71 | | 13.37 | | 12.04 |
| Coal, B.L., Ultimate | Nitrogen | CHN Analyzer | % | | 1.81 | | 1.78 | | 1.78 | | 1.79 |
| Coal, B.L., Ultimate | Ash | ASTM D5142 | % | | 10.45 | | 10.00 | | 9.38 | | 9.94 |
| Coal, B.L., Ultimate | HHV | ASTM D1989 | Btu/lb | | 12,507 | | 12,548 | | 12,639 | | 12,565 |
| Coal, B.L., Ultimate | Sulfur | ASTM D4239 | % | | 0.53 | | 0.49 | | 0.46 | | 0.49 |

## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1/2 11/17 | Run 3/4 11/18 | Run 5/6 11/19 | Average Used |
|---|---|---|---|---|---|---|---|
| Coal, B.L., Radionuclides | Uranium-233 & -234 | Alpha spectrometry | pCi/g | 0.16 | 0.13 | 0.11 | 0.13 |
| Coal, B.L., Radionuclides | Uranium-235 | Alpha spectrometry | pCi/g | ND< 0.01 | ND< 0.01 | 0.02 | 0.01 |
| Coal, B.L., Radionuclides | Uranium-238 | Alpha spectrometry | pCi/g | 0.12 | 0.05 | 0.11 | 0.09 |
| Coal, B.L., Radionuclides | Radium-226 | Alpha spectrometry | pCi/g | 0.29 | 0.31 | 0.24 | 0.28 |
| Coal, B.L., Radionuclides | Radium-228 | Alpha spectrometry | pCi/g | 0.35 | 0.20 | 0.16 | 0.24 |
| Coal, B.L., Radionuclides | Lead-210 | Alpha spectrometry | pCi/g | 0.37 | ND< 0.69 | 0.77 | 0.50 |
| Coal, B.L., Radionuclides | Polonium-210 | Alpha spectrometry | pCi/g | 0.1 | ND< 0.1 | 0.2 | 0.12 |
| Coal, B.L., Radionuclides | Thorium-228 | Alpha spectrometry | pCi/g | 0.09 | 0.08 | 0.12 | 0.10 |
| Coal, B.L., Radionuclides | Thorium-230 | Alpha spectrometry | pCi/g | 0.12 | 0.17 | 0.30 | 0.20 |
| Coal, B.L., Radionuclides | Thorium-232 | Alpha spectrometry | pCi/g | 0.12 | 0.04 | 0.15 | 0.10 |

APPENDIX B
SITE 115 DATA USED IN CALCULATIONS
PHASE I: BASELINE TESTS
NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 1/2 11/17 | | Run 3/4 11/18 | | Run 5/6 11/19 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Ash, B.L.,Metals | Arsenic | GFAAS | mg/Kg | | 1.3@ | | 1.3@ | | 1.5@ | | 1.3 |
| Bottom Ash, B.L.,Metals | Barium | ICP-AES | mg/Kg | | 860 | | 741 | | 880 | | 827 |
| Bottom Ash, B.L.,Metals | Beryllium | ICP-AES | mg/Kg | | 1.0@ | | 0.8@ | | 1.0@ | | 0.9 |
| Bottom Ash, B.L.,Metals | Cadmium | ICP-AES | mg/Kg | ND< | 0.25 | ND< | 0.25 | ND< | 0.25 | ND< | 0.25 |
| Bottom Ash, B.L.,Metals | Chromium | ICP-AES | mg/Kg | | 2.7@ | | 2.4@ | | 2.5@ | | 2.5 |
| Bottom Ash, B.L.,Metals | Cobalt | ICP-AES | mg/Kg | | 2.2@ | | 1.8@ | | 2.3@ | | 2.1 |
| Bottom Ash, B.L.,Metals | Copper | ICP-AES | mg/Kg | | 10 | | 7.6 | | 8.2 | | 8.6 |
| Bottom Ash, B.L.,Metals | Lead | GFAAS | mg/Kg | | 11@ | | 8.7 | | 7.7 | | 9.1 |
| Bottom Ash, B.L.,Metals | Manganese | ICP-AES | mg/Kg | | 40 | | 33 | | 34 | | 36 |
| Bottom Ash, B.L.,Metals | Mercury | CVAAS | mg/Kg | ND< | 0.1 | | 0.29 | ND< | 0.1 | | 0.13 |
| Bottom Ash, B.L.,Metals | Molybdenum | ICP-AES | mg/Kg | | 0.7@ | | 0.4@ | ND< | 0.7 | ND< | 0.7 |
| Bottom Ash, B.L.,Metals | Nickel | ICP-AES | mg/Kg | | 2.2@ | ND< | 1.6 | ND< | 1.6 | ND< | 1.6 |
| Bottom Ash, B.L.,Metals | Phosphorus | ICP-AES | mg/Kg | | 1,908 | | 1,600 | | 1,806 | | 1,771 |
| Bottom Ash, B.L.,Metals | Selenium | GFAAS | mg/Kg | ND< | 2.5 | ND< | 2.5 | ND< | 2.5 | ND< | 2.5 |
| Bottom Ash, B.L.,Metals | Vanadium | ICP-AES | mg/Kg | | 12 | | 9.4 | | 11 | | 11 |
| Bottom Ash, B.L., Anions | Chloride | IC | mg/Kg | | 47@ | | 41@ | | 51@ | | 47 |
| Bottom Ash, B.L., Anions | Fluoride | ISE | mg/Kg | ND< | 28 | ND< | 25 | ND< | 31 | ND< | 31 |
| Bottom Ash, B.L., Radio. | Uranium-233 & -234 | Alpha spectrometry | pCi/g | | 2.1 | | 2.4 | | 2.1 | | 2.2 |
| Bottom Ash, B.L., Radio. | Uranium-235 | Alpha spectrometry | pCi/g | | 0.1 | | 0.1 | | 0.1 | | 0.1 |
| Bottom Ash, B.L., Radio. | Uranium-238 | Alpha spectrometry | pCi/g | | 2.0 | | 2.3 | | 2.3 | | 2.2 |
| Bottom Ash, B.L., Radio. | Radium-226 | Alpha spectrometry | pCi/g | | 2.2 | | 3.1 | | 2.9 | | 2.7 |
| Bottom Ash, B.L., Radio. | Radium-228 | Alpha spectrometry | pCi/g | | 1.8 | | 2.0 | | 2.1 | | 2.0 |
| Bottom Ash, B.L., Radio. | Lead-210 | Alpha spectrometry | pCi/g | | 0.7 | | 0.9 | | 0.6 | | 0.7 |
| Bottom Ash, B.L., Radio. | Polonium-210 | Alpha spectrometry | pCi/g | | 0.6 | | 0.2 | | 0.3 | | 0.4 |
| Bottom Ash, B.L., Radio. | Thorium-228 | Alpha spectrometry | pCi/g | | 3.2 | | 2.9 | | 3.2 | | 3.1 |
| Bottom Ash, B.L., Radio. | Thorium-230 | Alpha spectrometry | pCi/g | | 3.2 | | 2.8 | | 3.0 | | 3.0 |
| Bottom Ash, B.L., Radio. | Thorium-232 | Alpha spectrometry | pCi/g | | 3.4 | | 3.3 | | 3.0 | | 3.2 |
| Bottom Ash, B.L., L.O.I. | Loss on Ignition | ASTM C25 | % | | 0.74 | | 1.2 | | 0.78 | | 0.91 |

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APPENDIX B
SITE 115 DATA USED IN CALCULATIONS
PHASE I: BASELINE TESTS
NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1/2 11/17 | Run 3/4 11/18 | Run 5/6 11/19 | Average Used |
|---|---|---|---|---|---|---|---|
| Fly Ash, B.L., Metals | Arsenic | GFAAS | mg/Kg | 2.7 | 7.0 | 1.6 | 3.8 |
| Fly Ash, B.L., Metals | Barium | ICP-AES | mg/Kg | 1,800 | 1,600 | 1,500 | 1,633 |
| Fly Ash, B.L., Metals | Beryllium | ICP-AES | mg/Kg | 1.8@ | 1.6@ | 1.5@ | 1.6 |
| Fly Ash, B.L., Metals | Cadmium | ICP-AES | mg/Kg | ND< 0.25 | ND< 0.25 | 0.3 | ND< 0.25 |
| Fly Ash, B.L., Metals | Chromium | ICP-AES | mg/Kg | 8.5@ | 7.3@ | 7.0@ | 7.6 |
| Fly Ash, B.L., Metals | Cobalt | ICP-AES | mg/Kg | 5.6@ | 4.4@ | 4.5@ | 4.8 |
| Fly Ash, B.L., Metals | Copper | ICP-AES | mg/Kg | 25 | 27 | 18 | 23 |
| Fly Ash, B.L., Metals | Lead | GFAAS | mg/Kg | 28 | 24 | 20 | 24 |
| Fly Ash, B.L., Metals | Manganese | ICP-AES | mg/Kg | 66 | 70 | 69 | 68 |
| Fly Ash, B.L., Metals | Mercury | CVAAS | mg/Kg | 0.3@ | 0.2@ | ND< 0.1 | 0.15 |
| Fly Ash, B.L., Metals | Molybdenum | ICP-AES | mg/Kg | 3.8@ | 3.8@ | 3.4@ | 3.7 |
| Fly Ash, B.L., Metals | Nickel | ICP-AES | mg/Kg | 5.9@ | 3.0@ | 2.8@ | 3.9 |
| Fly Ash, B.L., Metals | Phosphorus | ICP-AES | mg/Kg | 3,900 | 3,300 | 2,900 | 3,367 |
| Fly Ash, B.L., Metals | Selenium | GFAAS | mg/Kg | 4.2@ | 3.9@ | 3.8@ | 4.0 |
| Fly Ash, B.L., Metals | Vanadium | ICP-AES | mg/Kg | 32 | 25 | 21 | 26 |
| | | | | | | | |
| Fly Ash, B.L., Anions | Chloride | IC | mg/Kg | 13@ | 8.2@ | 13@ | 11 |
| Fly Ash, B.L., Anions | Fluoride | ISE | mg/Kg | 20 | 18 | 34 | 24 |
| | | | | | | | |
| Fly Ash, B.L., Radio. | Uranium-233 & -234 | Alpha spectrometry | pCi/g | 2.6 | 2.3 | 2.0 | 2.3 |
| Fly Ash, B.L., Radio. | Uranium-235 | Alpha spectrometry | pCi/g | 0.2 | 0.1 | ND< 0.1 | 0.1 |
| Fly Ash, B.L., Radio. | Uranium-238 | Alpha spectrometry | pCi/g | 2.6 | 2.4 | 2.2 | 2.4 |
| Fly Ash, B.L., Radio. | Radium-226 | Alpha spectrometry | pCi/g | 3.2 | 2.7 | 2.5 | 2.8 |
| Fly Ash, B.L., Radio. | Radium-228 | Alpha spectrometry | pCi/g | 2.0 | 1.6 | 1.7 | 1.8 |
| Fly Ash, B.L., Radio. | Lead-210 | Alpha spectrometry | pCi/g | 0.8 | 1.1 | 1.3 | 1.1 |
| Fly Ash, B.L., Radio. | Polonium-210 | Alpha spectrometry | pCi/g | 1.4 | 1.2 | 1.8 | 1.5 |
| Fly Ash, B.L., Radio. | Thorium-228 | Alpha spectrometry | pCi/g | 2.8 | 2.5 | 2.2 | 2.5 |
| Fly Ash, B.L., Radio. | Thorium-230 | Alpha spectrometry | pCi/g | 3.2 | 2.2 | 2.1 | 2.5 |
| Fly Ash, B.L., Radio. | Thorium-232 | Alpha spectrometry | pCi/g | 2.7 | 2.7 | 2.4 | 2.6 |
| | | | | | | | |
| Flyash, B.L., L.O.I. | Loss on Ignition | ASTM C25 | % | 5.77 | 6.76 | 6.31 | 6.28 |

# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | Run 10 | Run 11 | Run 12 | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Metals | Arsenic | ICP-AES HYDRIDE | ug/Nm3 | 0.23@B | 0.20@B | 0.13@B | 0.19 |
| Outlet Gas, U.I., Metals | Barium | ICP-AES | ug/Nm3 | 2.82B | 0.03@B | 1.08B | 1.31 |
| Outlet Gas, U.I., Metals | Beryllium | ICP-AES | ug/Nm3 | ND< 0.03 | ND< 0.03 | ND< 0.03 | ND< 0.03 |
| Outlet Gas, U.I., Metals | Cadmium | ICP-AES | ug/Nm3 | ND< 0.08 | ND< 0.09 | ND< 0.08 | ND< 0.09 |
| Outlet Gas, U.I., Metals | Chromium | ICP-AES | ug/Nm3 | 0.42@B | 0.26@B | 0.43@B | 0.37 |
| Outlet Gas, U.I., Metals | Cobalt | ICP-AES | ug/Nm3 | ND< 0.28 | ND< 0.29 | ND< 0.27 | ND< 0.29 |
| Outlet Gas, U.I., Metals | Copper | ICP-AES | ug/Nm3 | 2.0B | 1.4B | 1.6B | 1.7 |
| Outlet Gas, U.I., Metals | Lead | GFAAS | ug/Nm3 | 0.48@B | 0.50@B | 0.51@B | 0.50 |
| Outlet Gas, U.I., Metals | Manganese | ICP-AES | ug/Nm3 | 0.28@B | 2.72 | 0.30@B | 1.1 |
| Outlet Gas, U.I., Metals | Mercury | CVAAS | ug/Nm3 | 0.79@ | 0.56@ | ND< 0.40 | 0.52 |
| Outlet Gas, U.I., Metals | Molybdenum | ICP-AES | ug/Nm3 | 0.56@B | 0.23@B | 0.22@B | 0.34 |
| Outlet Gas, U.I., Metals | Nickel | ICP-AES | ug/Nm3 | 0.6@B | 0.6@B | 0.5@B | 0.6 |
| Outlet Gas, U.I., Metals | Selenium | ICP-AES HYDRIDE | ug/Nm3 | ND< 0.08 | ND< 0.08 | ND< 0.08 | ND< 0.08 |
| Outlet Gas, U.I., Metals | Phosphorus | ICP-AES | ug/Nm3 | 5.92@ | 10.52@ | ND< 1.62 | 0.8 |
| Outlet Gas, U.I., Metals | Vanadium | ICP-AES | ug/Nm3 | 0.37@ | 0.29@ | 0.40@ | 0.35 |
| Outlet Gas, U.I., Particulate | Particulate, total | GRAV | mg/Nm3 | 2.9 | 0.9 | 0.6 | 1.5 |
| Outlet Gas, U.I., Anions | Chloride | IC/TITRATION | ug/Nm3 | 830 | 841 | 994 | 888 |
| Outlet Gas, U.I., Anions | Fluoride | IC | ug/Nm3 | 6,053 | 5,586 | 6,181 | 5,940 |

| Stream | Substance | Method | UOM | Run 13A | Run 13B | Run13C | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Cyanide | Cyanide | Colorimetric | ug/Nm3 | ND< 11 | ND< 10 | ND< 9 | ND< 11 |

| Stream | Substance | Method | UOM | Run 10 | Run 12A | Run 12B | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 5,389 | 11,462 | 13,283 | – |

| Stream | Substance | Method | UOM | Run 12C | Run 12D | Run 12E | Run 12F | Average Used |
|---|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 9,412 | 9,944 | 12,524 | 8,501 | 10,854 |

PRELIMINARY

## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | Run 10 | Run 11 | Run 12 | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Metals | Arsenic | ICP-AES | ug/Nm3 | 22.6@ | 18.1@ | 7.7@ | 16.2 |
| Inlet Gas, U.I., Metals | Barium | ICP-AES | ug/Nm3 | 268 | 167 | 286 | 241 |
| Inlet Gas, U.I., Metals | Beryllium | ICP-AES | ug/Nm3 | 9.4 | 8.0 | 10.7 | 9.4 |
| Inlet Gas, U.I., Metals | Cadmium | ICP-AES | ug/Nm3 | 2.6 | 2.0 | 3.0 | 2.5 |
| Inlet Gas, U.I., Metals | Chromium | ICP-AES | ug/Nm3 | 57.3 | 55.1 | 78.7 | 63.7 |
| Inlet Gas, U.I., Metals | Cobalt | ICP-AES | ug/Nm3 | 35.2 | 25.9 | 37.9 | 33.0 |
| Inlet Gas, U.I., Metals | Copper | ICP-AES | ug/Nm3 | 228 | 203 | 341 | 258 |
| Inlet Gas, U.I., Metals | Lead | GFAAS | ug/Nm3 | 18.8 | 65.0 | 87.2 | 57.0 |
| Inlet Gas, U.I., Metals | Manganese | ICP-AES | ug/Nm3 | 101 | 87.1 | 144 | 111 |
| Inlet Gas, U.I., Metals | Mercury | CVAAS | ug/Nm3 | 4.3 | 1.7 | 1.1 | 2.4 |
| Inlet Gas, U.I., Metals | Molybdenum | ICP-AES | ug/Nm3 | 15.9 | 15.6 | 12.8 | 14.8 |
| Inlet Gas, U.I., Metals | Nickel | ICP-AES | ug/Nm3 | 33.7 | 29.1 | 47.6 | 36.8 |
| Inlet Gas, U.I., Metals | Selenium | ICP-AES | ug/Nm3 | 22.8 | 17.1 | ND< 10.0 | 15.0 |
| Inlet Gas, U.I., Metals | Phosphorus | ICP-AES | ug/Nm3 | 11,962 | 9,571 | 13,453 | 11,662 |
| Inlet Gas, U.I., Metals | Vanadium | ICP-AES | ug/Nm3 | 152 | 124 | 176 | 151 |
| Inlet Gas, U.I., Particulate | Particulate, total | GRAV | mg/Nm3 | 7,190 | 7,640 | 8,075 | 7,635 |
| Inlet Gas, U.I., Anions | Chloride | IC/TITRATION | ug/Nm3 | 1,239 | 1,322 | 1,252 | 1,271 |
| Inlet Gas, U.I., Anions | Fluoride | IC | ug/Nm3 | 6,989 | 7,677 | 7,102 | 7,256 |

| Stream | Substance | Method | UOM | Run 13A | Run 13B | Run13C | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Cyanide | Cyanide | Colorimetric | ug/Nm3 | ND< 16 | ND< 12 | ND< 16 | ND< 16 |

| Stream | Substance | Method | UOM | Run 10A | Run 10B | Average Used |
|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 15,352 | 10,930 | 13,141 |

| Stream | Substance | Method | UOM | Run 12A | Run 12B | Average Used |
|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 15,864 | 15,864 | – |

| Stream | Substance | Method | UOM | Run 13A | Run 13B | Average Used |
|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 17,762 | 17,155 | 16,661 |



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## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | Run 10 3/10 AM | Run 11 3/10 PM | Run 12 3/11 | Average Used |
|---|---|---|---|---|---|---|---|
| Coal, U.I., Metals | Beryllium | ICP-AES | mg/Kg | 0.30 | 0.58 | 0.77 | 0.55 |
| Coal, U.I., Metals | Cadmium | ICP-AES | mg/Kg | ND< 0.05 | ND< 0.06 | 0.06 | ND< 0.06 |
| Coal, U.I., Metals | Chromium | ICP-AES | mg/Kg | 1.2 | 2.1 | 1.0 | 1.4 |
| Coal, U.I., Metals | Cobalt | ICP-AES | mg/Kg | 1.1 | 1.4 | 1.4 | 1.3 |
| Coal, U.I., Metals | Copper | ICP-AES | mg/Kg | 3.8 | 4.0 | 3.3 | 3.7 |
| Coal, U.I., Metals | Lead | GFAAS | mg/Kg | 1.7@ | 2.3 | 2.7 | 2.2 |
| Coal, U.I., Metals | Manganese | ICP-AES | mg/Kg | 4.2 | 6.7 | 4.8 | 5.2 |
| Coal, U.I., Metals | Molybdenum | ICP-AES | mg/Kg | 0.4@ | 0.4@ | 0.7@ | 0.5 |
| Coal, U.I., Metals | Nickel | ICP-AES | mg/Kg | 1.0@ | 1.0@ | 1.0@ | 1.0 |
| Coal, U.I., Metals | Phosphorus | ICP-AES | mg/Kg | 320 | 310 | 320 | 317 |
| Coal, U.I., Metals | Vanadium | ICP-AES | mg/Kg | 3.5 | 5.3 | 4.2 | 4.3 |
| | | | | | | | |
| Coal, U.I., Metals | Arsenic | INAA | mg/Kg | 0.75 | 0.47 | 0.70 | 0.64 |
| Coal, U.I., Metals | Barium | INAA | mg/Kg | 350 | 335 | 333 | 339 |
| Coal, U.I., Metals | Mercury | INAA | mg/Kg | 0.011 | – | 0.027 | 0.017 |
| Coal, U.I., Metals | Selenium | INAA | mg/Kg | 1.1 | 0.91 | 2.4 | 1.5 |
| | | | | | | | |
| Coal, U.I., Anion Precursors | Chlorine | INAA | mg/Kg | 16 | 17 | 16 | 16 |

| Stream | Substance | Method | UOM | Run 10/11 3/10 AM/PM | Run 12 3/11 | Average Used |
|---|---|---|---|---|---|---|
| Coal, U.I., Ultimate | Moisture | ASTM D-5142 | % | 9.64 | 9.55 | 9.60 |
| Coal, U.I., Ultimate | Carbon | LECO CHN/600 | % | 72.41 | 71.64 | 72.03 |
| Coal, U.I., Ultimate | Hydrogen | LECO CHN/600 | % | 5.11 | 5.01 | 5.06 |
| Coal, U.I., Ultimate | Oxygen | Difference | % | 10.99 | 11.23 | 11.11 |
| Coal, U.I., Ultimate | Nitrogen | LECO CHN/600 | % | 1.87 | 1.80 | 1.84 |
| Coal, U.I., Ultimate | Ash | ASTM D-5142 | % | 9.13 | 9.84 | 9.49 |
| Coal, U.I., Ultimate | HHV | ASTM D-1989 | Btu/lb | 12,692 | 12,584 | 12,638 |
| Coal, U.I., Ultimate | Sulfur | ASTM D-4239 | % | 0.49 | 0.48 | 0.49 |

# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | | Run 10 3/10 AM | | Run 11 3/10 PM | | Run 12 3/11 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Ash, U.I., Metals | Arsenic | GFAAS | mg/Kg | | 8.8@ | | 3.8@ | | 9.7@ | | 7.5 |
| Bottom Ash, U.I., Metals | Barium | ICP-AES | mg/Kg | | 879 | | 999 | | 1,499 | | 1,126 |
| Bottom Ash, U.I., Metals | Beryllium | ICP-AES | mg/Kg | | 1.4@ | | 1.6@ | | 1.8@ | | 1.6 |
| Bottom Ash, U.I., Metals | Cadmium | ICP-AES | mg/Kg | ND< | 0.5 | ND< | 0.5 | ND< | 0.5 | ND< | 0.5 |
| Bottom Ash, U.I., Metals | Chromium | ICP-AES | mg/Kg | | 9@ | | 10 | | 10 | | 9.6 |
| Bottom Ash, U.I., Metals | Cobalt | ICP-AES | mg/Kg | | 5@ | | 6@ | | 7@ | | 6 |
| Bottom Ash, U.I., Metals | Copper | ICP-AES | mg/Kg | | 14 | | 15 | | 19 | | 16 |
| Bottom Ash, U.I., Metals | Lead | GFAAS | mg/Kg | | 17 | | 2.7@ | | 12@ | | 11 |
| Bottom Ash, U.I., Metals | Manganese | ICP-AES | mg/Kg | | 38 | | 55 | | 64 | | 52 |
| Bottom Ash, U.I., Metals | Mercury | CVAAS | mg/Kg | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 |
| Bottom Ash, U.I., Metals | Molybdenum | ICP-AES | mg/Kg | ND< | 1.0 | ND< | 1.0 | ND< | 1.0 | ND< | 1.0 |
| Bottom Ash, U.I., Metals | Nickel | ICP-AES | mg/Kg | | 5@ | | 6@ | | 7@ | | 6 |
| Bottom Ash, U.I., Metals | Phosphorus | ICP-AES | mg/Kg | | 1,699 | | 1,899 | | 2,499 | | 2,032 |
| Bottom Ash, U.I., Metals | Selenium | GFAAS | mg/Kg | ND< | 10 | ND< | 43 | ND< | 12 | ND< | 22 |
| Bottom Ash, U.I., Metals | Vanadium | ICP-AES | mg/Kg | | 21 | | 24 | | 27 | | 24 |
| Bottom Ash, U.I., Anions | Chloride | IC | mg/Kg | | 90@ | | 18@ | | 70@ | | 59 |
| Bottom Ash, U.I., Anions | Fluoride | ISE | mg/Kg | ND< | 3 | ND< | 3 | ND< | 3 | ND< | 3 |
| Bottom Ash, U.I., L.O.I. | Loss on Ignition | ASTM C25 | % | | 1.85 | | 1.66 | | | | 1.76 |

PRELIMINARY

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## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | | Run 10 3/10 AM | | Run 11 3/10 PM | | Run 12 3/11 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fly Ash, U.I., Metals | Arsenic | GFAAS | mg/Kg | | 11@ | | 11@ | | 3.7@ | | 9 |
| Fly Ash, U.I., Metals | Barium | ICP-AES | mg/Kg | | 1200 | | 880 | | 690 | | 923 |
| Fly Ash, U.I., Metals | Beryllium | ICP-AES | mg/Kg | | 2.4 | | 2.8 | | 2.4 | | 2.5 |
| Fly Ash, U.I., Metals | Cadmium | ICP-AES | mg/Kg | ND< | 1 | ND< | 1 | ND< | 1 | ND< | 1 |
| Fly Ash, U.I., Metals | Chromium | ICP-AES | mg/Kg | | 15 | | 16 | | 12 | | 14 |
| Fly Ash, U.I., Metals | Cobalt | ICP-AES | mg/Kg | | 13 | | 12 | | 12 | | 12 |
| Fly Ash, U.I., Metals | Copper | ICP-AES | mg/Kg | | 40 | | 38 | | 36 | | 38 |
| Fly Ash, U.I., Metals | Lead | GFAAS | mg/Kg | | 31 | | 34 | | 24 | | 25 |
| Fly Ash, U.I., Metals | Manganese | ICP-AES | mg/Kg | | 61 | | 68 | | 62 | | 64 |
| Fly Ash, U.I., Metals | Mercury | CVAAS | mg/Kg | | 0.3@ | | 0.2@ | | 0.1@ | | 0.2 |
| Fly Ash, U.I., Metals | Molybdenum | ICP-AES | mg/Kg | | 3@ | | 3@ | | 5 | | 4 |
| Fly Ash, U.I., Metals | Nickel | ICP-AES | mg/Kg | | 15 | | 10@ | | 13@ | | 13 |
| Fly Ash, U.I., Metals | Phosphorus | ICP-AES | mg/Kg | | 4,200 | | 4,400 | | 4,000 | | 4,200 |
| Fly Ash, U.I., Metals | Selenium | GFAAS | mg/Kg | ND< | 8.8 | ND< | 1.3 | | 4.3@ | ND< | 8.8 |
| Fly Ash, U.I., Metals | Vanadium | ICP-AES | mg/Kg | | 66 | | 54 | | 54 | | 58 |
| Fly Ash, U.I., Anions | Chloride | IC | mg/Kg | ND< | 50 | ND< | 50 | ND< | 50 | ND< | 50 |
| Fly Ash, U.I., Anions | Fluoride | ISE | mg/Kg | | 23 | | 40 | | 34 | | 32 |
| Fly Ash, U.I., L.O.I. | Loss on Ignition | ASTM C25 | % | | 9.47 | | 9.57 | | | | 9.52 |

## APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1 | Run 3 | Run 5 | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Total Metals | Arsenic | GFAAS | ug/Nm3 | 33.5 | 19.4 | 37.0 | 30.0 |
| Inlet Gas, B.L., Total Metals | Barium | ICP-AES | ug/Nm3 | 237.5 | 88.4 | 588.2 | 304.7 |
| Inlet Gas, B.L., Total Metals | Beryllium | ICP-AES | ug/Nm3 | 6.7 | 14.4 | 14.1 | 11.7 |
| Inlet Gas, B.L., Total Metals | Cadmium | ICP-AES | ug/Nm3 | 2.46 | 2.72 | 3.70 | 2.96 |
| Inlet Gas, B.L., Total Metals | Chromium | ICP-AES | ug/Nm3 | 36.7 | 84.8 | 73.6 | 65.0 |
| Inlet Gas, B.L., Total Metals | Cobalt | ICP-AES | ug/Nm3 | 21.6 | 50.4 | 44.4 | 38.8 |
| Inlet Gas, B.L., Total Metals | Copper | ICP-AES | ug/Nm3 | 248.8 | 197.2 | 214.2 | 220.0 |
| Inlet Gas, B.L., Total Metals | Lead | GFAAS | ug/Nm3 | 147.3 | 36.3 | 65.0 | 82.9 |
| Inlet Gas, B.L., Total Metals | Manganese | ICP-AES | ug/Nm3 | 148.6 | 310.0 | 299.7 | 252.8 |
| Inlet Gas, B.L., Total Metals | Mercury | CVAAS | ug/Nm3 | 2.42 | 1.49 | 1.26 | 1.72 |
| Inlet Gas, B.L., Total Metals | Molybdenum | ICP-AES | ug/Nm3 | 7.8 | 15.5 | 18.5 | 14.0 |
| Inlet Gas, B.L., Total Metals | Nickel | ICP-AES | ug/Nm3 | 19.4 | 50.4 | 48.1 | 39.3 |
| Inlet Gas, B.L., Total Metals | Selenium | ICP-AES HYDRIDE | ug/Nm3 | 23.5 | 34.1 | 29.6 | 29.1 |
| Inlet Gas, B.L., Total Metals | Phosphorus | ICP-AES | ug/Nm3 | 17,867 | 19,009 | 18,889 | 18,588 |
| Inlet Gas, B.L., Total Metals | Vanadium | ICP-AES | ug/Nm3 | 100.3 | 213.1 | 214.6 | 176.0 |
| Inlet Gas, B.L., PM | Particulate, total | GRAV | mg/Nm3 | 7,705.8 | 7,835.9 | 5,306.7 | 6,949.5 |
| Inlet Gas, B.L., Anions | Chloride | IC/TITRATION | ug/Nm3 | 1,017 | 1,091 | 988 | 1,032 |
| Inlet Gas, B.L., Anions | Fluoride | IC | ug/Nm3 | 7,223 | 5,679 | 5,711 | 6,204 |

# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | | Run 2 | | Run 4 | | Run 6 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., PAH | Naphthalene | HRGC/LRMS-SIM | ug/Nm3 | | 0.306@ | | 0.235@ | | 0.402@ | | 0.314 |
| Inlet Gas, B.L., PAH | Acenaphthylene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.012 | ND< | 0.011 | ND< | 0.033 | ND< | 0.033 |
| Inlet Gas, B.L., PAH | Acenaphthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.014 | ND< | 0.012 | ND< | 0.012 | ND< | 0.014 |
| Inlet Gas, B.L., PAH | Fluorene | HRGC/LRMS-SIM | ug/Nm3 | | 0.015@ | | 0.013@ | | 0.015@ | | 0.014 |
| Inlet Gas, B.L., PAH | Phenanthrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.142 | ND< | 0.140 | ND< | 0.183 | ND< | 0.183 |
| Inlet Gas, B.L., PAH | Anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.019 | ND< | 0.010 | ND< | 0.019 | ND< | 0.019 |
| Inlet Gas, B.L., PAH | Fluoranthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.030 | ND< | 0.033 | ND< | 0.030 | ND< | 0.033 |
| Inlet Gas, B.L., PAH | Pyrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.031 | ND< | 0.034 | ND< | 0.030 | ND< | 0.034 |
| Inlet Gas, B.L., PAH | Benz(a)anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.019 | ND< | 0.021 | ND< | 0.040 | ND< | 0.040 |
| Inlet Gas, B.L., PAH | Chrysene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.019 | ND< | 0.020 | ND< | 0.037 | ND< | 0.037 |
| Inlet Gas, B.L., PAH | Benzo(b)fluoranthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.011 | ND< | 0.024 | ND< | 0.030 | ND< | 0.030 |
| Inlet Gas, B.L., PAH | Benzo(k)fluoranthene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.021 | ND< | 0.096 | ND< | 0.069 | ND< | 0.096 |
| Inlet Gas, B.L., PAH | Benzo(a)pyrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.056 | ND< | 0.077 | ND< | 0.011 | ND< | 0.077 |
| Inlet Gas, B.L., PAH | Indeno(1,2,3-cd)pyrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.030 | ND< | 0.029 | ND< | 0.029 | ND< | 0.030 |
| Inlet Gas, B.L., PAH | Dibenzo(a,h)anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.037 | ND< | 0.037 | ND< | 0.037 | ND< | 0.037 |
| Inlet Gas, B.L., PAH | Benzo(g,h,i)perylene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.037 | ND< | 0.029 | ND< | 0.029 | ND< | 0.037 |
| Inlet Gas, B.L., PAH | 2-Methylnaphthalene | HRGC/LRMS-SIM | ug/Nm3 | | 0.041@ | | 0.026@ | | 0.015@ | | 0.027 |
| Inlet Gas, B.L., PAH | 7,12-Dimethylbenz(a)anthracene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.025 | ND< | 0.004 | ND< | 0.047 | ND< | 0.047 |
| Inlet Gas, B.L., PAH | 3-Methylcholanthrene | HRGC/LRMS-SIM | ug/Nm3 | ND< | 0.149 | ND< | 0.007 | ND< | 0.146 | ND< | 0.149 |

| Stream | Substance | Method | UOM | | Run 2B | | Run 2C | | Run 3A | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., VOC | Benzene | GC/MS | ug/Nm3 | | 2.1@ | ND< | 0.9 | | 1.6@ | | 0.5 |
| Inlet Gas, B.L., VOC | Toluene | GC/MS | ug/Nm3 | | 15.5 | | 5.8 | | 5.8 | | 9.1 |

| Stream | Substance | Method | UOM | | Run 4A | | Run 4B | | Run 4C | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Form | Formaldehyde | HPLC | ug/Nm3 | | 17.4 | | 18.6 | | 22.8 | | 19.6 |

| Stream | Substance | Method | UOM | | Run 6A | | Run 6B | | Run 6C | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Cyanide | Cyanide | Colorimetric | ug/Nm3 | ND< | 10.0 | ND< | 9.8 | | 11.0@ | ND< | 10.0 |

**APPENDIX B**
**SITE 115 DATA USED IN CALCULATIONS**
**PHASE I: BASELINE TESTS**
**NOVEMBER 1992**

| Stream | Substance | Method | UOM | | Run 1/2 11/17 | | Run 3/4 11/18 | | Run 5/6 11/19 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal, B.L., Metals | Beryllium | ICP-AES | mg/Kg | | 0.21 | | 0.24 | | 0.23 | | 0.22 |
| Coal, B.L., Metals | Cadmium | ICP-AES | mg/Kg | | 0.09 | ND< | 0.05 | ND< | 0.05 | ND< | 0.05 |
| Coal, B.L., Metals | Chromium | ICP-AES | mg/Kg | | 0.8 | | 1.3 | | 1.1 | | 1.1 |
| Coal, B.L., Metals | Cobalt | ICP-AES | mg/Kg | | 0.8 | | 1.0 | | 1.0 | | 0.90 |
| Coal, B.L., Metals | Copper | ICP-AES | mg/Kg | | 2.7 | | 2.8 | | 2.7 | | 2.7 |
| Coal, B.L., Metals | Lead | GFAAS | mg/Kg | | 2.1 | | 2.5 | | 1.6 | | 2.1 |
| Coal, B.L., Metals | Manganese | ICP-AES | mg/Kg | | 3.4 | | 5.9 | | 3.4 | | 4.2 |
| Coal, B.L., Metals | Molybdenum | ICP-AES | mg/Kg | ND< | 0.1 | ND< | 0.1 | | 0.2@ | | 0.1 |
| Coal, B.L., Metals | Nickel | ICP-AES | mg/Kg | | 0.4@ | | 0.8@ | | 0.5@ | | 0.6 |
| Coal, B.L., Metals | Phosphorus | ICP-AES | mg/Kg | | 510 | | 350 | | 370 | | 410 |
| Coal, B.L., Metals | Vanadium | ICP-AES | mg/Kg | | 2.6 | | 3.5 | | 2.8 | | 3.0 |
| Coal, B.L., Metals | Arsenic | INAA | mg/Kg | | 0.55 | | 0.40 | | 0.49 | | 0.48 |
| Coal, B.L., Metals | Barium | INAA | mg/Kg | | 350 | | 525 | | 383 | | 419 |
| Coal, B.L., Metals | Mercury | INAA | mg/Kg | | 0.025 | | 0.026 | | 0.013 | | 0.021 |
| Coal, B.L., Metals | Selenium | INAA | mg/Kg | | 0.75 | | 0.77 | | 0.93 | | 0.82 |
| Coal, B.L., Anion Precursors | Chlorine | INAA | mg/Kg | | 19 | | 22 | | 26 | | 22 |
| Coal, B.L., Anion Precursors | Fluorine | ISE | mg/Kg | | 79 | | 89 | | 85 | | 84 |
| Coal, B.L., Ultimate | Moisture | ASTM D5142 | % | | 11.14 | | 11.11 | | 11.34 | | 11.20 |
| Coal, B.L., Ultimate | Carbon | CHN Analyzer | % | | 70.99 | | 71.90 | | 69.94 | | 70.94 |
| Coal, B.L., Ultimate | Hydrogen | CHN Analyzer | % | | 4.76 | | 5.12 | | 5.07 | | 4.98 |
| Coal, B.L., Ultimate | Oxygen | Difference | % | | | | 10.71 | | 13.37 | | 12.04 |
| Coal, B.L., Ultimate | Nitrogen | CHN Analyzer | % | | 1.81 | | 1.78 | | 1.78 | | 1.79 |
| Coal, B.L., Ultimate | Ash | ASTM D5142 | % | | 10.45 | | 10.00 | | 9.38 | | 9.94 |
| Coal, B.L., Ultimate | HHV | ASTM D1989 | Btu/lb | | 12,507 | | 12,548 | | 12,639 | | 12,565 |
| Coal, B.L., Ultimate | Sulfur | ASTM D4239 | % | | 0.53 | | 0.49 | | 0.46 | | 0.49 |

# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1/2 11/17 | Run 3/4 11/18 | Run 5/6 11/19 | Average Used |
|---|---|---|---|---|---|---|---|
| Coal, B.L., Radionuclides | Uranium-233 & -234 | Alpha spectrometry | pCi/g | 0.16 | 0.13 | 0.11 | 0.13 |
| Coal, B.L., Radionuclides | Uranium-235 | Alpha spectrometry | pCi/g | ND< 0.01 | ND< 0.01 | 0.02 | 0.01 |
| Coal, B.L., Radionuclides | Uranium-238 | Alpha spectrometry | pCi/g | 0.12 | 0.05 | 0.11 | 0.09 |
| Coal, B.L., Radionuclides | Radium-226 | Alpha spectrometry | pCi/g | 0.29 | 0.31 | 0.24 | 0.28 |
| Coal, B.L., Radionuclides | Radium-228 | Alpha spectrometry | pCi/g | 0.35 | 0.20 | 0.16 | 0.24 |
| Coal, B.L., Radionuclides | Lead-210 | Alpha spectrometry | pCi/g | 0.37 | ND< 0.69 | 0.77 | 0.50 |
| Coal, B.L., Radionuclides | Polonium-210 | Alpha spectrometry | pCi/g | 0.1 | ND< 0.1 | 0.2 | 0.12 |
| Coal, B.L., Radionuclides | Thorium-228 | Alpha spectrometry | pCi/g | 0.09 | 0.08 | 0.12 | 0.10 |
| Coal, B.L., Radionuclides | Thorium-230 | Alpha spectrometry | pCi/g | 0.12 | 0.17 | 0.30 | 0.20 |
| Coal, B.L., Radionuclides | Thorium-232 | Alpha spectrometry | pCi/g | 0.12 | 0.04 | 0.15 | 0.10 |

## APPENDIX B
## *SITE 115 DATA USED IN CALCULATIONS*
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1/2 11/17 | Run 3/4 11/18 | Run 5/6 11/19 | Average Used |
|---|---|---|---|---|---|---|---|
| Bottom Ash, B.L.,Metals | Arsenic | GFAAS | mg/Kg | 1.3@ | 1.3@ | 1.5@ | 1.3 |
| Bottom Ash, B.L.,Metals | Barium | ICP-AES | mg/Kg | 860 | 741 | 880 | 827 |
| Bottom Ash, B.L.,Metals | Beryllium | ICP-AES | mg/Kg | 1.0@ | 0.8@ | 1.0@ | 0.9 |
| Bottom Ash, B.L.,Metals | Cadmium | ICP-AES | mg/Kg | ND< 0.25 | ND< 0.25 | ND< 0.25 | ND< 0.25 |
| Bottom Ash, B.L.,Metals | Chromium | ICP-AES | mg/Kg | 2.7@ | 2.4@ | 2.5@ | 2.5 |
| Bottom Ash, B.L.,Metals | Cobalt | ICP-AES | mg/Kg | 2.2@ | 1.8@ | 2.3@ | 2.1 |
| Bottom Ash, B.L.,Metals | Copper | ICP-AES | mg/Kg | 10 | 7.6 | 8.2 | 8.6 |
| Bottom Ash, B.L.,Metals | Lead | GFAAS | mg/Kg | 11@ | 8.7 | 7.7 | 9.1 |
| Bottom Ash, B.L.,Metals | Manganese | ICP-AES | mg/Kg | 40 | 33 | 34 | 36 |
| Bottom Ash, B.L.,Metals | Mercury | CVAAS | mg/Kg | ND< 0.1 | 0.29 | ND< 0.1 | 0.13 |
| Bottom Ash, B.L.,Metals | Molybdenum | ICP-AES | mg/Kg | 0.7@ | 0.4@ | ND< 0.7 | ND< 0.7 |
| Bottom Ash, B.L.,Metals | Nickel | ICP-AES | mg/Kg | 2.2@ | ND< 1.6 | ND< 1.6 | ND< 1.6 |
| Bottom Ash, B.L.,Metals | Phosphorus | ICP-AES | mg/Kg | 1,908 | 1,600 | 1,806 | 1,771 |
| Bottom Ash, B.L.,Metals | Selenium | GFAAS | mg/Kg | ND< 2.5 | ND< 2.5 | ND< 2.5 | ND< 2.5 |
| Bottom Ash, B.L.,Metals | Vanadium | ICP-AES | mg/Kg | 12 | 9.4 | 11 | 11 |
| Bottom Ash, B.L., Anions | Chloride | IC | mg/Kg | 47@ | 41@ | 51@ | 47 |
| Bottom Ash, B.L., Anions | Fluoride | ISE | mg/Kg | ND< 28 | ND< 25 | ND< 31 | ND< 31 |
| Bottom Ash, B.L., Radio. | Uranium-233 & -234 | Alpha spectrometry | pCi/g | 2.1 | 2.4 | 2.1 | 2.2 |
| Bottom Ash, B.L., Radio. | Uranium-235 | Alpha spectrometry | pCi/g | 0.1 | 0.1 | 0.1 | 0.1 |
| Bottom Ash, B.L., Radio. | Uranium-238 | Alpha spectrometry | pCi/g | 2.0 | 2.3 | 2.3 | 2.2 |
| Bottom Ash, B.L., Radio. | Radium-226 | Alpha spectrometry | pCi/g | 2.2 | 3.1 | 2.9 | 2.7 |
| Bottom Ash, B.L., Radio. | Radium-228 | Alpha spectrometry | pCi/g | 1.8 | 2.0 | 2.1 | 2.0 |
| Bottom Ash, B.L., Radio. | Lead-210 | Alpha spectrometry | pCi/g | 0.7 | 0.9 | 0.6 | 0.7 |
| Bottom Ash, B.L., Radio. | Polonium-210 | Alpha spectrometry | pCi/g | 0.6 | 0.2 | 0.3 | 0.4 |
| Bottom Ash, B.L., Radio. | Thorium-228 | Alpha spectrometry | pCi/g | 3.2 | 2.9 | 3.2 | 3.1 |
| Bottom Ash, B.L., Radio. | Thorium-230 | Alpha spectrometry | pCi/g | 3.2 | 2.8 | 3.0 | 3.0 |
| Bottom Ash, B.L., Radio. | Thorium-232 | Alpha spectrometry | pCi/g | 3.4 | 3.3 | 3.0 | 3.2 |
| Bottom Ash, B.L., L.O.I. | Loss on Ignition | ASTM C25 | % | 0.74 | 1.2 | 0.78 | 0.91 |

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**APPENDIX B**
**SITE 115 DATA USED IN CALCULATIONS**
**PHASE I: BASELINE TESTS**
**NOVEMBER 1992**

| Stream | Substance | Method | UOM | | Run 1/2 11/17 | | Run 3/4 11/18 | | Run 5/6 11/19 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fly Ash, B.L., Metals | Arsenic | GFAAS | mg/Kg | | 2.7 | | 7.0 | | 1.6 | | 3.8 |
| Fly Ash, B.L., Metals | Barium | ICP-AES | mg/Kg | | 1,800 | | 1,600 | | 1,500 | | 1,633 |
| Fly Ash, B.L., Metals | Beryllium | ICP-AES | mg/Kg | | 1.8@ | | 1.6@ | | 1.5@ | | 1.6 |
| Fly Ash, B.L., Metals | Cadmium | ICP-AES | mg/Kg | ND< | 0.25 | ND< | 0.25 | | 0.3 | ND< | 0.25 |
| Fly Ash, B.L., Metals | Chromium | ICP-AES | mg/Kg | | 8.5@ | | 7.3@ | | 7.0@ | | 7.6 |
| Fly Ash, B.L., Metals | Cobalt | ICP-AES | mg/Kg | | 5.6@ | | 4.4@ | | 4.5@ | | 4.8 |
| Fly Ash, B.L., Metals | Copper | ICP-AES | mg/Kg | | 25 | | 27 | | 18 | | 23 |
| Fly Ash, B.L., Metals | Lead | GFAAS | mg/Kg | | 28 | | 24 | | 20 | | 24 |
| Fly Ash, B.L., Metals | Manganese | ICP-AES | mg/Kg | | 66 | | 70 | | 69 | | 68 |
| Fly Ash, B.L., Metals | Mercury | CVAAS | mg/Kg | | 0.3@ | | 0.2@ | ND< | 0.1 | | 0.15 |
| Fly Ash, B.L., Metals | Molybdenum | ICP-AES | mg/Kg | | 3.8@ | | 3.8@ | | 3.4@ | | 3.7 |
| Fly Ash, B.L., Metals | Nickel | ICP-AES | mg/Kg | | 5.9@ | | 3.0@ | | 2.8@ | | 3.9 |
| Fly Ash, B.L., Metals | Phosphorus | ICP-AES | mg/Kg | | 3,900 | | 3,300 | | 2,900 | | 3,367 |
| Fly Ash, B.L., Metals | Selenium | GFAAS | mg/Kg | | 4.2@ | | 3.9@ | | 3.8@ | | 4.0 |
| Fly Ash, B.L., Metals | Vanadium | ICP-AES | mg/Kg | | 32 | | 25 | | 21 | | 26 |
| | | | | | | | | | | | |
| Fly Ash, B.L., Anions | Chloride | IC | mg/Kg | | 13@ | | 8.2@ | | 13@ | | 11 |
| Fly Ash, B.L., Anions | Fluoride | ISE | mg/Kg | | 20 | | 18 | | 34 | | 24 |
| | | | | | | | | | | | |
| Fly Ash, B.L., Radio. | Uranium-233 & -234 | Alpha spectrometry | pCi/g | | 2.6 | | 2.3 | | 2.0 | | 2.3 |
| Fly Ash, B.L., Radio. | Uranium-235 | Alpha spectrometry | pCi/g | | 0.2 | | 0.1 | ND< | 0.1 | | 0.1 |
| Fly Ash, B.L., Radio. | Uranium-238 | Alpha spectrometry | pCi/g | | 2.6 | | 2.4 | | 2.2 | | 2.4 |
| Fly Ash, B.L., Radio. | Radium-226 | Alpha spectrometry | pCi/g | | 3.2 | | 2.7 | | 2.5 | | 2.8 |
| Fly Ash, B.L., Radio. | Radium-228 | Alpha spectrometry | pCi/g | | 2.0 | | 1.6 | | 1.7 | | 1.8 |
| Fly Ash, B.L., Radio. | Lead-210 | Alpha spectrometry | pCi/g | | 0.8 | | 1.1 | | 1.3 | | 1.1 |
| Fly Ash, B.L., Radio. | Polonium-210 | Alpha spectrometry | pCi/g | | 1.4 | | 1.2 | | 1.8 | | 1.5 |
| Fly Ash, B.L., Radio. | Thorium-228 | Alpha spectrometry | pCi/g | | 2.8 | | 2.5 | | 2.2 | | 2.5 |
| Fly Ash, B.L., Radio. | Thorium-230 | Alpha spectrometry | pCi/g | | 3.2 | | 2.2 | | 2.1 | | 2.5 |
| Fly Ash, B.L., Radio. | Thorium-232 | Alpha spectrometry | pCi/g | | 2.7 | | 2.7 | | 2.4 | | 2.6 |
| | | | | | | | | | | | |
| Flyash, B.L., L.O.I. | Loss on Ignition | ASTM C25 | % | | 5.77 | | 6.76 | | 6.31 | | 6.28 |

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# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | Run 10 | Run 11 | Run 12 | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Metals | Arsenic | ICP-AES HYDRIDE | ug/Nm3 | 0.23@B | 0.20@B | 0.13@B | 0.19 |
| Outlet Gas, U.I., Metals | Barium | ICP-AES | ug/Nm3 | 2.82B | 0.03@B | 1.08B | 1.31 |
| Outlet Gas, U.I., Metals | Beryllium | ICP-AES | ug/Nm3 | ND< 0.03 | ND< 0.03 | ND< 0.03 | ND< 0.03 |
| Outlet Gas, U.I., Metals | Cadmium | ICP-AES | ug/Nm3 | ND< 0.08 | ND< 0.09 | ND< 0.08 | ND< 0.09 |
| Outlet Gas, U.I., Metals | Chromium | ICP-AES | ug/Nm3 | 0.42@B | 0.26@B | 0.43@B | 0.37 |
| Outlet Gas, U.I., Metals | Cobalt | ICP-AES | ug/Nm3 | ND< 0.28 | ND< 0.29 | ND< 0.27 | ND< 0.29 |
| Outlet Gas, U.I., Metals | Copper | ICP-AES | ug/Nm3 | 2.0B | 1.4B | 1.6B | 1.7 |
| Outlet Gas, U.I., Metals | Lead | GFAAS | ug/Nm3 | 0.48@B | 0.50@B | 0.51@B | 0.50 |
| Outlet Gas, U.I., Metals | Manganese | ICP-AES | ug/Nm3 | 0.28@B | 2.72 | 0.30@B | 1.1 |
| Outlet Gas, U.I., Metals | Mercury | CVAAS | ug/Nm3 | 0.79@ | 0.56@ | ND< 0.40 | 0.52 |
| Outlet Gas, U.I., Metals | Molybdenum | ICP-AES | ug/Nm3 | 0.56@B | 0.23@B | 0.22@B | 0.34 |
| Outlet Gas, U.I., Metals | Nickel | ICP-AES | ug/Nm3 | 0.6@B | 0.6@B | 0.5@B | 0.6 |
| Outlet Gas, U.I., Metals | Selenium | ICP-AES HYDRIDE | ug/Nm3 | ND< 0.08 | ND< 0.08 | ND< 0.08 | ND< 0.08 |
| Outlet Gas, U.I., Metals | Phosphorus | ICP-AES | ug/Nm3 | 5.92@ | 10.52@ | ND< 1.62 | 0.8 |
| Outlet Gas, U.I., Metals | Vanadium | ICP-AES | ug/Nm3 | 0.37@ | 0.29@ | 0.40@ | 0.35 |
| Outlet Gas, U.I., Particulate | Particulate, total | GRAV | mg/Nm3 | 2.9 | 0.9 | 0.6 | 1.5 |
| Outlet Gas, U.I., Anions | Chloride | IC/TITRATION | ug/Nm3 | 830 | 841 | 994 | 888 |
| Outlet Gas, U.I., Anions | Fluoride | IC | ug/Nm3 | 6,053 | 5,586 | 6,181 | 5,940 |

| Stream | Substance | Method | UOM | Run 13A | Run 13B | Run13C | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Cyanide | Cyanide | Colorimetric | ug/Nm3 | ND< 11 | ND< 10 | ND< 9 | ND< 11 |

| Stream | Substance | Method | UOM | Run 10 | Run 12A | Run 12B | Average Used |
|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 5,389 | 11,462 | 13,283 | - |

| Stream | Substance | Method | UOM | Run 12C | Run 12D | Run 12E | Run 12F | Average Used |
|---|---|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 9,412 | 9,944 | 12,524 | 8,501 | 10,854 |

**APPENDIX B**
**SITE 115 DATA USED IN CALCULATIONS**
**PHASE II: UREA INJECTION TESTS**
**MARCH 1993**

| Stream | Substance | Method | UOM | Run 10 | Run 11 | Run 12 | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Metals | Arsenic | ICP-AES | ug/Nm3 | 22.6@ | 18.1@ | 7.7@ | 16.2 |
| Inlet Gas, U.I., Metals | Barium | ICP-AES | ug/Nm3 | 268 | 167 | 286 | 241 |
| Inlet Gas, U.I., Metals | Beryllium | ICP-AES | ug/Nm3 | 9.4 | 8.0 | 10.7 | 9.4 |
| Inlet Gas, U.I., Metals | Cadmium | ICP-AES | ug/Nm3 | 2.6 | 2.0 | 3.0 | 2.5 |
| Inlet Gas, U.I., Metals | Chromium | ICP-AES | ug/Nm3 | 57.3 | 55.1 | 78.7 | 63.7 |
| Inlet Gas, U.I., Metals | Cobalt | ICP-AES | ug/Nm3 | 35.2 | 25.9 | 37.9 | 33.0 |
| Inlet Gas, U.I., Metals | Copper | ICP-AES | ug/Nm3 | 228 | 203 | 341 | 258 |
| Inlet Gas, U.I., Metals | Lead | GFAAS | ug/Nm3 | 18.8 | 65.0 | 87.2 | 57.0 |
| Inlet Gas, U.I., Metals | Manganese | ICP-AES | ug/Nm3 | 101 | 87.1 | 144 | 111 |
| Inlet Gas, U.I., Metals | Mercury | CVAAS | ug/Nm3 | 4.3 | 1.7 | 1.1 | 2.4 |
| Inlet Gas, U.I., Metals | Molybdenum | ICP-AES | ug/Nm3 | 15.9 | 15.6 | 12.8 | 14.8 |
| Inlet Gas, U.I., Metals | Nickel | ICP-AES | ug/Nm3 | 33.7 | 29.1 | 47.6 | 36.8 |
| Inlet Gas, U.I., Metals | Selenium | ICP-AES | ug/Nm3 | 22.8 | 17.1 | ND< 10.0 | 15.0 |
| Inlet Gas, U.I., Metals | Phosphorus | ICP-AES | ug/Nm3 | 11,962 | 9,571 | 13,453 | 11,662 |
| Inlet Gas, U.I., Metals | Vanadium | ICP-AES | ug/Nm3 | 152 | 124 | 176 | 151 |
| Inlet Gas, U.I., Particulate | Particulate, total | GRAV | mg/Nm3 | 7,190 | 7,640 | 8,075 | 7,635 |
| Inlet Gas, U.I., Anions | Chloride | IC/TITRATION | ug/Nm3 | 1,239 | 1,322 | 1,252 | 1,271 |
| Inlet Gas, U.I., Anions | Fluoride | IC | ug/Nm3 | 6,989 | 7,677 | 7,102 | 7,256 |

| Stream | Substance | Method | UOM | Run 13A | Run 13B | Run13C | Average Used |
|---|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Cyanide | Cyanide | Colorimetric | ug/Nm3 | ND< 16 | ND< 12 | ND< 16 | ND< 16 |

| Stream | Substance | Method | UOM | Run 10A | Run 10B | Average Used |
|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 15,352 | 10,930 | 13,141 |

| Stream | Substance | Method | UOM | Run 12A | Run 12B | Average Used |
|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 15,864 | 15,864 | -- |

| Stream | Substance | Method | UOM | Run 13A | Run 13B | Average Used |
|---|---|---|---|---|---|---|
| Inlet Gas, U.I., Ammonia | Ammonia | ISE | ug/Nm3 | 17,762 | 17,155 | 16,661 |

APPENDIX B
SITE 115 DATA USED IN CALCULATIONS
PHASE II: UREA INJECTION TESTS
MARCH 1993

| Stream | Substance | Method | UOM | Run 10 3/10 AM | Run 11 3/10 PM | Run 12 3/11 | Average Used |
|---|---|---|---|---|---|---|---|
| Coal, U.I., Metals | Beryllium | ICP-AES | mg/Kg | 0.30 | 0.58 | 0.77 | 0.55 |
| Coal, U.I., Metals | Cadmium | ICP-AES | mg/Kg | ND< 0.05 | ND< 0.06 | 0.06 | ND< 0.06 |
| Coal, U.I., Metals | Chromium | ICP-AES | mg/Kg | 1.2 | 2.1 | 1.0 | 1.4 |
| Coal, U.I., Metals | Cobalt | ICP-AES | mg/Kg | 1.1 | 1.4 | 1.4 | 1.3 |
| Coal, U.I., Metals | Copper | ICP-AES | mg/Kg | 3.8 | 4.0 | 3.3 | 3.7 |
| Coal, U.I., Metals | Lead | GFAAS | mg/Kg | 1.7@ | 2.3 | 2.7 | 2.2 |
| Coal, U.I., Metals | Manganese | ICP-AES | mg/Kg | 4.2 | 6.7 | 4.8 | 5.2 |
| Coal, U.I., Metals | Molybdenum | ICP-AES | mg/Kg | 0.4@ | 0.4@ | 0.7@ | 0.5 |
| Coal, U.I., Metals | Nickel | ICP-AES | mg/Kg | 1.0@ | 1.0@ | 1.0@ | 1.0 |
| Coal, U.I., Metals | Phosphorus | ICP-AES | mg/Kg | 320 | 310 | 320 | 317 |
| Coal, U.I., Metals | Vanadium | ICP-AES | mg/Kg | 3.5 | 5.3 | 4.2 | 4.3 |
| Coal, U.I., Metals | Arsenic | INAA | mg/Kg | 0.75 | 0.47 | 0.70 | 0.64 |
| Coal, U.I., Metals | Barium | INAA | mg/Kg | 350 | 335 | 333 | 339 |
| Coal, U.I., Metals | Mercury | INAA | mg/Kg | 0.011 | -- | 0.027 | 0.017 |
| Coal, U.I., Metals | Selenium | INAA | mg/Kg | 1.1 | 0.91 | 2.4 | 1.5 |
| Coal, U.I., Anion Precursors | Chlorine | INAA | mg/Kg | 16 | 17 | 16 | 16 |

| Stream | Substance | Method | UOM | Run 10/11 3/10 AM/PM | Run 12 3/11 | Average Used |
|---|---|---|---|---|---|---|
| Coal, U.I., Ultimate | Moisture | ASTM D-5142 | % | 9.64 | 9.55 | 9.60 |
| Coal, U.I., Ultimate | Carbon | LECO CHN/600 | % | 72.41 | 71.64 | 72.03 |
| Coal, U.I., Ultimate | Hydrogen | LECO CHN/600 | % | 5.11 | 5.01 | 5.06 |
| Coal, U.I., Ultimate | Oxygen | Difference | % | 10.99 | 11.23 | 11.11 |
| Coal, U.I., Ultimate | Nitrogen | LECO CHN/600 | % | 1.87 | 1.80 | 1.84 |
| Coal, U.I., Ultimate | Ash | ASTM D-5142 | % | 9.13 | 9.84 | 9.49 |
| Coal, U.I., Ultimate | HHV | ASTM D-1989 | Btu/lb | 12,692 | 12,584 | 12,638 |
| Coal, U.I., Ultimate | Sulfur | ASTM D-4239 | % | 0.49 | 0.48 | 0.49 |



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# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | | Run 10 3/10 AM | | Run 11 3/10 PM | | Run 12 3/11 | | Average Used |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Ash, U.I., Metals | Arsenic | GFAAS | mg/Kg | | 8.8@ | | 3.8@ | | 9.7@ | | 7.5 |
| Bottom Ash, U.I., Metals | Barium | ICP-AES | mg/Kg | | 879 | | 999 | | 1,499 | | 1,126 |
| Bottom Ash, U.I., Metals | Beryllium | ICP-AES | mg/Kg | | 1.4@ | | 1.6@ | | 1.8@ | | 1.6 |
| Bottom Ash, U.I., Metals | Cadmium | ICP-AES | mg/Kg | ND< | 0.5 | ND< | 0.5 | ND< | 0.5 | ND< | 0.5 |
| Bottom Ash, U.I., Metals | Chromium | ICP-AES | mg/Kg | | 9@ | | 10 | | 10 | | 9.6 |
| Bottom Ash, U.I., Metals | Cobalt | ICP-AES | mg/Kg | | 5@ | | 6@ | | 7@ | | 6 |
| Bottom Ash, U.I., Metals | Copper | ICP-AES | mg/Kg | | 14 | | 15 | | 19 | | 16 |
| Bottom Ash, U.I., Metals | Lead | GFAAS | mg/Kg | | 17 | | 2.7@ | | 12@ | | 11 |
| *Bottom Ash, U.I., Metals* | *Manganese* | *ICP-AES* | *mg/Kg* | | 38 | | 55 | | 64 | | 52 |
| Bottom Ash, U.I., Metals | Mercury | CVAAS | mg/Kg | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 |
| Bottom Ash, U.I., Metals | Molybdenum | ICP-AES | mg/Kg | ND< | 1.0 | ND< | 1.0 | ND< | 1.0 | ND< | 1.0 |
| Bottom Ash, U.I., Metals | Nickel | ICP-AES | mg/Kg | | 5@ | | 6@ | | 7@ | | 6 |
| Bottom Ash, U.I., Metals | Phosphorus | ICP-AES | mg/Kg | | 1,699 | | 1,899 | | 2,499 | | 2,032 |
| Bottom Ash, U.I., Metals | Selenium | GFAAS | mg/Kg | ND< | 10 | ND< | 43 | ND< | 12 | ND< | 22 |
| Bottom Ash, U.I., Metals | Vanadium | ICP-AES | mg/Kg | | 21 | | 24 | | 27 | | 24 |
| | | | | | | | | | | | |
| Bottom Ash, U.I., Anions | Chloride | IC | mg/Kg | | 90@ | | 18@ | | 70@ | | 59 |
| Bottom Ash, U.I., Anions | Fluoride | ISE | mg/Kg | ND< | 3 | ND< | 3 | ND< | 3 | ND< | 3 |
| | | | | | | | | | | | |
| *Bottom Ash, U.I., L.O.I.* | *Loss on Ignition* | *ASTM C25* | % | | 1.85 | | 1.66 | | | | 1.76 |

PRELIMINARY

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# APPENDIX B
## SITE 115 DATA USED IN CALCULATIONS
## PHASE II: UREA INJECTION TESTS
## MARCH 1993

| Stream | Substance | Method | UOM | Run 10 3/10 AM | Run 11 3/10 PM | Run 12 3/11 | Average Used |
|---|---|---|---|---|---|---|---|
| Fly Ash, U.I., Metals | Arsenic | GFAAS | mg/Kg | 11@ | 11@ | 3.7@ | 9 |
| Fly Ash, U.I., Metals | Barium | ICP-AES | mg/Kg | 1200 | 880 | 690 | 923 |
| Fly Ash, U.I., Metals | Beryllium | ICP-AES | mg/Kg | 2.4 | 2.8 | 2.4 | 2.5 |
| Fly Ash, U.I., Metals | Cadmium | ICP-AES | mg/Kg | ND< 1 | ND< 1 | ND< 1 | ND< 1 |
| Fly Ash, U.I., Metals | Chromium | ICP-AES | mg/Kg | 15 | 16 | 12 | 14 |
| Fly Ash, U.I., Metals | Cobalt | ICP-AES | mg/Kg | 13 | 12 | 12 | 12 |
| Fly Ash, U.I., Metals | Copper | ICP-AES | mg/Kg | 40 | 38 | 36 | 38 |
| Fly Ash, U.I., Metals | Lead | GFAAS | mg/Kg | 31 | 34 | 24 | 25 |
| Fly Ash, U.I., Metals | Manganese | ICP-AES | mg/Kg | 61 | 68 | 62 | 64 |
| Fly Ash, U.I., Metals | Mercury | CVAAS | mg/Kg | 0.3@ | 0.2@ | 0.1@ | 0.2 |
| Fly Ash, U.I., Metals | Molybdenum | ICP-AES | mg/Kg | 3@ | 3@ | 5 | 4 |
| Fly Ash, U.I., Metals | Nickel | ICP-AES | mg/Kg | 15 | 10@ | 13@ | 13 |
| Fly Ash, U.I., Metals | Phosphorus | ICP-AES | mg/Kg | 4,200 | 4,400 | 4,000 | 4,200 |
| Fly Ash, U.I., Metals | Selenium | GFAAS | mg/Kg | ND< 8.8 | ND< 1.3 | 4.3@ | ND< 8.8 |
| Fly Ash, U.I., Metals | Vanadium | ICP-AES | mg/Kg | 66 | 54 | 54 | 58 |
| Fly Ash, U.I., Anions | Chloride | IC | mg/Kg | ND< 50 | ND< 50 | ND< 50 | ND< 50 |
| Fly Ash, U.I., Anions | Fluoride | ISE | mg/Kg | 23 | 40 | 34 | 32 |
| Fly Ash, U.I., L.O.I. | Loss on Ignition | ASTM C25 | % | 9.47 | 9.57 | | 9.52 |



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# APPENDIX C
## DATA NOT USED IN CALCULATIONS

This appendix contains data not used in emissions or mass balance calculations. The mercury and chromium speciation results are presented here.

## APPENDIX C
## SITE 115 DATA NOT USED IN CALCULATIONS
## PHASE I: BASELINE TESTS
## NOVEMBER 1992

| Stream | Substance | Method | UOM | Run 1 | Run 3 | Run 5 |
|---|---|---|---|---|---|---|
| Outlet Gas, B.L., Anions | Phosphate | IC | ug/Nm3 | ND< 2,470 | ND< 1,988 | ND< 643 |
| Outlet Gas, B.L., Anions | Sulfate | IC | ug/Nm3 | 1.23E+06 | 1.30E+06 | 1.29E+06 |
| Inlet Gas, B.L., Anions | Phosphate | IC | ug/Nm3 | 1487 | 2722 | 775 |
| Inlet Gas, B.L., Anions | Sulfate | IC | ug/Nm3 | 1.49E+06 | 1.36E+06 | 1.26E+06 |

| Stream | Substance | Method | UOM | Run 2A | Run 2B | Run 2C |
|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Ammonia | Ammonia | ISE | ug/Nm3 | 304 | 152 | 76 |

| Stream | Substance | Method | UOM | Run 1/2 | Run 3/4 | Run 5/6 |
|---|---|---|---|---|---|---|
| Coal, B.L., Metals | Arsenic | GFAAS | mg/Kg | ND< 0.5 | ND< 0.5 | ND< 0.5 |
| Coal, B.L., Metals | Barium | ICP-AES | mg/Kg | 0.6 | 28 | 21 |
| Coal, B.L., Metals | Mercury | CVAAS | mg/Kg | ND< 0.1 | 0.1@ | ND< 0.1 |
| Coal, B.L., Metals | Selenium | GFAAS | mg/Kg | ND< 0.05 | ND< 0.05 | ND< 0.05 |
| Coal, B.L., Metals | Cadmium | INAA | mg/Kg | 0.13 | 0.09 | 0.11 |
| Coal, B.L., Metals | Chrom ium | INAA | mg/Kg | 3.0 | 3.5 | 2.1 |
| Coal, B.L., Metals | Cobalt | INAA | mg/Kg | 0.74 | 0.75 | 0.70 |
| Coal, B.L., Metals | Molybdenum | INAA | mg/Kg | 0.89 | 1.2 | 0.95 |
| Coal, B.L., Anion Precursors | Chlorine | ASTM D2361 | % | 0.06 | ND< 0.01 | 0.06 |
| Bottom Ash, B.L., Anions | Phosphate | IC | mg/Kg | ND< 189 | ND< 165 | ND< 206 |
| Bottom Ash, B.L., Anions | Sulfate | IC | mg/Kg | 189 | 759 | 617 |
| Fly Ash, B.L., Anions | Phosphate | IC | mg/Kg | ND< 20 | ND< 20 | ND< 20 |
| Fly Ash, B.L., Anions | Sulfate | IC | mg/Kg | 1,000 | 1,100 | 840 |

**APPENDIX C**
**SITE 115 DATA NOT USED IN CALCULATIONS**
**PHASE II: BASELINE**
**MARCH 1993**

| Stream | Substance | Method | UOM | Run 8A | Run 8B | Run 9A |
|---|---|---|---|---|---|---|
| Outlet Gas, B.L., VOC | Benzene | GC/MS | ug/Nm3 | 9.6 | 8.8 | 6.3 |
| Outlet Gas, B.L., VOC | Toluene | GC/MS | ug/Nm3 | 180 | 222 | 77 |

| Stream | Substance | Method | UOM | Run 14A | Run 14B | Run 14C |
|---|---|---|---|---|---|---|
| Outlet Gas, B.L., Mercury | Hg(II) - ionic | CVAFS | ug/Nm3 | ND< 0.03 | 0.04@B | 0.13@B |
| Outlet Gas, B.L., Mercury | Hg(0) | CVAFS | ug/Nm3 | ND< 0.01 | ND< 0.01 | ND< 0.01 |
| Outlet Gas, B.L., Mercury | Hg - Filter Plug+Probe** | CVAFS | ug/Nm3 | ND< 0.005 | ND< 0.005 | ND< 0.005 |
| Outlet Gas, B.L., Mercury | Hg (total) | CVAFS | ug/Nm3 | ND< 0.05 | 0.05 | 0.14 |

** Filter Plug and Probe fractions were analyzed for total mercury only

| Stream | Substance | Method | UOM | Run 8A | Run 9A | Run 9B |
|---|---|---|---|---|---|---|
| Inlet Gas, B.L., VOC | Benzene | GC/MS | ug/Nm3 | 10.18 | 13.80 | 16.07 |
| Inlet Gas, B.L., VOC | Toluene | GC/MS | ug/Nm3 | 78.51 | 136.88 | 51.38 |

| Stream | Substance | Method | UOM | Run 8A | Run 8B | Run 9 |
|---|---|---|---|---|---|---|
| Inlet Gas, B.L.,Chrome | Chromium, total | EPAREC/ICP | ug/Nm3 | 121 | 90.1 | 69.2 |
| Inlet Gas, B.L.,Chrome | Hexavalent Chromium | EPAREC/IC-PCR | ug/Nm3 | 5.74 | 2.52 | 7.25 |

| Stream | Substance | Method | UOM | Run 14A | Run 14B | Run 14C |
|---|---|---|---|---|---|---|
| Inlet Gas, B.L., Mercury | Hg(II) | CVAFS | ug/Nm3 | 0.52 | 0.47B | 0.07B |
| Inlet Gas, B.L., Mercury | Hg(0) | CVAFS | ug/Nm3 | 0.32 | 0.53B | 0.05 |
| Inlet Gas, B.L., Mercury | Hg - Filter+Probe** | CVAFS | ug/Nm3 | 0.99 | 0.94 | 0.09 |
| Inlet Gas, B.L., Mercury | Hg (total) | CVAFS | ug/Nm3 | 1.8 | 1.9 | 0.2 |

** Hg - Filter + Probe fraction was analyzed for total mercury only

## APPENDIX C
## SITE 115 DATA NOT USED IN CALCULATIONS
## PHASE II: BASELINE
## MARCH 1993

| Stream | Substance | Method | UOM | Run 14 |
|---|---|---|---|---|
| Coal, B.L., Mercury | Total Hg | CVAFS | ng/g | 21 |
| Flyash, B.L., Mercury | Total Hg | CVAFS | ng/g | 216 |

| Stream | Substance | Method | UOM | Run 7 | Run 8/9? | Run 14 |
|---|---|---|---|---|---|---|
| Coal, B.L., Ultimate | Moisture | ASTM D-5142 | % | 10.10 | 10.01 | 10.26 |
| Coal, B.L., Ultimate | Carbon | LECO CHN/600 | % | 67.01 | 72.00 | 70.82 |
| Coal, B.L., Ultimate | Hydrogen | LECO CHN/600 | % | 4.63 | 5.03 | 4.92 |
| Coal, B.L., Ultimate | Oxygen | Difference | % | 11.67 | 11.36 | 11.96 |
| Coal, B.L., Ultimate | Nitrogen | LECO CHN/600 | % | 1.57 | 1.79 | 1.80 |
| Coal, B.L., Ultimate | Ash | ASTM D-5142 | % | 14.52 | 9.30 | 9.83 |
| Coal, B.L., Ultimate | HHV | ASTM D-1989 | Btu/lb | 11,832 | 12,846 | 12,408 |
| Coal, B.L., Ultimate | Sulfur | ASTM D-4239 | % | 0.6 | 0.52 | 0.67 |

**APPENDIX C**
**SITE 115 DATA NOT USED IN CALCULATIONS**
**PHASE II: UREA INJECTION TESTS**
**MARCH 1993**

| Stream | Substance | Method | UOM | Run 1 | Run 3 | Run 5 |
|---|---|---|---|---|---|---|
| Outlet Gas, U.I., Metals | Calcium | ICP-AES | ug/Nm3 | 36.63 | 23.38B | 45.82 |
| Outlet Gas, U.I., Metals | Sodium | ICP-AES | ug/Nm3 | 394B | 205B | 755B |
| Inlet Gas, U.I., Metals | Calcium | ICP-AES | ug/Nm3 | 1,878 | 550 | 890 |
| Inlet Gas, U.I., Metals | Sodium | ICP-AES | ug/Nm3 | 7,213 | 1,555B | 1,345B |
| Outlet Gas, U.I., Anions | Phosphate | IC | ug/Nm3 | ND< 536 | ND< 635 | ND< 500 |
| Outlet Gas, U.I., Anions | Sulfate | IC | ug/Nm3 | 1.79E+06 | 1.29E+06 | 1.27E+06 |
| Inlet Gas, U.I., Anions | Phosphate | IC | ug/Nm3 | 379 | 494 | 330 |
| Inlet Gas, U.I., Anions | Sulfate | IC | ug/Nm3 | 1.28E+06 | 1.28E+06 | 1.16E+06 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Coal, U.I., Metals | Arsenic | GFAAS | mg/Kg | ND< | 3 | ND< | 3 | ND< | 3 |
| Coal, U.I., Metals | Barium | ICP-AES | mg/Kg | | 26.9 | | 15 | | 38 |
| Coal, U.I., Metals | Mercury | CVAAS | mg/Kg | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 |
| Coal, U.I., Metals | Selenium | GFAAS | mg/Kg | ND< | 3 | ND< | 3 | ND< | 3 |
| Coal, U.I., Metals | Cadmium | INAA | mg/Kg | | 0.12 | | 0.1 | | 0.13 |
| Coal, U.I., Metals | Chrom ium | INAA | mg/Kg | | 3.4 | | 2.4 | | 2.5 |
| Coal, U.I., Metals | Cobalt | INAA | mg/Kg | | 0.97 | | 1.00 | | 0.79 |
| Coal, U.I., Metals | Molybdenum | INAA | mg/Kg | | 1.6 | | 1.4 | | 1.5 |
| Coal, U.I., Metals | Calcium | ICP-AES | mg/Kg | | 1,870 | | 2,770 | | 1,770 |
| Coal, U.I., Metals | Sodium | ICP-AES | mg/Kg | | 270 | | 400 | | 680 |
| Coal, U.I., Anion Precursors | Fluorine | ASTM D3761 | mg/Kg | | 0.043@ | | 0.04@ | | 0.038@ |
| Coal, U.I.., Anion Precursors | Chlorine | ASTM D2361 | mg/Kg | | 259 | | 262 | | 261 |
| Bottom Ash, U.I., Metals | Calcium | ICP-AES | mg/Kg | | 14,534 | | 13,534 | | 25,528 |
| Bottom Ash, U.I., Metals | Sodium | ICP-AES | mg/Kg | | 3,021 | | 2,721 | | 3,813 |
| Bottom Ash, U.I., Anions | Phosphate | IC | mg/Kg | ND< | 20 | ND< | 20 | ND< | 20 |
| Bottom Ash, U.I., Anions | Sulfate | IC | mg/Kg | | 251 | | 932 | | 1,241 |
| Fly Ash, U.I., Metals | Calcium | ICP-AES | mg/Kg | | 30,000 | | 31,000 | | 30,000 |
| Fly Ash, U.I., Metals | Sodium | ICP-AES | mg/Kg | | 4,100 | | 5,600 | | 4,700 |
| Fly Ash, U.I., Anions | Phosphate | IC | mg/Kg | ND< | 200 | ND< | 200 | ND< | 200 |
| Fly Ash, U.I., Anions | Sulfate | IC | mg/Kg | | 1,500 | | 1,500 | | 1,500 |

# APPENDIX D

# PROCESS STREAM FLOW RATES AND CALCULATION PROCEDURES

The tables in Appendix D summarize the following information:

Table D-1: Mean process stream flows at Site 115

Table D-2: Coal and Ash flow rate summary

Table D-3: FFDC inlet and outlet gas conditions and flow rate summary, including comparison of the measured flow rate to the calculated flow rate

Table D-4: Sample train test summaries including sample volumes and isokinetic ratios

Table D-5: Calculations

# TABLE D-1A
# MEAN PROCESS STREAM FLOWS AT SITE 115
# PHASE I: BASELINE

| Stream | Mean Flow Rate | Standard Deviation | Source |
|---|---|---|---|
| Coal | | | |
| (lb/hr) | 78,297 | 1,027 | Measured[1] |
| (lb/$10^6$ Btu) | 79.59 | 0.43 | Calculated[2] |
| Bottom Ash | | | |
| (lb/hr) | 1474 | 21 | Calculated[3] |
| (lb/MMBtu) | 2.31 | 0.03 | Calculated[3] |
| Flyash | | | |
| (lb/hr) | 6746 | 121 | Calculated[4] |
| (lb/$10^6$ Btu) | 5.99 | 0.06 | Calculated[4] |
| FFDC Outlet Gas | | | |
| (dscfm) | 250,911 | 6,999 | Measured[5] |
| FFDC Inlet Gas | | | |
| (dscfm) | 249,630 | 6,028 | Calculated[6] |

Note: All flow rates are on a dry basis. Coal and ash flow rate are the average for the three runs during which particulate and metals tests were conducted.

(1) Measured from plant instrumentation
(2) Calculated from HHV of Coal
(3) Difference between ash input from fuel and FFDC inlet particulate
(4) Difference between FFDC inlet and FFDC outlet particulate
(5) Measured with S-type pitot tube
(6) Calculated from measured outlet flow rate and inlet $O_2$ concentration

# TABLE D-1B
# MEAN PROCESS STREAM FLOWS AT SITE 115
# PHASE II: UREA INJECTION

| Stream | Mean Flow Rate | Standard Deviation | Source |
|---|---|---|---|
| Coal | | | |
| (lb/hr) | 84,002 | 3,276 | Measured(1) |
| (lb/$10^6$ Btu) | 79.02 | 0.39 | Calculated(2) |
| Bottom Ash | | | |
| (lb/hr) | 1887 | 304 | Calculated(3) |
| (lb/MMBtu) | 2.02 | 0.33 | Calculated(3) |
| Flyash | | | |
| (lb/hr) | 6755 | 535 | Calculated(4) |
| (lb/$10^6$ Btu) | 6.09 | 0.40 | Calculated(4) |
| FFDC Outlet Gas | | | |
| (dscfm) | 257,367 | 5,940 | Measured(5) |
| FFDC Inlet Gas | | | |
| (dscfm) | 253,541 | 4,373 | Calculated(6) |

Note: All flow rates are on a dry basis. Coal and ash flow rates are the average for the three runs during which particulate and metals tests were conducted.

(1) Measured from plant instrumentation
(2) Calculated from HHV of Coal
(3) Difference between ash input from fuel and FFDC inlet particulate
(4) Difference between FFDC inlet and FFDC outlet particulate
(5) Measured with S-type pitot tube
(6) Calculated from measured outlet flow rate and inlet $O_2$ concentration

## TABLE D-2a
## COAL AND ASH FLOW RATE SUMMARY
## SITE 115

| | | FLOW RATE, lb/hr | | | | | |
|---|---|---|---|---|---|---|---|
| Test No. | Date | Coal | Total Ash | FFDC Inlet Ash (1) | FFDC Outlet Ash | Bottom Ash | Flyash |
| **PHASE I BASELINE:** | | | | | | | |
| 1 | 11/17 | 77,114 | 7,668 | 6,228 | 0.56 | 1,450 | 6,609 |
| 3 | 11/18 | 78,963 | 7,852 | 6,380 | 4.1 | 1,489 | 6,838 |
| 5 | 11/19 | 78,815 | 7,837 | 6,364 | 1.9 | 1,484 | 6,791 |
| AVERAGE | | 78,297 | 7,786 | 6,324 | 2.2 | 1,474 | 6,746 |
| STD. DEVIATION | | 1,027 | 102 | 84 | 1.8 | 21 | 121 |
| 95% C.I. | | 2,551 | 254 | 207 | 4.4 | 53 | 300 |
| **PHASE II - UREA INJECTION:** | | | | | | | |
| 10 | 3/10-AM | 80,435 | 7,629 | 5,585 | 2.47 | 2,083 | 6,166 |
| 11 | 3/10-PM | 86,877 | 8,240 | 6,237 | 0.79 | 2,041 | 6,888 |
| 12 | 3/11-AM | 84,694 | 8,033 | 6,523 | 0.57 | 1,536 | 7,212 |
| AVERAGE | | 84,002 | 7,967 | 6,115 | 1.28 | 1,887 | 6,755 |
| STD. DEVIATION | | 3,276 | 311 | 481 | 1.04 | 304 | 535 |
| 95% C.I. | | 8,134 | 771 | 1,194 | 2.58 | 756 | 1,329 |

Note: Flowrates are on a dry basis and were calculated only for tests when metals and particulate were collected.
(1) Inlet particulate loading for test 5 was inconsistent with tests 1 and 3, and was not used. The average inlet/total as for tests 1and 3 was multiplied by the total ash flow for test 5 to calculate an inlet ash flow for test 5.

Calculations:

Coal flow rate, lb/hr dry = Coal flow rate, lb/hr wet / (Average coal moisture(%)/100)
Total ash flow rate, lb/hr = Coal flow rate, lb/hr dry • Average coal ash (%)/100
FFDC inlet ash flow rate, lb/hr = Inlet particulate, lb/hr • (1 - Flyash LOI(%))/100.
FFDC outlet ash flow rate, lb/hr = Outlet particulate, lb/hr
Bottom ash flow rate, lb/hr = (Total ash flow rate, lb/hr - inlet ash flow rate, lb/hr) • (1 + Bottom ash LOI(%))/100
Flyash flow rate, lb/hr = Inlet particulate, lb/hr - Outlet particulate, lb/hr

# TABLE D-2b
# COAL AND ASH FLOW RATE SUMMARY
# SITE 115

| | | FLOW RATE, lb/10^ Btu | | | | | |
|---|---|---|---|---|---|---|---|
| Test No. | Date | Coal | Total Ash | FFDC Inlet Ash (1) | FFDC Outlet Ash | Bottom Ash | Flyash |
| **PHASE I BASELINE:** | | | | | | | |
| 1 | 11/17 | 79.95 | 7.95 | 5.61 | 0.0005 | 2.35 | 5.96 |
| 3 | 11/18 | 79.69 | 7.92 | 5.66 | 0.0037 | 2.29 | 6.07 |
| 5 | 11/19 | 79.12 | 7.87 | 5.59 | 0.0016 | 2.30 | 5.96 |
| AVERAGE | | 79.59 | 7.91 | 5.62 | 0.0019 | 2.31 | 5.99 |
| STD. DEVIATION | | 0.43 | 0.04 | 0.04 | 0.0016 | 0.03 | 0.06 |
| 95% C.I. | | 1.06 | 0.11 | 0.09 | 0.0040 | 0.08 | 0.16 |
| **PHASE II - UREA INJECTION:** | | | | | | | |
| 10 | 3/10-AM | 78.79 | 7.47 | 5.15 | 0.0023 | 2.36 | 5.69 |
| 11 | 3/10-PM | 78.79 | 7.47 | 5.51 | 0.0007 | 2.00 | 6.08 |
| 12 | 3/11-AM | 79.47 | 7.54 | 5.87 | 0.0005 | 1.69 | 6.49 |
| AVERAGE | | 79.02 | 7.49 | 5.51 | 0.0012 | 2.02 | 6.09 |
| STD. DEVIATION | | 0.39 | 0.04 | 0.36 | 0.0010 | 0.33 | 0.40 |
| 95% C.I. | | 0.97 | 0.09 | 0.89 | 0.0024 | 0.83 | 1.00 |

Note: Flowrates are on a dry basis and were calculated only for tests when metals and particulate were collected.

(1) Inlet particulate loading for test 5 was inconsistent with tests 1 and 3, and was not used. The average inlet/total as for tests 1and 3 was multiplied by the total ash flow for test 5 to calculate an inlet ash flow for test 5.

Calculations:

Coal flow rate, lb/10^6 Btu dry = 10^6/Coal HHV, dry

Total ash flow rate, lb/10^6 Btu = Coal flow rate, lb/10^6 Btu dry * Average coal ash (%)/100

FFDC inlet ash flow rate, lb/10^6 Btu = Inlet particulate, lb/10^6 Btu • (1 - Flyash LOI(%))/100.

FFDC outlet ash flow rate, lb/10^6 Btu = Outlet particulate, lb/10^6 Btu

Bottom ash flow rate, lb/10^6 Btu = (Total ash flow rate, lb/10^6 Btu - inlet ash flow rate, lb10^6 Btu) • (1 + Bott

Flyash flow rate, lb/10^6 Btu = Inlet particulate, lb/10^6 Btu - Outlet particulate, lb/10^6 Btu

## TABLE D-3
## SUMMARY OF EXHAUST GAS CONDITIONS AND FLOW RATES FOR ISOKINETIC TESTS
## SITE 115

| Test No. | Date | Time | O2 (1) % | CO2 (1) % | H20 % | Temp °F | Vm std dscf | Measured Flow Rate (Pitot) dscfm | Corrected Flow Rate (Pitot)(2) dscfm | Gross Output MW |
|---|---|---|---|---|---|---|---|---|---|---|
| **PHASE I - BASELINE:** | | | | | | | | | | |
| 1-MTLS-IN | 11/17/92 | 0828/1340 | 5.66 | 13.28 | 7.2 | 271 | 101.80 | 273,415 | 247,183 | 102 |
| 1-MTLS-OUT | 11/17/92 | 0830/1257 | 5.57 | 12.93 | 7.1 | 263 | 136.23 | 245,732 | -- | 102 |
| 1-PM/AN-OUT | 11/17/92 | 0905/1337 | 5.57 | 12.93 | 7.3 | 264 | 131.92 | 244,320 | -- | 102 |
| 1-PM/AN-IN | 11/17/92 | 0906/1334 | 5.66 | 13.28 | 7.4 | 266 | 98.11 | 266,060 | 245,763 | 102 |
| 2-PAH-OUT | 11/17/92 | 1520/1944 | 5.88 | 12.8 | 7.5 | 269 | 107.50 | 248,247 | -- | 104 |
| 2-PAH-IN | 11/17/92 | 1521/1948 | 5.68 | 13.22 | 7.4 | 271 | 101.67 | 281,676 | 244,985 | 104 |
| 3-MTLS-IN | 11/18/92 | 0801/1226 | 5.69 | 13.23 | 7.8 | 270 | 97.68 | 262,066 | 252,067 | 103 |
| 3-MTLS-OUT | 11/18/92 | 0801/1241 | 5.75 | 12.94 | 7.7 | 259 | 135.62 | 253,065 | -- | 103 |
| 3-PM/AN-IN | 11/18/92 | 0853/1323 | 5.69 | 13.23 | 7.6 | 263 | 98.16 | 263,334 | 250,194 | 103 |
| 3-PM/AN-OUT | 11/18/92 | 0853/1320 | 5.75 | 12.94 | 7.5 | 263 | 134.70 | 251,185 | -- | 103 |
| 4-PAH-OUT | 11/18/92 | 1448/1902 | 5.9 | 12.89 | 7.7 | 264 | 129.30 | 247,105 | -- | 104 |
| 4-PAH-IN | 11/18/92 | 1451/1939 | 5.79 | 13.32 | 7.9 | 270 | 103.14 | 270,703 | 245,306 | 104 |
| 5-MTLS-IN | 11/19/92 | 0746/1210 | 5.47 | 13.18 | 7.7 | 268 | 102.31 | 273,034 | 261,773 | 104 |
| 5-MTLS-OUT | 11/19/92 | 0748/1211 | 5.65 | 12.69 | 7.8 | 259 | 144.94 | 264,863 | -- | 104 |
| 5-PM/AN-OUT | 11/19/92 | 0832/1239 | 5.65 | 12.69 | 7.6 | 262 | 139.78 | 258,872 | -- | 104 |
| 5-PM/AN-IN | 11/19/92 | 0834/1302 | 5.47 | 13.18 | 7.6 | 261 | 101.93 | 274,536 | 255,852 | 104 |
| 6-PAH-IN | 11/19/92 | 1445/1907 | 5.41 | 13.33 | 7.7 | 269 | 103.79 | 271,123 | 243,544 | 104 |
| 6-PAH-OUT | 11/19/92 | 1520/1944 | 5.49 | 12.92 | 7.6 | 265 | 134.51 | 244,808 | -- | 104 |
| 6A-CN-IN | 11/19/92 | 1551/1638 | 5.41 | 13.33 | 9.5 | 267 | 15.13 | SP | SP | 104 |
| 6A-CN-OUT | 11/19/92 | 1551/1638 | 5.49 | 12.92 | 9.4 | 263 | 17.13 | SP | SP | 104 |
| 6B-CN-IN | 11/19/92 | 1730/1809 | 5.41 | 13.33 | 11.3 | 266 | 15.41 | SP | SP | 104 |
| 6B-CN-OUT | 11/19/92 | 1730/1800 | 5.49 | 12.92 | 9.8 | 259 | 17.36 | SP | SP | 104 |
| 6C-CN-IN | 11/19/92 | 1846/1918 | 5.41 | 13.33 | 9.9 | 260 | 15.43 | SP | SP | 104 |
| 6C-CN-OUT | 11/19/92 | 1846/1916 | 5.49 | 12.92 | 11.3 | 260 | 15.50 | SP | SP | 104 |
| **AVERAGE INLET** | | | 5.61 | 13.25 | 7.6 | 267 | | 270,661 | 249,630 | |
| **AVERAGE OUTLET** | | | 5.69 | 12.86 | 7.5 | 263 | | 250,911 | -- | |
| **STANDARD DEVIATION INLET** | | | 0.11 | 0.24 | 0.3 | 5.3 | | 6,108 | 6,028 | |
| **STANDARD DEVIATION OUTLET** | | | 0.11 | 0.17 | 0.2 | 4.5 | | 6,999 | -- | |
| **95% C.I. INLET** | | | 0.08 | 0.18 | 0.23 | 4.1 | | 4704 | 4642 | |
| **95% C.I. OUTLET** | | | 0.09 | 0.13 | 0.16 | 3.4 | | 5389 | -- | |

Notes:
SP - single point test
(1) Phase I inlet O2 and CO2 are from a six point CEMS grid located at the FFDC inlet.
Phase I outlet O2 and CO2 are from a single point CEMS at the FFDC outlet.
(2) Inlet corrected flowrates were calculated by correcting outlet pitot measured flowrates for inlet 02 levels.

**TABLE D-3 (continued)**
**SUMMARY OF EXHAUST GAS CONDITIONS AND FLOW RATES FOR ISOKINETIC TESTS**
**SITE 115**

| Test No. | Date | Time | O2 (1) % | CO2 (1) % | H20 % | Temp °F | Vm std dscf | Measured Flow Rate (Pitot) dscfm | Corrected Flow Rate (Pitot)(2) dscfm | Flow Rate (Heat Rate)(3) dscfm | Gross Output MW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PHASE II - BASELINE:** | | | | | | | | | | | |
| 8A-Cr-IN | 3/9/93 | 850/1050 | 5.68 | 13.63 | 12.7 | 272 | 47.862 | SP | SP | | 104 |
| 8B-Cr-IN | 3/9/93 | 1125/1325 | 5.68 | 13.63 | 9.7 | 270 | 45.881 | SP | SP | | 104 |
| 9-Cr-IN | 3/9/93 | 1620/1820 | 5.96 | 13.47 | 9.7 | 264 | 44.980 | SP | SP | | 103 |
| **PHASE II - UREA INJECTION:** | | | | | | | | | | | |
| 10-MTLS-IN | 3/10/93 | 806/1235 | 5.83 | 13.64 | 8.5 | 262 | 104.538 | 261,755 | 251,864 | | 103 |
| 10-MTLS-OUT | 3/10/93 | 806/1224 | 5.93 | 13.63 | 8.2 | 256 | 134.488 | 253,546 | - | | 103 |
| 10-PM/AN-IN | 3/10/93 | 946/1428 | 5.83 | 13.64 | 8.1 | 271 | 102.956 | 263,402 | 245,823 | | 103 |
| 10-PM/AN-OUT | 3/10/93 | 950/1412 | 5.93 | 13.63 | 7.9 | 260 | 153.538 | 247,465 | - | | 103 |
| 11-MTLS-IN | 3/10/93 | 1526/2002 | 5.91 | 13.52 | 8.3 | 264 | 95.023 | 277,369 | 253,663 | | 104 |
| 11-MTLS-OUT | 3/10/93 | 1526/2001 | 6.12 | 13.41 | 8.1 | 260 | 129.665 | 257,267 | - | | 104 |
| 11-PM/AN-IN | 3/10/93 | 1614/2000 | 5.91 | 13.52 | 8.2 | 270 | 72.073 | 267,419 | 258,366 | | 104 |
| 11-PM/AN-OUT | 3/10/93 | 1613/2001 | 6.12 | 13.41 | 7.9 | 262 | 118.080 | 262,037 | - | | 104 |
| 12-MTLS-IN | 3/11/93 | 901/1344 | 6.06 | 13.43 | 8.0 | 261 | 109.857 | 279,250 | 255,611 | | 106 |
| 12-MTLS-OUT | 3/11/93 | 900/1312 | 6.41 | 13.21 | 8.0 | 258 | 140.606 | 261,785 | - | | 106 |
| 12-PM/AN-IN | 3/11/93 | 952/1431 | 6.06 | 13.43 | 7.7 | 283 | 104.832 | 280,310 | 255,920 | | 106 |
| 12-PM/AN-OUT | 3/11/93 | 944/1403 | 6.41 | 13.21 | 7.7 | 257 | 162.865 | 262,102 | - | | 106 |
| 13A-CN-IN | 3/11/93 | 1610/1652 | 6.03 | 13.51 | 12.7 | 261 | 13.624 | SP | SP | 265,653 | 115 |
| 13A-CN-OUT | 3/11/93 | 1610/1640 | 6.45 | 13.21 | 10.4 | 263 | 18.023 | SP | SP | 273,375 | 115 |
| 13B-CN-IN | 3/11/93 | 1722/1801 | 6.03 | 13.51 | 10.7 | 268 | 12.365 | SP | SP | 265,653 | 115 |
| 13B-CN-OUT | 3/11/93 | 1722/1752 | 6.45 | 13.21 | 10.1 | 264 | 18.677 | SP | SP | 273,375 | 115 |
| 13C-CN-IN | 3/11/93 | 1826/1921 | 6.03 | 13.51 | 11.3 | 260 | 12.707 | SP | SP | 265,653 | 115 |
| 13C-CN-OUT | 3/11/93 | 1826/1856 | 6.45 | 13.21 | 10.0 | 264 | 20.077 | SP | SP | 273,375 | 115 |
| **AVERAGE INLET** | | | 5.93 | 13.53 | 8.1 | 268 | | 271,584 | 253,541 | 265,653 | |
| **AVERAGE OUTLET** | | | 6.15 | 13.42 | 8.0 | 259 | | 257,367 | - | 273,375 | |
| **STANDARD DEVIATION INLET** | | | 0.10 | 0.09 | 0.3 | 8.3 | | 8,358 | 4,373 | | |
| **STANDARD DEVIATION OUTLET** | | | 0.22 | 0.19 | 0.2 | 2.4 | | 5,940 | - | | |
| **95% C.I. INLET** | | | 0.11 | 0.10 | 0.3 | 8.7 | | 8769 | 4588 | | |
| **95% C.I. OUTLET** | | | 0.23 | 0.20 | 0.2 | 2.5 | | 6232 | - | | |

Notes:
SP - single point test
(1) Phase II inlet O2 and CO2 are from a twelve point CEMS grid located at the economizer exit.
Phase II outlet O2 concentrations are from portable O2 meter readings. CO2 are from single point CEMS readings corrected to portable O2.
Outlet O2 concentrations for tests 10-12 are from the metals test portable O2 meter only.
Outlet O2 concentration for test 13 is an average of all three cyanide tests.
(2) Inlet corrected flowrates were calculated by correcting outlet pitot measured flowrates for inlet 02 levels.
(3) Flow rate calculated from average heat rate using:
DSCFM = Heat rate, Btu/kW(net)hr * (Gross Load, kW - Aux. Demand, kW) * F-factor @ 0% O2, dscf/MM Btu * 20.9/(20.9-%O2) * 1hr/60 min.

## TABLE D-4
## SAMPLE TRAIN TEST SUMMARY
## SITE 115
## PHASE I BASELINE

| PARAMETER | MULTI-METALS FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 11/17/92 | 11/17/92 |
| Test Number | 1-MTLS-In | 1-MTLS-Out |
| Std Sample Vol (SCF) | 101.801 | 136.231 |
| Std Sample Vol (Nm^3) | 2.686 | 3.595 |
| Moisture Fraction | 0.072 | 0.071 |
| Stack Gas Mol Wt. | 29.46 | 29.42 |
| Stack Gas Velocity (ft/sec) | 46.24 | 39.28 |
| Stack Flow Rate (wacfm) | 506,528 | 439,728 |
| Stack Flow Rate (dscfm) | 273,415 | 245,732 |
| Isokinetic Ratio (%) | 98.8 | 97.3 |
| | | |
| Date | 11/18/92 | 11/18/92 |
| Test Number | 3-MTLS-In | 3-MTLS-Out |
| Std Sample Vol (SCF) | 97.681 | 135.619 |
| Std Sample Vol (Nm^3) | 2.577 | 3.578 |
| Moisture Fraction | 0.078 | 0.077 |
| Stack Gas Mol Wt. | 29.38 | 29.35 |
| Stack Gas Velocity (ft/sec) | 44.60 | 40.69 |
| Stack Flow Rate (wacfm) | 488,576 | 455,495 |
| Stack Flow Rate (dscfm) | 262,066 | 253,065 |
| Isokinetic Ratio (%) | 99.5 | 96.0 |
| | | |
| Date | 11/19/92 | 11/19/92 |
| Test Number | 5-MTLS-In | 5-MTLS-Out |
| Std. Sample Vol. (SCF) | 102.311 | 144.935 |
| Std Sample Vol (Nm^3) | 2.700 | 3.824 |
| Moisture Fraction | 0.077 | 0.078 |
| Stack Gas Mol Wt. | 29.38 | 29.30 |
| Stack Gas Velocity (ft/sec) | 46.24 | 42.36 |
| Stack Flow Rate (wacfm) | 506,496 | 474,232 |
| Stack Flow Rate (dscfm) | 273,034 | 264,863 |
| Isokinetic Ratio (%) | 100.1 | 98.1 |

Note: Stack flow rate as measured by an S-type pitot traverse

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE I BASELINE

| PARAMETER | PAH FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 11/17/92 | 11/17/92 |
| Test Number | 2-PAH-In | 2-PAH-Out |
| Std Sample Vol (SCF) | 101.668 | 107.497 |
| Std Sample Vol (Nm^3) | 2.683 | 2.836 |
| Moisture Fraction | 0.074 | 0.075 |
| Stack Gas Mol Wt. | 29.42 | 29.36 |
| Stack Gas Velocity (ft/sec) | 47.89 | 40.14 |
| Stack Flow Rate (wacfm) | 524,587 | 449,389 |
| Stack Flow Rate (dscfm) | 281,676 | 248,247 |
| Isokinetic Ratio (%) | 98.1 | 97.9 |
| | | |
| Date | 11/18/92 | 11/18/92 |
| Test Number | 4-PAH-In | 4-PAH-Out |
| Std Sample Vol (SCF) | 103.144 | 129.301 |
| Std Sample Vol (Nm^3) | 2.722 | 3.412 |
| Moisture Fraction | 0.079 | 0.077 |
| Stack Gas Mol Wt. | 29.39 | 29.35 |
| Stack Gas Velocity (ft/sec) | 46.17 | 39.79 |
| Stack Flow Rate (wacfm) | 505,674 | 445,481 |
| Stack Flow Rate (dscfm) | 270,703 | 247,105 |
| Isokinetic Ratio (%) | 103.6 | 94.4 |
| | | |
| Date | 11/19/92 | 11/19/92 |
| Test Number | 6-PAH-In | 6-PAH-Out |
| Std. Sample Vol. (SCF) | 103.786 | 134.508 |
| Std Sample Vol (Nm^3) | 2.738 | 3.549 |
| Moisture Fraction | 0.077 | 0.076 |
| Stack Gas Mol Wt. | 29.40 | 29.35 |
| Stack Gas Velocity (ft/sec) | 45.99 | 39.44 |
| Stack Flow Rate (wacfm) | 503,710 | 441,545 |
| Stack Flow Rate (dscfm) | 271,123 | 244,808 |
| Isokinetic Ratio (%) | 99.5 | 100.3 |

Note: Stack flow rate as measured by an S-type pitot traverse

(continued)

## TABLE D-4 (continued)
## SAMPLE TRAIN TEST SUMMARY
## SITE 115
## PHASE I BASELINE

| PARAMETER | PARTICULATE/ANIONS FFDC INLET | PARTICULATE/ANIONS/RADIONUCLIDES FFDC OUTLET |
|---|---|---|
| Date | 11/17/92 | 11/17/92 |
| Test Number | 1-PM/An-In | 1-PM-Out |
| Std Sample Vol (SCF) | 98.107 | 131.923 |
| Std Sample Vol (Nm^3) | 2.589 | 3.481 |
| Moisture Fraction | 0.074 | 0.073 |
| Stack Gas Mol Wt. | 29.43 | 29.40 |
| Stack Gas Velocity (ft/sec) | 44.78 | 39.17 |
| Stack Flow Rate (wacfm) | 490,508 | 438,521 |
| Stack Flow Rate (dscfm) | 266,060 | 244,320 |
| Isokinetic Ratio (%) | 96.7 | 97.4 |
| | | |
| Date | 11/18/92 | 11/18/92 |
| Test Number | 3-PM/An-In | 3-PM-Out |
| Std Sample Vol (SCF) | 98.155 | 134.696 |
| Std Sample Vol (Nm^3) | 2.590 | 3.554 |
| Moisture Fraction | 0.076 | 0.075 |
| Stack Gas Mol Wt. | 29.40 | 29.37 |
| Stack Gas Velocity (ft/sec) | 44.23 | 40.29 |
| Stack Flow Rate (wacfm) | 484,526 | 451,113 |
| Stack Flow Rate (dscfm) | 263,334 | 251,185 |
| Isokinetic Ratio (%) | 97.8 | 96.8 |
| | | |
| Date | 11/19/92 | 11/19/92 |
| Test Number | 5-PM/An-In | 5-PM-Out |
| Std. Sample Vol. (SCF) | 101.925 | 139.778 |
| Std Sample Vol (Nm^3) | 2.689 | 3.688 |
| Moisture Fraction | 0.076 | 0.076 |
| Stack Gas Mol Wt. | 29.39 | 29.33 |
| Stack Gas Velocity (ft/sec) | 45.98 | 41.44 |
| Stack Flow Rate (wacfm) | 503,674 | 463,988 |
| Stack Flow Rate (dscfm) | 274,536 | 258,872 |
| Isokinetic Ratio (%) | 100.0 | 99.5 |

Note: Stack flow rate as measured by an S-type pitot traverse

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE I BASELINE

| PARAMETER | CYANIDE<br>FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 11/19/92 | 11/19/92 |
| Test Number | 6A-CN-IN | 6A-CN-OUT |
| Std Sample Vol (SCF) | 15.134 | 17.127 |
| Std Sample Vol (Nm^3) | 0.399 | 0.452 |
| Moisture Fraction | 0.095 | 0.094 |
| Stack Gas Mol Wt. | 29.17 | 29.14 |
| Stack Gas Velocity (ft/sec) | 46.38 | 40.15 |
| Isokinetic Ratio (%) | 103.8 | 100.2 |
| | | |
| Date | 11/19/92 | 11/19/92 |
| Test Number | 6B-CN-IN | 6B-CN-OUT |
| Std Sample Vol (SCF) | 15.405 | 17.361 |
| Std Sample Vol (Nm^3) | 0.113 | 0.458 |
| Moisture Fraction | 0.113 | 0.098 |
| Stack Gas Mol Wt. | 28.96 | 29.09 |
| Stack Gas Velocity (ft/sec) | 45.81 | 38.75 |
| Isokinetic Ratio (%) | 108.9 | 105.0 |
| | | |
| Date | 11/19/92 | 11/19/92 |
| Test Number | 6C-CN-IN | 6C-CN-OUT |
| Std. Sample Vol. (SCF) | 15.433 | 15.503 |
| Std Sample Vol (Nm^3) | 0.407 | 0.409 |
| Moisture Fraction | 0.099 | 0.113 |
| Stack Gas Mol Wt. | 29.13 | 28.90 |
| Stack Gas Velocity (ft/sec) | 46.19 | 37.45 |
| Isokinetic Ratio (%) | 105.6 | 98.9 |

Note: Stack flow rate as measured by an S-type pitot traverse

(continued)

## TABLE D-4 (continued)
## SAMPLE TRAIN TEST SUMMARY
## SITE 115
## PHASE I BASELINE

| PARAMETER | AMMONIA FFDC INLET |
|---|---|
| Date | 11/17/92 |
| Test Number | 2A-NH3-IN |
| % H2O | 7.40 |
| % O2 | 5.68 |
| Date | 11/17/92 |
| Test Number | 2B-NH3-IN |
| % H2O | 7.40 |
| % O2 | 5.68 |
| Date | 11/17/92 |
| Test Number | 2C-NH3-IN |
| % H2O | 7.40 |
| % O2 | 5.68 |

Note: O2 and H2O from corresponding isokinetic test

(continued)

## TABLE D-4 (continued)
## SAMPLE TRAIN TEST SUMMARY
## SITE 115
## PHASE I BASELINE

| PARAMETER | BENZENE AND TOLUENE FFDC INLET | FFDC OUTLET |
| --- | --- | --- |
| Date | 11/17/92 | 11/17/92 |
| Test Number | 2B-VOC-IN | 2B-VOC-OUT |
| % O2 | 5.68 | 5.88 |
| Date | 11/17/92 | 11/17/92 |
| Test Number | 2C-V0C-IN | 2C-VOC-OUT |
| % O2 | 5.68 | 5.88 |
| Date | 11/18/92 | 11/18/92 |
| Test Number | 3A-VOC-IN | 3A-VOC-OUT |
| % O2 | 5.69 | 5.75 |

Note: O2 values from tests 2B and 2C are from 2-PAH-IN and 2-PAH-OUT, O2 values for tests 3A are from 3-MTLS-IN and 3-MTLS-OUT.

(continued)

## TABLE D-4 (continued)
## SAMPLE TRAIN TEST SUMMARY
## SITE 115
## PHASE I BASELINE

| PARAMETER | FORMALDEHYDE<br>FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 11/18/92 | 11/18/92 |
| Test Number | 4A-FORM-IN | 4A-FORM-OUT |
| Std Sample Vol (SCF) | 3.101 | 3.817 |
| Std Sample Vol (SCM) | 0.088 | 0.108 |
| % O2 | 5.79 | 5.90 |
| | | |
| Date | 11/18/92 | 11/18/92 |
| Test Number | 4B-FORM-IN | 4B-FORM-OUT |
| Std Sample Vol (SCF) | 3.163 | 3.600 |
| Std Sample Vol (SCM) | 0.090 | 0.102 |
| % O2 | 5.79 | 5.90 |
| | | |
| Date | 11/18/92 | 11/18/92 |
| Test Number | 4C-FORM-IN | 4C-FORM-OUT |
| Std. Sample Vol. (SCF) | 3.067 | 3.250 |
| Std Sample Vol (SCM) | 0.087 | 0.092 |
| % O2 | 5.79 | 5.90 |

Note: % O2 values are from 4-PAH-IN and 4-PAH-OUT

## TABLE D-4 (continued)
## SAMPLE TRAIN TEST SUMMARY
## SITE 115
## PHASE II UREA INJECTION

| PARAMETER | MULTI-METALS FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 3/10/93 | 3/10/93 |
| Test Number | 10-MTLS-In | 10-MTLS-Out |
| Std Sample Vol (SCF) | 104.538 | 134.488 |
| Std Sample Vol (Nm^3) | 2.758 | 3.549 |
| Moisture Fraction | 0.085 | 0.082 |
| Stack Gas Mol Wt. | 29.37 | 29.40 |
| Stack Gas Velocity (ft/sec) | 44.42 | 40.71 |
| Stack Flow Rate (wacfm) | 486,562 | 455,725 |
| Stack Flow Rate (dscfm) | 261,755 | 253,546 |
| Isokinetic Ratio (%) | 102.0 | 97.8 |
| | | |
| Date | 3/10/93 | 3/10/93 |
| Test Number | 11-MTLS-In | 11-MTLS-Out |
| Std Sample Vol (SCF) | 95.023 | 129.665 |
| Std Sample Vol (Nm^3) | 2.507 | 3.421 |
| Moisture Fraction | 0.083 | 0.081 |
| Stack Gas Mol Wt. | 29.37 | 29.38 |
| Stack Gas Velocity (ft/sec) | 47.13 | 41.51 |
| Stack Flow Rate (wacfm) | 516,252 | 464,743 |
| Stack Flow Rate (dscfm) | 277,369 | 257,267 |
| Isokinetic Ratio (%) | 99.3 | 100.5 |
| | | |
| Date | 3/11/93 | 3/11/93 |
| Test Number | 12-MTLS-In | 12-MTLS-Out |
| Std. Sample Vol. (SCF) | 109.857 | 140.606 |
| Std Sample Vol (Nm^3) | 2.899 | 3.710 |
| Moisture Fraction | 0.080 | 0.080 |
| Stack Gas Mol Wt. | 29.40 | 29.38 |
| Stack Gas Velocity (ft/sec) | 47.18 | 42.05 |
| Stack Flow Rate (wacfm) | 516,759 | 470,731 |
| Stack Flow Rate (dscfm) | 279,250 | 261,785 |
| Isokinetic Ratio (%) | 100.5 | 99.0 |

Note: Stack flow rate as measured by an S-type pitot traverse

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE II UREA INJECTION

| PARAMETER | PARTICULATE/ANIONS FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 3/10/93 | 3/10/93 |
| Test Number | 10-PM/An-In | 10-PM/An-Out |
| Std Sample Vol (SCF) | 102.956 | 153.538 |
| Std Sample Vol (Nm^3) | 2.717 | 4.051 |
| Moisture Fraction | 0.081 | 0.079 |
| Stack Gas Mol Wt. | 29.41 | 29.44 |
| Stack Gas Velocity (ft/sec) | 45.04 | 39.82 |
| Stack Flow Rate (wacfm) | 493,301 | 445,793 |
| Stack Flow Rate (dscfm) | 263,402 | 247,465 |
| Isokinetic Ratio (%) | 99.8 | 98.2 |
| | | |
| Date | 3/10/93 | 3/10/93 |
| Test Number | 11-PM/An-In | 11-PM/An-Out |
| Std Sample Vol (SCF) | 72.073 | 118.080 |
| Std Sample Vol (Nm^3) | 1.902 | 3.116 |
| Moisture Fraction | 0.082 | 0.079 |
| Stack Gas Mol Wt. | 29.39 | 29.42 |
| Stack Gas Velocity (ft/sec) | 45.75 | 42.28 |
| Stack Flow Rate (wacfm) | 501,107 | 473,321 |
| Stack Flow Rate (dscfm) | 267,419 | 262,037 |
| Isokinetic Ratio (%) | 99.7 | 99.6 |
| | | |
| Date | 3/11/93 | 3/11/93 |
| Test Number | 12-PM/An-In | 12-PM/An-Out |
| Std. Sample Vol. (SCF) | 104.832 | 162.865 |
| Std Sample Vol (Nm^3) | 2.766 | 4.297 |
| Moisture Fraction | 0.077 | 0.077 |
| Stack Gas Mol Wt. | 29.43 | 29.42 |
| Stack Gas Velocity (ft/sec) | 48.67 | 41.87 |
| Stack Flow Rate (wacfm) | 533,094 | 468,701 |
| Stack Flow Rate (dscfm) | 280,310 | 262,102 |
| Isokinetic Ratio (%) | 95.5 | 98.4 |

Note: Stack flow rate as measured by an S-type pitot traverse

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE II UREA INJECTION

| PARAMETER | CYANIDE FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 3-11-93 | 3-11-93 |
| Test Number | 13A-CN-IN | 13A-CN-OUT |
| Std Sample Vol (SCF) | 13.624 | 18.023 |
| Std Sample Vol (Nm^3) | 0.359 | 0.476 |
| Moisture Fraction | 0.127 | 0.104 |
| Stack Gas Mol Wt. | 28.83 | 29.09 |
| Stack Gas Velocity (ft/sec) | 53.13 | 40.09 |
| Isokinetic Ratio (%) | 103.4 | 107.5 |
| | | |
| Date | 3/11/93 | 3-11-93 |
| Test Number | 13B-CN-IN | 13B-CN-OUT |
| Std Sample Vol (SCF) | 12.365 | 18.677 |
| Std Sample Vol (Nm^3) | 0.326 | 0.493 |
| Moisture Fraction | 0.107 | 0.101 |
| Stack Gas Mol Wt. | 29.07 | 29.12 |
| Stack Gas Velocity (ft/sec) | 49.04 | 42.93 |
| Isokinetic Ratio (%) | 100.4 | 104.1 |
| | | |
| Date | 3/11/93 | 3-11-93 |
| Test Number | 13C-CN-IN | 13C-CN-OUT |
| Std. Sample Vol. (SCF) | 12.707 | 20.077 |
| Std Sample Vol (Nm^3) | 0.335 | 0.530 |
| Moisture Fraction | 0.113 | 0.100 |
| Stack Gas Mol Wt. | 29.00 | 29.13 |
| Stack Gas Velocity (ft/sec) | 49.47 | 46.69 |
| Isokinetic Ratio (%) | 101.8 | 102.7 |

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE II UREA INJECTION

| | AMMONIA | | | |
|---|---|---|---|---|
| PARAMETER | FFDC INLET | | FFDC OUTLET | |
| Date | 3/10/93 | 3/10/93 | 3/10/93 | |
| Test Number | 10A-NH3-IN | 10B-NH3-IN | 10-NH3-OUT | |
| % H2O | 8.10 | 8.10 | 8.20 | |
| % O2 | 5.83 | 5.83 | 5.93 | |
| Date | 3/11/93 | 3/11/93 | 3/11/93 | 3/11/93 |
| Test Number | 12A-NH3-IN | 12B-NH3-IN | 12A-NH3-OUT | 12B-NH3-OUT |
| % H2O | 7.70 | 7.70 | 7.70 | 7.70 |
| % O2 | 6.06 | 6.06 | 6.41 | 6.41 |
| Date | | | 3/11/93 | 3/11/93 |
| Test Number | | | 12C-NH3-OUT | 12D-NH3-OUT |
| % H2O | | | 7.70 | 7.70 |
| % O2 | | | 6.41 | 6.41 |
| Date | | | 3/11/93 | 3/11/93 |
| Test Number | | | 12E-NH3-OUT | 12F-NH3-OUT |
| % H2O | | | 7.70 | 7.70 |
| % O2 | | | 6.41 | 6.41 |
| Date | 3/11/93 | 3/11/93 | | |
| Test Number | 13A-NH3-IN | 13B-NH3-IN | | |
| % H2O | 11.60 | 11.60 | | |
| % O2 | 6.03 | 6.03 | | |

Note: O2 and H2O from corresponding isokinetic test

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE II BASELINE

| PARAMETER | BENZENE AND TOLUENE FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 3/9/93 | 3/9/93 |
| Test Number | 8A-VOC-IN | 8A-VOC-OUT |
| % O2 | 5.68 | 6.37 |
| Date | 3/9/93 | 3/9/93 |
| Test Number | 8B-VOC-IN | 8B-VOC-OUT |
| % O2 | 5.68 | 6.37 |
| Date | 3/9/93 | 3/9/9-3 |
| Test Number | 9A-VOC-IN | 9A-VOC-OUT |
| % O2 | 5.96 | 6.09 |
| Date | 3/9/93 | 3/9/93 |
| Test Number | 9B-VOC-IN | 9B-V0C-OUT |
| % O2 | 5.96 | 6.09 |

Note: O2 values are from velocity traverses conducted concurrent with VOC tests.

(continued)

**TABLE D-4 (continued)**
**SAMPLE TRAIN TEST SUMMARY**
**SITE 115**
**PHASE II BASELINE**

| PARAMETER | CHROMIUM SPECIATION FFDC INLET |
|---|---|
| Date | 3/9/93 |
| Test Number | 8A-Cr-IN |
| Std Sample Vol (SCF) | 47.862 |
| Std Sample Vol (Nm^3) | 1.263 |
| %O2 | 5.68 |
| Moisture Fraction | 0.127 |
| Stack Gas Velocity | 44.25 |
| Isokinetic Ratio | 107.69 |
| | |
| Date | 3/9/93 |
| Test Number | 8B-CR-IN |
| Std Sample Vol (SCF) | 45.881 |
| Std Sample Vol (Nm^3) | 1.211 |
| %O2 | 5.68 |
| Moisture Fraction | 0.097 |
| Stack Gas Velocity | 43.89 |
| Isokinetic Ratio | 100.32 |
| | |
| Date | 3/9/93 |
| Test Number | 9-CR-IN |
| Std Sample Vol (SCF) | 44.980 |
| Std Sample Vol (Nm^3) | 1.187 |
| %O2 | 5.96 |
| Moisture Fraction | 0.0975 |
| Stack Gas Velocity | 44.94 |
| Isokinetic Ratio | 95.35 |

(continued)

TABLE D-4 (continued)
SAMPLE TRAIN TEST SUMMARY
SITE 115
PHASE II BASELINE

| PARAMETER | MERCURY SPECIATION FFDC INLET | FFDC OUTLET |
|---|---|---|
| Date | 3/15/93 | 3/15/93 |
| Test No. | 14A-Hg-In | 14B-Hg-Out |
| Sample Volume (m^3) | 0.0370 | 0.0583 |
| | | |
| Date | 3/15/93 | 3/15/93 |
| Test No. | 14B-Hg-IN | 14B-Hg-Out |
| Sample Volume (m^3) | 0.0360 | 0.0591 |
| | | |
| Date | 3/15/93 | 3/15/93 |
| Test No. | 14C-Hg-In | 14C-Hg-Out |
| Sample Volume (m^3) | 0.0410 | 0.0600 |

# TABLE D-5
# SAMPLE TRAIN CALCULATION PROCEDURES
# SITE 115

1. To Calculate Sample Volume, Actual Exhaust Flow Rate and Isokinetics for Each Sample Train

a. Sample gas volume, dscf

$$V_{m\,std} = 0.03342\ V_m \left(P_{bar} + \frac{H}{13.6}\right)\left(\frac{T_{ref}}{T_m}\right)(Y)$$

b. Water vapor volume, scf

$$V_{w\,std} = 0.0472\ V_{lc}\left(\frac{T_{ref}}{528\ {}^\circ R}\right)$$

c. Moisture content, nondimensional

$$B_{wo} = \frac{V_{w\,std}}{V_{m\,std} + V_{w\,std}}$$

d. Stack gas molecular weight, lb/lb mole

$$MW_{dry} = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2)$$

$$MW_{wet} = MW_{dry}\ (1 - B_{wo}) + 18\ (B_{wo})$$

e. Absolute stack pressure, in Hg

$$P_s = P_{bar} + \frac{P_{sg}}{13.6}$$

f. Stack velocity, ft/sec

$$V_s = 2.90\ C_p\ \sqrt{\Delta P T_s}\ \sqrt{\left(\frac{29.92}{P_s}\right)\left(\frac{28.95}{MW_{wet}}\right)}$$

g. Actual stack flow rate, wacfm

$$Q = (V_s)(A_s)(60)$$

h. Standard stack gas flow rate, dscfm

$$Q_{sd} = Q\ (1 - B_{wo})\left(\frac{T_{ref}}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

i. Percent isokinetic

$$I = \left(\frac{17.32(T_s)(V_{m\ std})}{(1 - B_{wo})(\Theta)(V_s)(P_s)(D_n^2)}\right)\left(\frac{528\ ^\circ R}{T_{ref}}\right)$$

2. To Calculate Particulate Emissions

a. Grain loading, gr/dscf

$$C = 0.01543\left(\frac{M_n}{V_{m\ std}}\right)$$

b. Grain loading at 12% $CO_2$, gr/dscf

$$C_{12\% CO_2} = C\left(\frac{12}{\% CO_2}\right)$$

c. Mass emissions, lb/hr

$$M = C(Q_{sd})\frac{(60\ min/hr)}{(7000\ gr/lb)}$$

3. To Calculate Gaseous Emissions, lb/hr

$$M = (ppm)(10^{-6})\left(\frac{MW_i\ lb/lb\ mole}{SV}\right)(Q_{sd})(60\ min/hr)$$

where,

$SV$ = *specific molar volume of an ideal gas*:

$$SV = 385.3\ ft^3/lb\ mole \quad for\ T_{ref} = 528\ ^\circ R$$

$$SV = 379.5\ ft^3/lb\ mole \quad for\ T_{ref} = 520\ ^\circ R$$

4. To Estimate Emissions Rates in lb/$10^6$ Btu Using EPA Method 19 and Given Fuel Analysis

a. Fuel factor at 68 °F, dscf/$10^6$ Btu at 0% $O_2$

$$F_{68} = \frac{10^6[3.64(\%H) + 1.53(\%C) + 0.14\ (\%N) + 0.57(\%S) - 0.46(\%O_2 fuel)]}{HHV,\ Btu/lb}$$

b. Fuel factor at 60 °F

$$F_{60} = F_{68}\left(\frac{520\ °R}{528\ °R}\right)$$

c. Gaseous Emissions factor, lb/$10^6$ Btu

$$\left(\frac{lb}{10^6\ Btu}\right)_i = (ppm)_i\ (10^{-6})\left(\frac{MW_i\ lb}{lb\ mole}\right)\left(\frac{1}{SV}\right)(F)\left(\frac{20.9}{20.9\ -\ \%O_2}\right)$$

d. Gaseous Emissions factor, lb/$10^{12}$ Btu

$$\left(\frac{lb}{10^{12}\ Btu}\right)_i = \left(\frac{lb}{10^6\ Btu}\right)_i \times 10^6$$

e. Particulate emission factor, lb/$10^6$ Btu

$$\left(\frac{lb}{10^6\ Btu}\right) = C\left(\frac{1\ lb}{7000\ gr}\right)(F)\left(\frac{20.9}{20.9\ -\ \%O_2}\right)$$

f. Particulate emission factor, lb/$10^{12}$ Btu

$$\left(\frac{lb}{10^{12}\ Btu}\right) = \left(\frac{lb}{10^6\ Btu}\right) \times 10^6$$

5. To Calculate Trace Species Emissions Given Laboratory Results

a. ng/sample train = (ng detected) - (ng in field or reagent blank)

b. ng/dscm = ng sample train x (35.31/$V_{m\ std}$)

c. ng/$Nm^3$ = ng/sample train x (35.31/$V_{m\ std\ dscf}$) x 528/492

d. lb/hr = ng/dscm x (1 g/$10^9$ ng) x (1 lb 454 g) x (1 $m^3$/35.31 $ft^3$) x $Q_{sd}$ x (60 min/hr)
where $Q_{sd}$ = standard flow rate, dscfm and $Nm^3$ = normal cubic meter (0°C, 1 atm)

e. lb/$10^{12}$ Btu = ng/dscm x (1$m^3$/35.31 $ft^3$) x F-factor @ 0% $O_2$, dscf/MMBtu x $10^6$ x 20.9/(20.9-$O_2$%) x (1 lb/454 g) x $10^{-9}$

f. For Formaldehyde Results
ppb = ($\mu$g/sample train) x 1/$V_{m\ std}$) x (1 lb/454 g) x (1 g/$10^6$ $\mu$g) x SV/$MW_i$ x $10^9$
lb/hr = ppb x $10^{-9}$ $MW_i$/SV x $Q_{sd}$ x 60 min/hr

g. For Anion Results
ppm = (mg/sample train) x (1/$V_{m\ std}$) x (1 lb/454 g) x (1 g/$10^3$ mg) x SV/$MW_i$ x $10^6$
lb/hr - ppm x $10^{-6}$ $MW_i$/SV x $Q_{sd}$ x 60 min/hr

Notes: Laboratory results could be in either $\mu g$ or mg. PAH, metals, chromium and formaldehyde results will be in $\mu g$ and anion results will be in mg.

Field and reagent blank values must be evaluated before subtracting them. For example, very low blanks may merely indicate "noise" and might be disregarded. On the other hand, very high blank values may indicate sampling or analysis problems which should be investigated. It may be acceptable to use a blank correction on some projects or with some reference methods. Typically a reagent blank is a more appropriate indicator of blank levels than a field blank.

6. To Calculate $CO_2$, % for Each Sample Train

a. Given CEM results for $O_2$, % and $CO_2$, % at the outlet and the portable $O_2$ meter results at each sample train.

b. $$Test\ CO_2 = CEM\ CO_2 \times \frac{20.9 - test\ O_2}{20.9 - CEM\ O_2}$$

7. To Construct a Mass Balance Around the Boiler-Stack System for a Given Parameter, *i*

a. Given flue gas, ash and fuel sample results.

b. $M_i$ (fuel) = $M_i$ (flue gas outlet) + $M_i$ (ash),
where $M_i$ is in units of either $lb_i/hr$ or $lb_i/10^{12}$ Btu and *i* denotes the particular parameter of interest.

8. To Calculate Exhaust Gas Flow Rate from Heat Rate and F-factor:

Flow rate, dscfm = Heat rate, Btu/kW(net)-hr x (Gross Load, kW - Aux. Demand, kW) x F-factor @ 0% $O_2$, dscf/MMBtu x 20.9/(20.9-%$O_2$) x hr/60 mi

9. To Calculate Ash Flow Rate and lb ash/$10^6$ Btu

a. total ash input, lb/hr = % ash in fuel (dry)/100 x coal flow rate (dry), lb/hr

b. bottom ash rate, lb/hr = (total ash input, lb/hr - (inlet particulate ash rate, lb/hr x (100 - flyash % LOI)/100)) x (100 + bottom ash % LOI)/100

c. fly ash rate, lb/hr = inlet particulate ash rate, lb/hr - outlet particulate ash rate, lb/hr

d. total ash input, lb/$10^6$ Btu = % ash in fuel (dry)/100 x coal flow rate (dry) lb/$10^6$ Btu

e. bottom ash rate, lb/$10^6$ Btu = (total ash input, lb/$10^6$ Btu - (inlet particulate ash rate, lb/$10^6$ Btu x (100 - flyash % LOI)/100) x (100 + bottom ash % LOI)/100

f. fly ash rate, lb/$10^6$ Btu = inlet particulate ash rate, lb/$10^6$ Btu - outlet particulate ash rate lb/$10^6$ Btu

10. <u>To Calculate lb/hr and lb/$10^{12}$ Btu of a species (*i*) in ash (*a*)</u>

a. $\mu g(i)/g(a) = lb(i)/10^6\ lb(a)$

b. $lb(i)/hr = lb(i)/10^6\ lb(a)$ x Ash Flow, $lb(a)/hr \times 10^{-6}$

c. $lb(i)/10^{12}\ Btu(f) = lb(i)/10^6\ lb(a)$ x Ash Flow, $lb(a)/10^6$ Btu (fuel)

11. <u>To Calculate lb/hr and lb/$10^{12}$ Btu of a species (*i*) in fuel (*f*)</u>

a. $\mu g(i)/g(f) = lb(i)/10^6\ lb(f)$

b. $lb(i)/hr = lb(i)/10^6\ lb(f)$ x Fuel Flow, $lb(f)/hr \times 10^{-6}$

c. $lb(i)/10^{12}\ Btu(f) = lb(i)/10^6\ lb(f) \times 1/HHV,\ Btu(f)/lb(f) \times 10^6$

12. <u>Nomenclature:</u>

| | | |
|---|---|---|
| $A_s$ | = | stack area, $ft^2$ |
| $B_{wo}$ | = | flue gas moisture content |
| $C_{12\%\ CO_2}$ | = | particulate grain loading, gr/dscf corrected to 12% $CO_2$ |
| $C$ | = | particulate grain loading, gr/dscf |
| $C_p$ | = | pitot calibration factor, dimensionless |
| $Dn$ | = | nozzle diameter, in. |
| $F$ | = | fuel F factor, dscf/$10^6$ Btu at 0% $O_2$ |
| $H$ | = | orifice pressure differential, iwg |
| $I$ | = | % isokinetics |
| $M_n$ | = | mass of collected particulate, mg |
| $M_i$ | = | mass emissions of species i, lb/hr |
| $MW$ | = | molecular weight of flue gas |

| | | |
|---|---|---|
| $MW_i$ | = | molecular weight of species i: |
| | | $NO_x$ : 46 |
| | | CO : 28 |
| | | $SO_x$ : 64 |
| | | HC : 16 |
| $\theta$ | = | sample time, min. |
| $\Delta P$ | = | average velocity head, iwg = $\left(\overline{\sqrt{\Delta P}}\right)^2$ |
| $P_{bar}$ | = | barometric pressure, in.Hg |
| $P_s$ | = | stack absolute pressure, in.Hg |
| $P_{sg}$ | = | stack static pressure, iwg |
| $Q$ | = | wet stack gas flow rate at actual conditions, wacfm |
| $Qsd$ | = | dry stack gas flow rate at standard conditions, dscfm |
| $SV$ | = | specific molar volume of an ideal gas at standard conditions, $ft^3$/lb mole |
| $Tm$ | = | meter temperature, °R |
| $T_{ref}$ | = | reference temperature, °R |
| $Ts$ | = | stack temperature, °R |
| $V_s$ | = | stack velocity, ft/sec |
| $V_{lc}$ | = | volume of liquid collected in impingers, ml |
| $Vm$ | = | dry meter volume uncorrected, dcf |
| $V_{m\ std}$ | = | dry meter volume at standard conditions, dscf |
| $V_{w\ std}$ | = | volume of water vapor at standard conditions, scf |
| $Y$ | = | meter calibration coefficient |

# APPENDIX E
# PROCESS OPERATION

# TABLE E-1
## SUMMARY OF UNIT OPERATION
## SITE 115
## PHASE I: BASELINE

| Test No. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Date | 11/17 | 11/17 | 11/18 | 11/18 | 11/19 | 11/19 |
| Unit load, MW gross | 102 | 104 | 103 | 104 | 104 | 104 |
| Steam flow, lb/hr | 836,000 | 851,000 | 836,000 | 851,000 | 853,000 | 852,000 |
| Air flow, lb/hr | 874,000 | 895,000 | 886,000 | 901,000 | 901,000 | 884,000 |
| Fuel flow, lb/hr | 86,837 | 91,797 | 88,919 | 91,265 | 88,752 | 90,452 |
| FFDC Outlet $O_2$ | | | | | | |
| % dry | 5.57 | 5.88 | 5.75 | 5.90 | 5.65 | 5.49 |
| % wet | 5.51 | 5.63 | 5.51 | 5.57 | 5.45 | 5.27 |
| FFDC Inlet $O_2$ | | | | | | |
| % dry | 5.66 | 5.68 | 5.69 | 5.79 | 5.47 | 5.41 |
| % wet | 5.06 | 5.13 | 5.06 | 5.06 | 4.72 | 4.84 |

Fuel flow from plant instrumentation.
FFDC Outlet wet and dry $O_2$ from single point CEMS.
FFDC Inlet dry $O_2$ from 6 point CEM grid.
FFDC Inlet wet $O_2$ from single point CEM.

# TABLE E-2
## SUMMARY OF UNIT OPERATION
## SITE 115
## PHASE II: BASELINE AND UREA INJECTION

| Test No. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|
| Date | 3/8/93 | 3/9/93 | 3/10/93 | 3/10/93 | 3/11/93 | 3/11/93 | 3/11/93 | 3/15/93 |
| Unit load, MW gross | 104 | 104 | 103 | 103 | 104 | 106 | 115 | 103 |
| Steam flow, lb/hr | 854,000 | 852,000 | 850,000 | 846,000 | 855,000 | 870,000 | 951,000 | 846,000 |
| Air flow, lb/hr | 854,000 | 874,000 | 889,000 | 838,000 | 875,000 | 891,000 | 980,000 | 869,000 |
| Fuel flow, lb/hr | 82,161 | 83,883 | 89,276 | 88,972 | 96,098 | 93,683 | 111,822 | 84,658 |
| Urea, % | N/A | N/A | N/A | 32.5 | 32.5 | 32.5 | 32.5 | N/A |
| Urea Injection Rate, gpm | N/A | N/A | N/A | 1.07 | 1.07 | 1.04 | 1.04 | N/A |
| FFDC Outlet $O_2$ | | | | | | | | |
| % dry | 6.47 | 6.55 | 6.82 | 6.62 | 6.73 | 6.99 | 6.85 | 6.68 |
| % wet | 5.94 | 6.01 | 6.24 | 6.03 | 6.13 | 6.38 | 6.24 | 6.11 |
| Economizer Outlet $O_2$ | | | | | | | | |
| % dry | 5.72 | 5.68 | 5.96 | 5.83 | 5.91 | 6.06 | 6.03 | 5.85 |
| FFDC Inlet $O_2$ | | | | | | | | |
| % wet | 5.57 | 5.58 | 5.84 | 5.73 | 5.71 | 6.14 | 6.12 | 5.79 |

Fuel flow from plant instrumentation.
FFDC Outlet wet and dry $O_2$ from single point CEM
Economizer Outlet $O_2$ from 12 point CEM grid.

Figure E-1 Unit Operation Parameters Site 115 Phase I Baseline

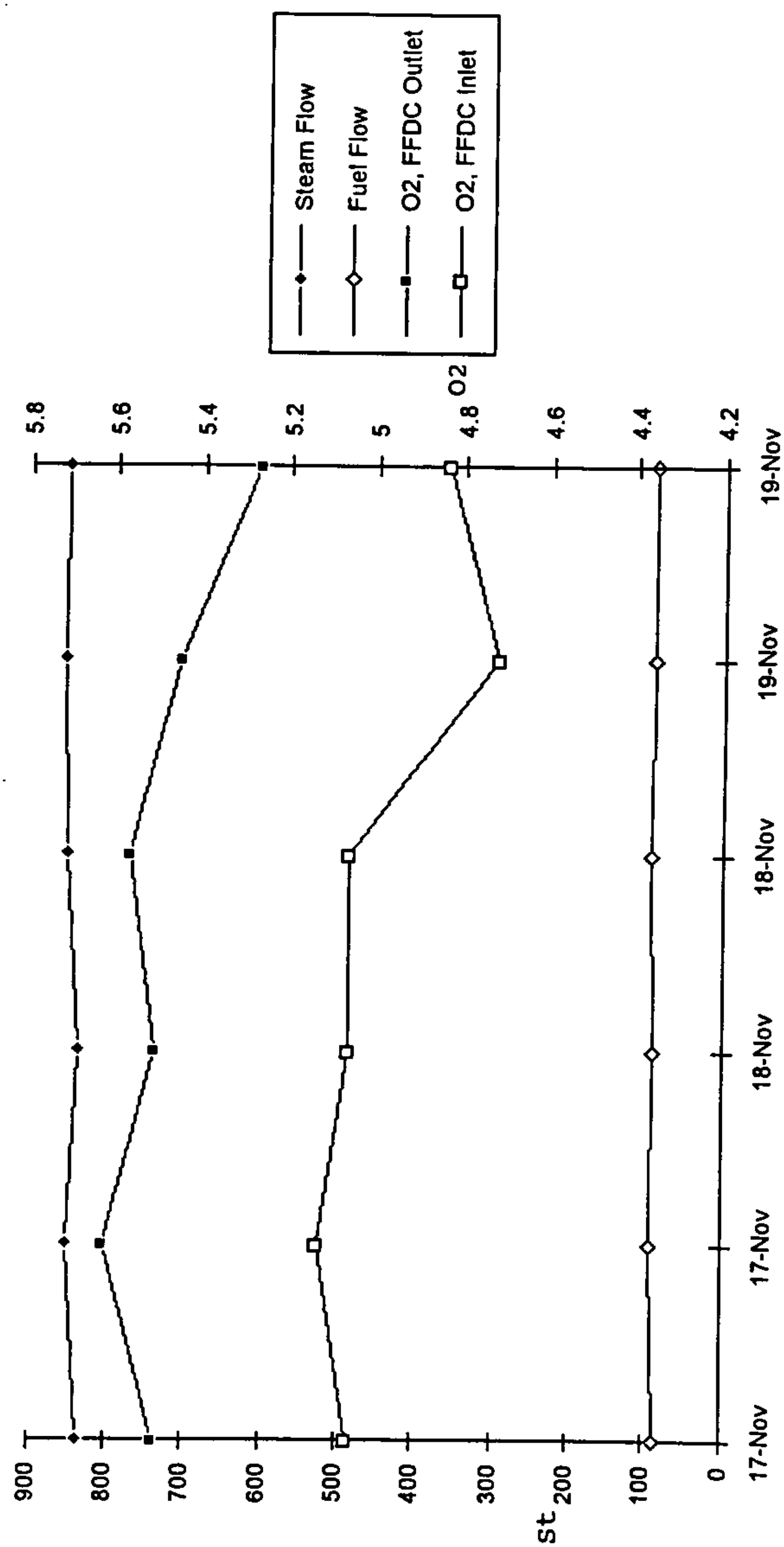
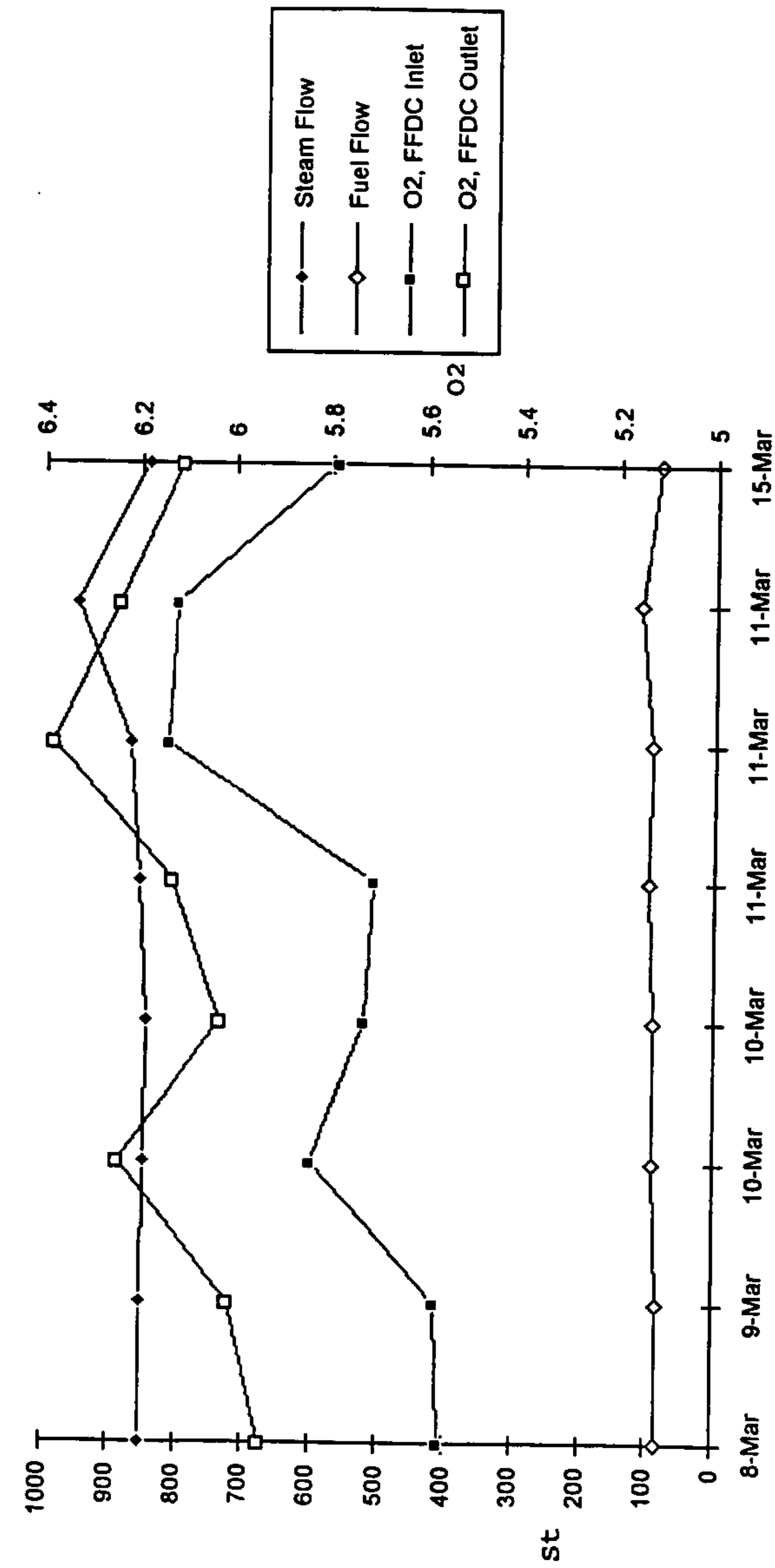


**Figure E-2 Unit Operation Parameters Site 115 Phase II Baseline and Urea Injection**



# APPENDIX F
# UNCERTAINTY ANALYSIS

Because the data generated in this program may be used in conducting risk assessments and in making policy and regulatory decisions, consideration of the uncertainties in the results generated in the program are important. Assessment of the uncertainty level of a measurement is especially important when the measured results are near the detection level of the methods.

In calculating uncertainties that are presented in this report, procedures were followed that have been previously established for PISCES data treatment. This procedure involved calculating an overall uncertainty for each result using standard statistical techniques and known measurement biases. An error propagation analysis was performed on calculated results to determine the contribution of process, sampling and analytical variability, and measurement bias, to the overall uncertainty in the result. This uncertainty was determined by propagating the bias and precision error of individual parameters in the calculation of the results.

This uncertainty does not represent the total uncertainty in the result since many important bias errors are unknown and have been assigned a value of zero for this analysis. This uncertainty is only the uncertainty in the result for the period of time that the measurements were taken and does not represent long-term process variations. In addition, the following calculations assume that the population distribution of each measurement is normally distributed and that the samples collected reflect the true population.

The method described below is based on ANSI/ASME PTC 19.1-1985, "Measurement Uncertainty."

Nomenclature

$r$ = Calculated result;
$S_{pi}$ = Sample standard deviation of parameter $i$;
$S_{\overline{pi}}$ = Standard deviation of the average of parameter $i$;
$\Theta_i$ = Sensitivity of the result to parameter $i$;
$B_{pi}$ = Bias error estimate for parameter $i$;
$v_i$ = Degrees of freedom in parameter $i$;
$v_r$ = Degrees of freedom in result;
$S_r$ = Precision component of result uncertainty;
$B_r$ = Bias component of result uncertainty;
$t$ = Student "t" factor (two-tailed distribution at 95%);
$U_r$ = Uncertainty in r;
$P_i$ = Parameter $i$;
$\Delta P_i$ = Perturbation in parameter $i$;
$N_i$ = Number of measurements of parameter $i$; and
$E$ = Emission rate

For a result, $r$, the uncertainty in $r$ is calculated as:

$$U_r = \sqrt{B_r^2 + (S_r * t)^2}$$

The components are calculated by combining the errors in the parameters used in the result calculation.

$$B_r = \sqrt{\sum_{i=1}^{j} (\theta_i * B_{pi})^2}$$

$$S_r = \sqrt{\sum_{i=1}^{j} (\theta_i * S_{\overline{pi}})^2}$$

The sensitivity of the result to each parameter is found from a Taylor series estimation method:

$$\theta_1 = \frac{\partial r}{\partial pi}$$

Or using a perturbation method (useful in computer applications):

$$\theta_i = \frac{r(P_i + \Delta P_i) - r(P_i)}{\Delta P_i}$$

The standard deviation of the average for each parameter is calculated as:

$$S_{\overline{pi}} = \frac{S_{pi}}{\sqrt{N_i}}$$

The degrees of freedom for each parameter is found from

$$v_i = N_i - 1$$

and the degrees of freedom for the result is found be weighing the sensitivity and precision error in each parameter.

$$v_r = \frac{S_r^4}{\sum_{i=1}^{j} \left[ \frac{(S_{\overline{pi}} * \theta_i)^4}{v_i} \right]}$$

The Student "t" in the first equation is associated with the degrees of freedom in the result.

The precision error terms are generated using collected data, and assigning degrees of freedom to each parameter. Bias errors are more qualitative in nature. Bias values are assigned based on observation of the process and engineering judgment.

For this report the following sources of bias and uncertainty were considered:

- No bias was assigned to analytical results unless the result is less than the detection limit. Then one-half the detection limit is used for both the parameter value and its bias in calculations.

  This bias component for results below the detection limit is calculated as:

  $$B_{pi} = \sqrt{\sum_{i=1}^{N_i} \left(B_i * \frac{1}{N_i}\right)^2}$$

- The nonaxial nature of the flue gas flow at the FFDC inlet and outlet sample locations in combination with the inherent high bias of S-type pitot probes resulted in measured velocities that were higher than flow rates calculated from unit heat rate information and stoichiometric calculations. Flow rates measured during Phase I were 10% higher than heat rate flow rates at the FFDC outlet and 19% higher at the inlet. Measured velocities for Phase II Urea Injection Tests were 7% higher than heat rate flow rates at the FFDC outlet and 18% higher at the inlet. During all isokinetic tests, sample flow rates was set based on the faster velocity indicated by the pitot probe, as specified in EPA Methods 1, 2, and 5. This means that "true" isokinetic sampling rates may have been low. Estimating errors induced by nonisokinetic sampling, this would correspond to an uncertainty of the same magnitude in the concentrations of particulate species. These uncertainties were applied to all particulate species for Phases I and II.

- The inlet sample location does not meet the minimum EPA flow disturbance criteria for an acceptable sample location. According to the procedures for alternate site election described in EPA Method 1, Section 2.5, a three-dimensional velocity traverse was performed at this location and the results show that this location meets the acceptability requirements as an alternative sampling site. The overall resultant angle was 9.9° with a standard deviation of 7.6°. Although the resultant angle is below twenty degrees, which is the maximum value acceptable, it still has an impact on velocities measured by a type-S pitot probe. Exhaust gas flow rates measured at the inlet sample location during Phase I were 19% higher than those calculated from the plant's heat rate and 9% higher than outlet flow rates. Phase II FFDC inlet measured flow rates were 14-18% higher than heat rate flow rates and 7-11% higher than outlet flow rates. Because of the higher uncertainty associated with inlet measured flow rates during both phases, outlet flow rates were corrected to inlet $\%O_2$ levels and used for inlet lb/hr calculations. Therefore, the uncertainty for outlet flow rates was applied to both inlet and outlet flow rates for Phase I (10%) and Phase II (7%).

- No uncertainty value was assigned to fuel and ash sample concentrations due to non-representative sampling procedures. The magnitude and direction of such an uncertainty is unknown.

- The fuel flow was volumetrically measured by a revolution totalizer on each mill feeder. This method has inherently large uncertainties associated with it. Fuel flow rate uncertainty was estimated by the difference between measured fuel flow rates and heat rate calculated flow rates. This uncertainty was used for fuel and bottom ash uncertainties where the measured fuel flow is a variable.

- The inlet particulate flow rates are used to calculate fly ash flow rates. Uncertainty in fly ash flow rates was estimated by the combination of the inlet particle collection uncertainty and the inlet exhaust gas flow rate uncertainty. This combined uncertainty is 21% for Phase I and 16% for Phase II.

- Both the inlet particulate flow rates and the fuel flow rates are used to calculate bottom ash flow rates, so a bottom ash flow rate uncertainty was estimated by combining the uncertainties associated with inlet particle collection, inlet flow rates, and fuel flow rates. This combined uncertainty was 22% for Phase I and 16% for Phase II.

In interpreting and understanding the uncertainty values, it should be pointed out that when two levels of uncertainty are combined using a root-sum-squared process, the larger uncertainty predominates. A few examples are presented below:

- Combining two uncertainties of 10% results in a total uncertainty of 14%.

- Combining uncertainties of 50% and 8% results in a total uncertainty of 51%.

- Combining uncertainties of 90% and 10% results in an uncertainty of 90.5%.

Confidence Interval Calculations

In this report the confidence interval as a percent uncertainty is reported with the sample results. The uncertainty values calculated for this report are based on the 95% confidence interval calculated for mass emissions of the target species. This confidence interval equation propagates the error associated with the parameters required to determine concentration, mass emissions, and emission factors. The uncertainty is then expressed as a percentage so that it may be applied to an average result expressed in the required units.

Emission factors are calculated in units of $lb/10^{12}$ Btu. However, the equations used for uncertainty calculations are in mass emission units of lb/hr since these equations allow for an estimate of overall uncertainty incorporating all parameters.

The following are sample calculations for the 95% confidence interval around the mean emission rate for air, fuel and ash samples. This procedure utilized the same method outlined earlier in this section and used in the computer program.

FLUE GAS

$$E,\ lb/hr = Concentration,\ \frac{\mu g}{Nm^3} \times Pitot\ Flow\ Rate,\ dscfm \times 3.4876 \times 10^{-9}$$

FUEL

$$E,\ lb/hr = Concentration,\ \frac{mg}{kg} \times Heat\ Rate,\ \frac{Btu}{MW\text{-}hr} \times 10^{-6} \times Load,\ MW \times \frac{1}{HHV,\ Btu/lb}$$

where

$$Heat\ Rate, \frac{Btu}{MW\text{-}hr} = HHV\ of\ fuel,\ Btu/lb \times Fuel\ Flow,\ lb/hr + Load,\ MW$$

FLY ASH

$$E,\ lb/hr = Concentration,\ \frac{mg}{kg} \times FlyAshRate,\ \frac{lb(ash)}{MWhr} \times Load,\ MW \times 10^{-6}$$

where

$$Fly\ Ash\ Rate = Fly\ Ash\ Flow\ Rate,\ lb/hr + Load,\ MW\text{-}hr$$

BOTTOM ASH

$$E,\ lb/hr = Concentration,\ \frac{mg}{kg} \times 10^{-6} \times \frac{1}{HHV,\ Btu/lb} \times \left(\frac{Ash\ Flow\ Rate}{Fuel\ Flow\ Rate}\right)_{,} \frac{lb\ (ash)}{lb\ (fuel)}$$

$$\times\ Heat\ Rate,\ \frac{Btu}{MWhr} \times Load,\ MW$$

The following example calculation shows how the overall uncertainty of the Phase I outlet vanadium value from this program was determined.

| Parameter | Units | Run 1 | Run 2 | Run 3 | Mean |
|---|---|---|---|---|---|
| Concentration | μg/Nm³ | 0.36 | 0.17 | 0.39 | 0.31 |
| Pitot Flow Rate | dscfm/MW-hr | 245,700 | 253,100 | 264,900 | 254,500 |

The sensitivity of each variable is calculated with a perturbation for each parameter that is equal to the larger value of the standard deviation of the average, $S_{\overline{pi}}$, or the bias error, $B_{pi}$. For the concentration variable:

$$S_{\overline{pi}} = \frac{S_{pi}}{\sqrt{N_i}} = \frac{0.12}{\sqrt{3}} = 0.07$$

$$E_{(i = 0.31)} = 0.31 \times 254{,}600 \times 3.4876 \times 10^{-9} = 2.7 \times 10^{-4}$$

$$E_{(i = 0.38)} = 0.38 \times 254{,}600 \times 3.4876 \times 10^{-9} = 3.3 \times 10^{-4}$$

$$\theta_i = \frac{E_{(Pi+\Delta Pi)} - E_{Pi}}{\Delta P_i} = \frac{E_{(i=0.38)} - E_{(i=0.31)}}{0.07}$$

$$\theta_i = \frac{3.3 \times 10^{-4} - 2.7 \times 10^{-4}}{0.07} = 0.0009$$

Similar calculations for each parameter produce the following results:

| | PARAMETER | |
|---|---|---|
| | Concentration, $\mu g/Nm^3$ | Pitot Flow Rate, dscfm |
| Mean | 0.31 | 254,600 |
| $S_{pi}$ | 0.12 | 9700 |
| $S_{\overline{pi}}$ | 0.07 | 5600 |
| $N_i$ | 3 | 3 |
| $B_{pi}$ | 0.03 | 25,500 |
| $\Theta_i$ | $9 \times 10^{-4}$ | $1 \times 10^{-9}$ |
| $\nu_i$ | 2 | 2 |
| $\Delta P_i$ | 0.07 | 25,500 |

# METALS
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE I -- BASELINE
# PAGE 1 OF 3

| SPECIES | LOC | RUN #1 | RUN #2 in ug/Nm3 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | |
| ARSENIC | IN | 33.5 | 19.4 | 37.0 | 3.00E+01 | 9.33E+00 | 77.7% | 21.5% | 80.6% | 2.65E-02 | 2.1E-02 | 23.53% | 0.0% |
| BARIUM | | 237.5 | 88.4 | 588 | 3.05E+02 | 2.57E+02 | 209.3% | 21.5% | 210.4% | 2.70E-01 | 5.7E-01 | 62.02% | 0.0% |
| BERYLLIUM | | 6.7 | 14.4 | 14.1 | 1.17E+01 | 4.34E+00 | 92.4% | 21.5% | 94.8% | 1.04E-02 | 9.8E-03 | 28.52% | 0.0% |
| CADMIUM | | 2.5 | 2.7 | 3.7 | 2.96E+00 | 6.58E-01 | 55.7% | 21.5% | 59.7% | 2.62E-03 | 1.6E-03 | 16.79% | 0.0% |
| CHROMIUM | | 36.7 | 84.8 | 73.6 | 6.50E+01 | 2.52E+01 | 96.4% | 21.5% | 98.8% | 5.75E-02 | 5.7E-02 | 29.04% | 0.0% |
| COBALT | | 21.6 | 50.4 | 44.4 | 3.88E+01 | 1.52E+01 | 97.7% | 21.5% | 100.0% | 3.43E-02 | 3.4E-02 | 29.59% | 0.0% |
| COPPER | | 248.8 | 197.2 | 214.2 | 2.20E+02 | 2.63E+01 | 30.6% | 21.5% | 37.3% | 1.95E-01 | 7.3E-02 | 8.70% | 0.0% |
| LEAD | | 147.3 | 36.3 | 65.0 | 8.29E+01 | 5.76E+01 | 172.8% | 21.5% | 174.1% | 7.33E-02 | 1.3E-01 | 51.80% | 0.0% |
| MANGANESE | | 149 | 310 | 300 | 2.53E+02 | 9.04E+01 | 89.1% | 21.5% | 91.7% | 2.24E-01 | 2.1E-01 | 27.48% | 0.0% |
| MERCURY | | 2.4 | 1.5 | 1.3 | 1.72E+00 | 6.14E-01 | 88.7% | 21.5% | 91.3% | 1.53E-03 | 1.4E-03 | 26.89% | 0.0% |
| MOLYBDENUM | | 7.8 | 15.5 | 18.5 | 1.40E+01 | 5.52E+00 | 98.6% | 21.5% | 100.9% | 1.23E-02 | 1.2E-02 | 29.31% | 0.0% |
| NICKEL | | 19.4 | 50.4 | 48.1 | 3.93E+01 | 1.73E+01 | 109.7% | 21.5% | 111.8% | 3.48E-02 | 3.9E-02 | 33.84% | 0.0% |
| SELENIUM | | 23.5 | 34.1 | 29.6 | 2.91E+01 | 5.37E+00 | 46.4% | 21.5% | 51.1% | 2.57E-02 | 1.3E-02 | 12.89% | 0.0% |
| PHOSPHORUS | | 17,867 | 19,009 | 18,889 | 1.86E+04 | 6.27E+02 | 7.2% | 21.5% | 22.6% | 1.64E+01 | 3.7E+00 | 2.59% | 0.0% |
| VANADIUM | | 100.3 | 213.1 | 214.6 | 1.76E+02 | 6.56E+01 | 92.9% | 21.5% | 95.3% | 1.56E-01 | 1.5E-01 | 28.68% | 0.0% |
| | | | | | | AVERAGES: | 91.0% | 21.5% | 94.7% | 1.17E+00 | 3.4E-01 | 27.44% | |
| METALS: | | | | | | | | | | | | | |
| ARSENIC | OUT | 0.47 | 1.79 | 0.65 | 9.72E-01 | 7.13E-01 | 182.6% | 14.1% | 183.1% | 8.63E-04 | 1.6E-03 | 56.04% | 0.0% |
| BARIUM | | 2.23 | 0.56 | 1.57 | 1.45E+00 | 8.39E-01 | 144.0% | 14.1% | 144.7% | 1.29E-03 | 1.9E-03 | 40.99% | 0.0% |
| BERYLLIUM | | ND< 0.03 | ND< 0.03 | ND< 0.03 | ND< 2.73E-02 | 1.00E-03 | 8.5% | 32.2% | 33.3% | ND< 2.42E-05 | 8.1E-06 | 2.82% | 100.0% |
| CADMIUM | | 0.28 | 0.14 | ND< 0.08 | 1.52E-01 | 1.20E-01 | 195.8% | 16.5% | 196.5% | 1.35E-04 | 2.7E-04 | 55.04% | 8.6% |
| CHROMIUM | | 0.72 | 0.70 | 1.12 | 8.49E-01 | 2.39E-01 | 70.6% | 14.1% | 72.0% | 7.53E-04 | 5.4E-04 | 21.65% | 0.0% |
| COBALT | | ND< 0.28 | ND< 0.28 | ND< 0.26 | ND< 2.73E-01 | 1.00E-02 | 8.5% | 32.2% | 33.3% | ND< 2.42E-04 | 8.1E-05 | 2.82% | 100.0% |
| COPPER | | 1.64 | 1.59 | 1.02 | 1.42E+00 | 3.46E-01 | 61.3% | 14.1% | 62.9% | 1.26E-03 | 7.9E-04 | 18.72% | 0.0% |
| LEAD | | 0.61 | 0.56 | 0.52 | 5.65E-01 | 4.48E-02 | 16.2% | 14.1% | 21.5% | 5.01E-04 | 1.1E-04 | 5.60% | 0.0% |
| MANGANESE | | 1.34 | 1.87 | 0.65 | 1.29E+00 | 6.11E-01 | 118.3% | 14.1% | 119.1% | 1.14E-03 | 1.4E-03 | 32.81% | 0.0% |
| MERCURY | | ND< 0.28 | ND< 0.45 | ND< 0.39 | ND< 3.72E-01 | 8.62E-02 | 58.2% | 32.6% | 66.7% | ND< 3.31E-04 | 2.2E-04 | 16.88% | 100.0% |
| MOLYBDENUM | | 0.22 | 0.22 | 0.21 | 2.18E-01 | 8.02E-03 | 8.5% | 14.1% | 16.5% | 1.94E-04 | 3.2E-05 | 2.82% | 0.0% |
| NICKEL (1) | | 1.31 | 2.51 | | 1.91E+00 | 8.49E-01 | 400.1% | 14.1% | 400.4% | 1.70E-03 | 6.8E-03 | 62.83% | 0.0% |
| SELENIUM | | 0.42 | 0.73 | 0.26 | 4.68E-01 | 2.37E-01 | 125.9% | 14.1% | 126.7% | 4.16E-04 | 5.3E-04 | 36.73% | 0.0% |
| PHOSPHORUS | | 8.07 | 8.66 | 9.15 | 8.63E+00 | 5.43E-01 | 13.5% | 14.1% | 19.6% | 7.66E-03 | 1.5E-03 | 4.33% | 0.0% |
| VANADIUM | | 0.36 | 0.17 | 0.39 | 3.07E-01 | 1.19E-01 | 97.1% | 14.1% | 98.1% | 2.72E-04 | 2.7E-04 | 29.71% | 0.0% |
| | | | | | | AVERAGES: | 100.6% | 17.9% | 106.3% | 1.12E-03 | 1.1E-03 | 25.99% | |

Notes: (1) Nickel result for Run #1 not used in average, avg. of Run#2,3 used

PRELIMINARY

DO NOT CITE OR QUOTE

[UNAIR.XLW]UNMETALS.XLS
5:36 PM
11/8/93

The precision and bias components are then calculated by root-sum-squaring the product of the parameter $S_{\overline{pi}}$ or $B_{pi}$ and the sensitivity:

$$S_r = \sqrt{(\theta_i * S_{\overline{pi}})^2 + (\theta_{fr} * S_{\overline{pfr}})^2}$$

$$S_r = 6 \times 10^{-5}$$

$$B_r = \sqrt{(\theta_i * B_{pi})^2 + (\theta_{fr} * B_{pfr})^2}$$

$$B_r = 4 \times 10^{-5}$$

The Student "t" factor for two degrees of freedom and a 95% confidence interval is 4.3.

The uncertainty in the result is then

$$U_r = \sqrt{B_r^2 + (S_r * t)^2} = \sqrt{(4 \times 10^{-5})^2 + (6 \times 10^{-5} \times 4.3)^2} = 0.0003$$

The overall emission rate is reported as

0.0003 ± 0.0003 lb/hr or 98% uncertainty.

# METALS - UNCERTAINTY ANALYSIS SITE 115, PHASE I -- BASELINE PAGE 2 OF 3

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| METALS IN: | | | | | | | | | |
| FLOW RATE, pitot | 247,183 | 252,067 | 261,773 | 253,674 | 7427 | 2.93% | 4288 | 10.00% | 25367 |
| Particle Collection Bias | | | | | | | | 19.00% | |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| METALS OUT: | | dscfm | | | | | | | |
| FLOW RATE, pitot | 245,732 | 253,065 | 264,863 | 254,553 | 9652 | 3.79% | 5573 | 10.00% | 25455 |
| Particle Collection Bias | | | | | | | | 10.00% | |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

[UNAIR.XLW]UNMETALS.XLS
5:38 PM
11/8/93

# METALS -
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE I -- BASELINE


PRELIMINARY

| SPECIES METALS: | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | Flow Rt. (THETAhr) | xxxxxx (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | IN | 5.39E+00 | 0.00E+00 | ** BIAS ** | 5.70E+00 | 8.8E-04 | 1.0E-07 | 0.0E+00 | 4.8E-03 | 5.7E-03 | 2.04 | 2 | 4.3 | 2.1E-02 | 80.6% |
| BARIUM | | 1.48E+02 | 0.00E+00 | NSTDV | 5.79E+01 | 8.8E-04 | 1.1E-06 | 0.0E+00 | 1.3E-01 | 5.8E-02 | 2.00 | 2 | 4.3 | 5.7E-01 | 210.4% |
| BERYLLIUM | | 2.51E+00 | 0.00E+00 | NSTDV | 2.22E+00 | 8.8E-04 | 4.1E-08 | 0.0E+00 | 2.2E-03 | 2.2E-03 | 2.02 | 2 | 4.3 | 9.8E-03 | 94.8% |
| CADMIUM | | 3.80E-01 | 0.00E+00 | ** BIAS ** | 5.62E-01 | 8.8E-04 | 1.0E-08 | 0.0E+00 | 3.4E-04 | 5.6E-04 | 2.07 | 2 | 4.3 | 1.6E-03 | 59.7% |
| CHROMIUM | | 1.45E+01 | 0.00E+00 | NSTDV | 1.24E+01 | 8.8E-04 | 2.3E-07 | 0.0E+00 | 1.3E-02 | 1.2E-02 | 2.02 | 2 | 4.3 | 5.7E-02 | 98.8% |
| COBALT | | 8.79E+00 | 0.00E+00 | NSTDV | 7.38E+00 | 8.8E-04 | 1.4E-07 | 0.0E+00 | 7.8E-03 | 7.4E-03 | 2.02 | 2 | 4.3 | 3.4E-02 | 100.0% |
| COPPER | | 1.52E+01 | 0.00E+00 | ** BIAS ** | 4.18E+01 | 8.8E-04 | 7.7E-07 | 0.0E+00 | 1.4E-02 | 4.2E-02 | 2.24 | 2 | 4.3 | 7.3E-02 | 37.3% |
| LEAD | | 3.32E+01 | 0.00E+00 | NSTDV | 1.57E+01 | 8.8E-04 | 2.9E-07 | 0.0E+00 | 2.9E-02 | 1.6E-02 | 2.01 | 2 | 4.3 | 1.3E-01 | 174.1% |
| MANGANESE | | 5.22E+01 | 0.00E+00 | NSTDV | 4.80E+01 | 8.8E-04 | 8.8E-07 | 0.0E+00 | 4.6E-02 | 4.8E-02 | 2.03 | 2 | 4.3 | 2.1E-01 | 91.7% |
| MERCURY | | 3.54E-01 | 0.00E+00 | NSTDV | 3.28E-01 | 8.8E-04 | 6.0E-09 | 0.0E+00 | 3.1E-04 | 3.3E-04 | 2.03 | 2 | 4.3 | 1.4E-03 | 91.3% |
| MOLYBDENUM | | 3.19E+00 | 0.00E+00 | NSTDV | 2.65E+00 | 8.8E-04 | 4.9E-08 | 0.0E+00 | 2.8E-03 | 2.7E-03 | 2.02 | 2 | 4.3 | 1.2E-02 | 100.9% |
| NICKEL | | 1.00E+01 | 0.00E+00 | NSTDV | 7.47E+00 | 8.8E-04 | 1.4E-07 | 0.0E+00 | 8.9E-03 | 7.5E-03 | 2.02 | 2 | 4.3 | 3.9E-02 | 111.8% |
| SELENIUM | | 3.10E+00 | 0.00E+00 | ** BIAS ** | 5.52E+00 | 8.8E-04 | 1.0E-07 | 0.0E+00 | 2.8E-03 | 5.5E-03 | 2.10 | 2 | 4.3 | 1.3E-02 | 51.1% |
| PHOSPHORUS | | 3.62E+02 | 0.00E+00 | ** BIAS ** | 3.53E+03 | 8.8E-04 | 6.5E-05 | 0.0E+00 | 4.2E-01 | 3.5E+00 | 3.92 | 4 | 2.78 | 3.7E+00 | 22.6% |
| VANADIUM | | 3.79E+01 | 0.00E+00 | NSTDV | 3.34E+01 | 8.8E-04 | 6.1E-07 | 0.0E+00 | 3.4E-02 | 3.3E-02 | 2.02 | 2 | 4.3 | 1.5E-01 | 95.3% |
| | | | | | | | | | | | | | | | 94.7% |

| METALS: | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | Part. Coll. Eff. Bias | THETA CALCULATIONS FOR: CONC. | Flow Rt. | xxxxxx | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | OUT | 4.12E-01 | 0.00E+00 | NSTDV | 9.72E-02 | 8.9E-04 | 3.4E-09 | 0.0E+00 | 3.7E-04 | 1.2E-04 | 2.01 | 2 | 4.3 | 1.6E-03 | 183.1% |
| BARIUM | | 4.85E-01 | 0.00E+00 | NSTDV | 1.45E-01 | 8.9E-04 | 5.1E-09 | 0.0E+00 | 4.3E-04 | 1.8E-04 | 2.02 | 2 | 4.3 | 1.9E-03 | 144.7% |
| BERYLLIUM | | 5.79E-04 | 7.88E-03 | ** BIAS ** | 2.73E-03 | 8.9E-04 | 9.5E-11 | 0.0E+00 | 7.4E-07 | 7.8E-06 | 4.00 | 4 | 2.78 | 8.1E-06 | 33.3% |
| CADMIUM | | 6.93E-02 | 1.31E-02 | NSTDV | 1.52E-02 | 8.9E-04 | 5.3E-10 | 0.0E+00 | 6.2E-05 | 2.2E-05 | 2.01 | 2 | 4.3 | 2.7E-04 | 196.5% |
| CHROMIUM | | 1.38E-01 | 0.00E+00 | NSTDV | 8.49E-02 | 8.9E-04 | 3.0E-09 | 0.0E+00 | 1.2E-04 | 1.1E-04 | 2.07 | 2 | 4.3 | 5.4E-04 | 72.0% |
| COBALT | | 5.79E-03 | 7.88E-02 | ** BIAS ** | 2.73E-02 | 8.9E-04 | 9.5E-10 | 0.0E+00 | 7.4E-06 | 7.8E-05 | 4.00 | 4 | 2.78 | 8.1E-05 | 33.3% |
| COPPER | | 2.00E-01 | 0.00E+00 | NSTDV | 1.42E-01 | 8.9E-04 | 4.9E-09 | 0.0E+00 | 1.8E-04 | 1.8E-04 | 2.10 | 2 | 4.3 | 7.9E-04 | 62.9% |
| LEAD | | 2.59E-02 | 0.00E+00 | ** BIAS ** | 5.65E-02 | 8.9E-04 | 2.0E-09 | 0.0E+00 | 2.5E-05 | 7.1E-05 | 2.87 | 3 | 3.18 | 1.1E-04 | 21.5% |
| MANGANESE | | 3.53E-01 | 0.00E+00 | NSTDV | 1.29E-01 | 8.9E-04 | 4.5E-09 | 0.0E+00 | 3.1E-04 | 1.6E-04 | 2.03 | 2 | 4.3 | 1.4E-03 | 119.1% |
| MERCURY | | 4.97E-02 | 1.09E-01 | ** BIAS ** | 3.72E-02 | 8.9E-04 | 1.3E-09 | 0.0E+00 | 4.5E-05 | 1.1E-04 | 2.11 | 2 | 4.3 | 2.2E-04 | 66.7% |
| MOLYBDENUM | | 4.63E-03 | 0.00E+00 | ** BIAS ** | 2.18E-02 | 8.9E-04 | 7.6E-10 | 0.0E+00 | 5.9E-06 | 2.7E-05 | 4.00 | 4 | 2.78 | 3.2E-05 | 16.5% |
| NICKEL (1) | | 6.00E-01 | 0.00E+00 | NSTDV | 1.91E-01 | 8.9E-04 | 6.7E-09 | 0.0E+00 | 5.3E-04 | 2.4E-04 | 1.01 | 1 | 12.7 | 6.8E-03 | 400.4% |
| SELENIUM | | 1.37E-01 | 0.00E+00 | NSTDV | 4.68E-02 | 8.9E-04 | 1.6E-09 | 0.0E+00 | 1.2E-04 | 5.9E-05 | 2.02 | 2 | 4.3 | 5.3E-04 | 126.7% |
| PHOSPHORUS | | 3.14E-01 | 0.00E+00 | ** BIAS ** | 8.63E-01 | 8.9E-04 | 3.0E-08 | 0.0E+00 | 3.2E-04 | 1.1E-03 | 3.28 | 3 | 3.18 | 1.5E-03 | 19.6% |
| VANADIUM | | 6.89E-02 | 0.00E+00 | NSTDV | 3.07E-02 | 8.9E-04 | 1.1E-09 | 0.0E+00 | 6.1E-05 | 3.9E-05 | 2.04 | 2 | 4.3 | 2.7E-04 | 98.1% |
| | | | | | | | | | | | | | | | 108.3% |

[UNAIR.XLW]UNMETALS.XLS
5:34 PM
11/8/93

DO NOT CITE OR QUOTE

PRELIMINARY

# PM/ANIONS -
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE I – BASELINE


| SPECIES | LOC | RUN #1 | RUN #2 in ppm | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | |
| CHLORIDE | IN | 0.64 | 0.69 | 0.62 | 6.52E-01 | 3.35E-02 | 10.1% | 21.5% | 23.7% | 9.02E-01 | 2.14E-01 | 3.80% | 0.0% |
| FLOURIDE | | 8.51 | 6.69 | 6.73 | 7.31E+00 | 1.04E+00 | 35.7% | 21.5% | 41.6% | 5.42E+00 | 2.26E+00 | 10.94% | 0.0% |
| PHOSPHORUS | | 0.35 | 0.64 | 0.18 | 3.92E-01 | 2.32E-01 | 147.4% | 21.5% | 148.9% | 1.45E+00 | 2.16E+00 | 42.56% | 0.0% |
| SULFATE | | 347.27 | 317.71 | 295.10 | 3.20E+02 | 2.62E+01 | 20.9% | 21.5% | 30.0% | 1.20E+03 | 3.59E+02 | 5.68% | 0.0% |
| | | | | | AVERAGE: | 6.87E+00 | 53.5% | 21.5% | 61.1% | 3.02E+02 | 9.10E+01 | 15.75% | |

| SPECIES | LOC | RUN #1 | RUN #2 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | |
| CHLORIDE | OUT | 0.67 | 0.60 | 0.27 | 5.12E-01 | 2.11E-01 | 101.9% | 14.1% | 102.9% | 7.13E-01 | 7.33E-01 | 31.26% | 0.0% |
| FLOURIDE | | 9.54 | 7.57 | 2.55 | 6.55E+00 | 3.60E+00 | 136.1% | 14.1% | 136.8% | 4.88E+00 | 6.68E+00 | 40.71% | 0.0% |
| PHOSPHORUS | | ND< 0.58 | ND< 0.47 | ND< 0.15 | ND< 4.01E-01 | 2.23E-01 | 137.7% | 34.6% | 142.0% | ND< 1.49E+00 | 2.12E+00 | 41.44% | 100.0% |
| SULFATE | | 287.19 | 303.52 | 299.79 | 2.97E+02 | 8.55E+00 | 6.2% | 14.1% | 15.4% | 1.12E+03 | 1.72E+02 | 2.17% | 0.0% |
| | | | | | AVERAGE: | 3.15E+00 | 95.5% | 19.2% | 99.3% | 2.81E+02 | 4.55E+01 | 28.90% | |

| SPECIES | LOC | RUN #1 | RUN #2 in mg/Nm^3 | RUN #3 | AVERAGE | SAMPLE STD. DEV. | % SAMPLE RND ERR | SAMPLE % BIAS | % UNCERT. | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM-AN | IN | 7705.8 | 7835.9 | 5306.7 | 6.95E+03 | 1.42E+03 | 51.2% | 21.5% | 55.5% | 6.07E+03 | 3.37E+03 | 15.76% | 0.0% |
| PM-AN | OUT | 0.66 | 4.70 | 2.10 | 2.49E+00 | 2.05E+00 | 204.6% | 14.1% | 205.1% | 2.18E+00 | 4.48E+00 | 59.34% | 0.0% |
| | | | | | AVERAGE: | 7.13E+02 | 127.9% | 17.8% | 130.3% | 3.04E+03 | 1.69E+03 | 37.55% | |

[UNAIR.XLW]UNPMAN.XLS
2:45 PM
1/11/94

DO NOT CITE OR QUOTE

# PM/ANIONS -
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE I -- BASELINE


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS IN: | | | | | | | | | | |
| FLOW RATE, pitot | In | 245,763 | 250,194 | 255,852 | 250,603 | 5057 | 2.02% | 2920 | 10.00% | 25060 |
| Particle Collection, Inlet | | | | | | | | | 19.00% | |
| ANIONS OUT: | | | | | | | | | | |
| FLOW RATE, pitot | Out | 245,732 | 251,185 | 258,872 | 251,930 | 6602 | 2.62% | 3811 | 10.00% | 25193 |
| Particle Collection, Outlet | | | | | | | | | 10.00% | |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 dscfm | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|---|
| FLUE FLOW RATE, pitot | In | 245,763 | 250,194 | 255,852 | 250,603 | 5057 | 2.02% | 2920 | 10.00% | 25060 |
| Particle Collection, Inlet | | | | | | | | | 19.00% | |
| FLUE FLOW RATE, pitot | Out | 245,732 | 251,185 | 258,872 | 251,930 | 6602 | 2.62% | 3811 | 10.00% | 25193 |
| Particle Collection, Outlet | | | | | | | | | 10.00% | |

[UNAIR.XLW]UNPMAN.XLS
2:37 PM
1/11/94

# PM/ANIONS -
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | | | |
| CHLORIDE | IN | 1.93E-02 | 0.00E+00 | ** BIAS ** | 0.12 | 1.4E+00 | 3.6E-06 | 0.0E+00 | 2.9E-02 | 1.9E-01 | 2.6 | 3 | 3.18 | 2.1E-01 | 23.7% |
| FLOURIDE | | 6.00E-01 | 0.00E+00 | ** BIAS ** | 1.39 | 7.4E-01 | 2.2E-05 | 0.0E+00 | 4.5E-01 | 1.2E+00 | 2.1 | 2 | 4.3 | 2.3E+00 | 41.6% |
| PHOSPHORUS | | 1.34E-01 | 0.00E+00 | NSTDV | 0.07 | 3.7E+00 | 5.8E-06 | 0.0E+00 | 5.0E-01 | 3.1E-01 | 2.0 | 2 | 4.3 | 2.2E+00 | 148.9% |
| SULFATE | | 1.51E+01 | 0.00E+00 | ** BIAS ** | 60.81 | 3.7E+00 | 4.8E-03 | 0.0E+00 | 5.8E+01 | 2.6E+02 | 2.2 | 2 | 4.3 | 3.6E+02 | 30.0% |
| ANIONS: | | | | | | | | | | | | | | | |
| CHLORIDE | OUT | 1.22E-01 | 0.00E+00 | NSTDV | 0.05 | 1.4E+00 | 2.8E-06 | 0.0E+00 | 1.7E-01 | 1.0E-01 | 2.0 | 2 | 4.3 | 7.3E-01 | 102.9% |
| FLOURIDE | | 2.08E+00 | 0.00E+00 | NSTDV | 0.66 | 7.4E-01 | 1.9E-05 | 0.0E+00 | 1.5E+00 | 6.9E-01 | 2.0 | 2 | 4.3 | 6.7E+00 | 136.8% |
| PHOSPHORUS | | 1.29E-01 | 1.27E-01 | ** BIAS ** | 0.04 | 3.7E+00 | 5.9E-06 | 0.0E+00 | 4.8E-01 | 5.2E-01 | 2.0 | 2 | 4.3 | 2.1E+00 | 142.0% |
| SULFATE | | 4.94E+00 | 0.00E+00 | ** BIAS ** | 29.68 | 3.7E+00 | 4.4E-03 | 0.0E+00 | 2.5E+01 | 1.6E+02 | 4.0 | 4 | 2.78 | 1.7E+02 | 15.4% |

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | Part. Coll. Eff. Bias | THETA CALCULATIONS FOR: CONC. | Flow Rt | xxxxxx | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM-AN | IN | 8.22E+02 | 0.00E+00 | ** BIAS ** | 1320 | 8.7E-01 | 2.4E-02 | 0.0E+00 | 7.2E+02 | 1.3E+03 | 2.0 | 2 | 4.3 | 3.4E+03 | 55.5% |
| PM-AN | OUT | 1.18E+00 | 0.00E+00 | NSTDV | 0.25 | 8.8E-01 | 8.7E-06 | 0.0E+00 | 1.0E+00 | 3.1E-01 | 2.0 | 2 | 4.3 | 4.5E+00 | 205.1% |

[UNAIR.XLW]UNPMAN.XLS
2:47 PM
1/11/94

PRELIMINARY

DO NOT CITE OR QUOTE

PAH
UNCERTAINTY ANALYSIS
SITE 115, PHASE I -- BASELINE
PAGE 1 OF 3

| SPECIES | LOC | | RUN #1 | | RUN #2 in ug/Nm3 | | RUN #3 | | | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PAH: | | | | | | | | | | | | | | | | | | | |
| Naphthalene | IN | | 0.306 | | 0.235 | | 0.402 | | | 3.14E-01 | 8.36E-02 | 66.1% | 21.5% | 69.5% | | 2.7E-04 | 1.9E-04 | 18.57% | 0.0% |
| Acenaphthylene | | ND< | 0.012 | ND< | 0.011 | ND< | 0.033 | | ND< | 1.86E-02 | 1.24E-02 | 165.0% | 39.2% | 169.6% | ND< | 1.6E-05 | 2.7E-05 | 51.09% | 100.0% |
| Acenaphthene | | ND< | 0.014 | ND< | 0.012 | ND< | 0.012 | | ND< | 1.29E-02 | 1.12E-03 | 21.5% | 36.0% | 42.0% | ND< | 1.1E-05 | 4.6E-06 | 6.52% | 100.0% |
| Fluorene | | | 0.015 | | 0.013 | | 0.015 | | | 1.45E-02 | 1.11E-03 | 19.0% | 21.5% | 28.7% | | 1.2E-05 | 3.5E-06 | 5.83% | 0.0% |
| Phenanthrene | | ND< | 0.142 | ND< | 0.140 | ND< | 0.183 | | ND< | 1.55E-01 | 2.42E-02 | 39.0% | 36.2% | 53.2% | ND< | 1.3E-04 | 7.0E-05 | 12.06% | 100.0% |
| Anthracene | | ND< | 0.019 | ND< | 0.010 | ND< | 0.019 | | ND< | 1.58E-02 | 5.45E-03 | 85.5% | 36.9% | 93.1% | ND< | 1.4E-05 | 1.3E-05 | 26.49% | 100.0% |
| Fluoranthene | | ND< | 0.030 | ND< | 0.033 | ND< | 0.030 | | ND< | 3.08E-02 | 1.65E-03 | 13.4% | 36.0% | 38.4% | ND< | 2.6E-05 | 1.0E-05 | 4.06% | 100.0% |
| Pyrene | | ND< | 0.031 | ND< | 0.034 | ND< | 0.030 | | ND< | 3.18E-02 | 1.80E-03 | 14.1% | 36.0% | 38.7% | ND< | 2.7E-05 | 1.0E-05 | 4.18% | 100.0% |
| Benz(a)anthracene | | ND< | 0.019 | ND< | 0.021 | ND< | 0.040 | | ND< | 2.65E-02 | 1.19E-02 | 111.8% | 37.5% | 117.9% | ND< | 2.3E-05 | 2.7E-05 | 34.53% | 100.0% |
| Chrysene | | ND< | 0.019 | ND< | 0.020 | ND< | 0.037 | | ND< | 2.51E-02 | 9.90E-03 | 97.9% | 37.2% | 104.7% | ND< | 2.1E-05 | 2.2E-05 | 30.24% | 100.0% |
| Benzo(b)fluoranthene | | ND< | 0.011 | ND< | 0.024 | ND< | 0.030 | | ND< | 2.15E-02 | 9.78E-03 | 112.8% | 37.5% | 118.8% | ND< | 1.8E-05 | 2.2E-05 | 33.22% | 100.0% |
| Benzo(k)fluoranthene | | ND< | 0.021 | ND< | 0.096 | ND< | 0.069 | | ND< | 6.20E-02 | 3.77E-02 | 150.9% | 38.7% | 155.7% | ND< | 5.3E-05 | 8.2E-05 | 43.84% | 100.0% |
| Benzo(a)pyrene | | ND< | 0.056 | ND< | 0.077 | ND< | 0.011 | | ND< | 4.80E-02 | 3.38E-02 | 174.9% | 39.6% | 179.4% | ND< | 4.1E-05 | 7.3E-05 | 51.45% | 100.0% |
| Indeno(1,2,3-cd)pyrene | | ND< | 0.030 | ND< | 0.029 | ND< | 0.029 | | ND< | 2.95E-02 | 3.12E-04 | 2.1% | 36.0% | 36.0% | ND< | 2.5E-05 | 9.1E-06 | 0.78% | 100.0% |
| Dibenzo(a,h)anthracene | | ND< | 0.037 | ND< | 0.037 | ND< | 0.037 | | ND< | 3.68E-02 | 3.90E-04 | 2.1% | 36.0% | 36.0% | ND< | 3.1E-05 | 1.1E-05 | 0.78% | 100.0% |
| Benzo(g,h,i)perylene | | ND< | 0.037 | ND< | 0.029 | ND< | 0.029 | | ND< | 3.20E-02 | 4.60E-03 | 35.8% | 36.1% | 50.9% | ND< | 2.7E-05 | 1.4E-05 | 11.09% | 100.0% |
| 2-Methylnaphthalene | | | 0.041 | | 0.026 | | 0.015 | | | 2.75E-02 | 1.29E-02 | 116.6% | 21.5% | 118.5% | | 2.3E-05 | 2.8E-05 | 32.82% | 0.0% |
| 7,12-Dimethbenz(a)anth | | ND< | 0.025 | ND< | 0.004 | ND< | 0.047 | | ND< | 2.54E-02 | 2.19E-02 | 214.4% | 41.3% | 218.4% | ND< | 2.2E-05 | 4.7E-05 | 58.06% | 100.0% |
| 3-Methylcholanthrene | | ND< | 0.149 | ND< | 0.007 | ND< | 0.146 | | ND< | 1.01E-01 | 8.10E-02 | 199.5% | 40.7% | 203.6% | ND< | 8.6E-05 | 1.8E-04 | 61.81% | 100.0% |
| | | | | | | | | | | | AVERAGES: | 86.4% | 35.0% | 98.6% | | 4.6E-05 | 4.40E-05 | 25.7% | |

| SPECIES | LOC | | RUN #1 | | RUN #2 in ug/Nm3 | | RUN #3 | | | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PAH: | | | | | | | | | | | | | | | | | | | |
| Naphthalene | *OUT* | | *0.423* | | *0.255* | | *0.339* | | | 3.39E-01 | 8.40E-02 | 61.7% | 14.1% | 63.3% | | 2.9E-04 | 1.8E-04 | 16.60% | 0.0% |
| Acenaphthylene | | ND< | 0.011 | ND< | 0.009 | ND< | 0.008 | | ND< | 9.49E-03 | 1.29E-03 | 33.7% | 32.3% | 46.7% | ND< | 8.2E-06 | 3.8E-06 | 10.12% | 100.0% |
| Acenaphthene | | ND< | 0.014 | ND< | 0.009 | ND< | 0.015 | | ND< | 1.26E-02 | 2.82E-03 | 55.7% | 32.6% | 64.5% | ND< | 1.1E-05 | 7.0E-06 | 17.01% | 100.0% |
| Fluorene | | | 0.014 | | 0.011 | ND< | 0.013 | @ | ND< | 1.30E-02 | 1.97E-03 | 37.8% | 21.9% | 43.7% | ND< | 1.1E-05 | 4.9E-06 | 10.04% | 100.0% |
| Phenanthrene | | ND< | 0.134 | ND< | 0.111 | ND< | 0.141 | | ND< | 1.29E-01 | 1.54E-02 | 29.8% | 32.3% | 43.9% | ND< | 1.1E-04 | 4.9E-05 | 8.99% | 100.0% |
| Anthracene | | | 0.012 | ND< | 0.014 | ND< | 0.006 | @ | ND< | 1.41E-02 | 3.98E-03 | 70.3% | 23.2% | 74.0% | ND< | 1.2E-05 | 9.0E-06 | 22.08% | 100.0% |
| Fluoranthene | | ND< | 0.029 | ND< | 0.024 | ND< | 0.023 | | ND< | 2.52E-02 | 2.89E-03 | 28.5% | 32.3% | 43.0% | ND< | 2.2E-05 | 9.3E-06 | 8.80% | 100.0% |
| Pyrene | | ND< | 0.029 | ND< | 0.024 | ND< | 0.023 | | ND< | 2.53E-02 | 2.82E-03 | 27.7% | 32.3% | 42.5% | ND< | 2.2E-05 | 9.3E-06 | 8.51% | 100.0% |
| Benz(a)anthracene | | ND< | 0.018 | ND< | 0.016 | ND< | 0.014 | | ND< | 1.59E-02 | 1.97E-03 | 30.9% | 32.3% | 44.7% | ND< | 1.4E-05 | 6.1E-06 | 8.88% | 100.0% |
| Chrysene | | ND< | 0.018 | ND< | 0.015 | ND< | 0.014 | | ND< | 1.56E-02 | 2.10E-03 | 33.6% | 32.3% | 46.6% | ND< | 1.3E-05 | 6.2E-06 | 10.30% | 100.0% |
| Benzo(b)fluoranthene | | ND< | 0.007 | ND< | 0.008 | ND< | 0.014 | | ND< | 9.87E-03 | 3.93E-03 | 99.0% | 33.5% | 104.5% | ND< | 8.5E-06 | 8.9E-06 | 30.33% | 100.0% |
| *Benzo(k)fluoranthene* | | ND< | 0.013 | ND< | 0.011 | ND< | 0.018 | | ND< | 1.41E-02 | 3.56E-03 | 62.9% | 32.7% | 70.9% | ND< | 1.2E-05 | 8.6E-06 | 18.77% | 100.0% |
| Benzo(a)pyrene | | ND< | 0.011 | ND< | 0.026 | ND< | 0.008 | | ND< | 1.53E-02 | 9.71E-03 | 158.2% | 35.5% | 162.2% | ND< | 1.3E-05 | 2.1E-05 | 48.62% | 100.0% |
| Indeno(1,2,3-cd)pyrene | | ND< | 0.033 | ND< | 0.047 | ND< | 0.039 | | ND< | 3.97E-02 | 7.06E-03 | 44.2% | 32.4% | 54.8% | ND< | 3.4E-05 | 1.9E-05 | 12.06% | 100.0% |
| Dibenzo(a,h)anthracene | | ND< | 0.039 | ND< | 0.056 | ND< | 0.045 | | ND< | 4.65E-02 | 8.54E-03 | 45.7% | 32.4% | 56.0% | ND< | 4.0E-05 | 2.2E-05 | 13.15% | 100.0% |
| Benzo(g,h,i)perylene | | ND< | 0.030 | ND< | 0.038 | ND< | 0.034 | | ND< | 3.38E-02 | 4.24E-03 | 31.2% | 32.3% | 44.9% | ND< | 2.9E-05 | 1.3E-05 | 8.39% | 100.0% |
| 2-Methylnaphthalene | | | 0.063 | | 0.020 | | 0.022 | | | 3.50E-02 | 2.46E-02 | 174.9% | 14.1% | 175.4% | | 3.0E-05 | 5.3E-05 | 54.12% | 0.0% |
| 7,12-Dimethylbenz(a)anthracene | | ND< | 0.007 | ND< | 0.006 | ND< | 0.003 | | ND< | 5.24E-03 | 2.18E-03 | 103.5% | 33.6% | 108.8% | ND< | 4.5E-06 | 4.9E-06 | 30.84% | 100.0% |
| 3-Methylcholanthrene | | ND< | 0.007 | ND< | 0.006 | ND< | 0.006 | | ND< | 6.28E-03 | 7.16E-04 | 28.4% | 32.3% | 43.0% | ND< | 5.4E-06 | 2.3E-06 | 8.18% | 100.0% |
| | | | | | | | | | | | AVERAGES: | 60.9% | 29.7% | 70.2% | | 3.6E-05 | 2.32E-05 | 18.2% | |

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11/8/93

PRELIMINARY

DO NOT CITE OR QUOTE

PAH
UNCERTAINTY ANALYSIS
SITE 115, PHASE I -- BASELINE


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| PAH IN: | | | | | | | | | |
| FLOW RATE, pitot | 244,985 | 245,306 | 243,544 | 244,612 | 938 | 0.38% | 542 | 10.00% | 24,461 |
| Particle Collection Bias | | | | | | | | 19.00% | |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| PAH OUT: | | | | | | | | | |
| FLOW RATE, pitot | 248,247 | 247,105 | 244,808 | 246,720 | 1752 | 0.71% | 1011 | 10.00% | 24,672 |
| Particle Collection Bias | | | | | | | | 10.00% | |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

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11/8/93

PAH -
UNCERTAINTY ANALYSIS
SITE 115, PHASE I – BASELINE
PAGE 3 OF 3

| SPECIES PAH: | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RT (THETAhr) | F-factor (THETAff) | RESULTS: Sr | Br | ν | ν | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Naphthalene | IN | 4.83E-02 | 0.00E+00 | ** BIAS ** | 5.97E-02 | 8.5E-04 | 1.1E-09 | 0.0E+00 | 4.1E-05 | 5.8E-05 | 2.00 | 2 | 4.3 | 1.9E-04 | 69.5% |
| Acenaphthylene | | 7.13E-03 | 6.11E-03 | NSTDV | 3.53E-03 | 8.5E-04 | 6.5E-11 | 0.0E+00 | 6.1E-06 | 6.2E-06 | 2.00 | 2 | 4.3 | 2.7E-05 | 169.6% |
| Acenaphthene | | 6.44E-04 | 3.73E-03 | ** BIAS ** | 2.45E-03 | 8.5E-04 | 4.5E-11 | 0.0E+00 | 5.5E-07 | 4.0E-06 | 2.01 | 2 | 4.3 | 4.6E-06 | 42.0% |
| Fluorene | | 6.40E-04 | 0.00E+00 | ** BIAS ** | 2.75E-03 | 8.5E-04 | 5.1E-11 | 0.0E+00 | 5.5E-07 | 2.7E-06 | 2.01 | 2 | 4.3 | 3.5E-06 | 28.7% |
| Phenanthrene | | 1.40E-02 | 4.50E-02 | ** BIAS ** | 2.94E-02 | 8.5E-04 | 5.4E-10 | 0.0E+00 | 1.2E-05 | 4.8E-05 | 2.00 | 2 | 4.3 | 7.0E-05 | 53.2% |
| Anthracene | | 3.15E-03 | 4.75E-03 | ** BIAS ** | 3.01E-03 | 8.5E-04 | 5.5E-11 | 0.0E+00 | 2.7E-06 | 5.0E-06 | 2.00 | 2 | 4.3 | 1.3E-05 | 93.1% |
| Fluoranthene | | 9.55E-04 | 8.91E-03 | ** BIAS ** | 5.86E-03 | 8.5E-04 | 1.1E-10 | 0.0E+00 | 8.2E-07 | 9.5E-06 | 2.02 | 2 | 4.3 | 1.0E-05 | 38.4% |
| Pyrene | | 1.04E-03 | 9.19E-03 | ** BIAS ** | 6.04E-03 | 8.5E-04 | 1.1E-10 | 0.0E+00 | 8.9E-07 | 9.8E-06 | 2.02 | 2 | 4.3 | 1.0E-05 | 38.7% |
| Benz(a)anthracene | | 6.88E-03 | 8.14E-03 | ** BIAS ** | 5.03E-03 | 8.5E-04 | 9.2E-11 | 0.0E+00 | 5.9E-06 | 8.5E-06 | 2.00 | 2 | 4.3 | 2.7E-05 | 117.9% |
| Chrysene | | 5.71E-03 | 7.62E-03 | ** BIAS ** | 4.77E-03 | 8.5E-04 | 8.8E-11 | 0.0E+00 | 4.9E-06 | 8.0E-06 | 2.00 | 2 | 4.3 | 2.2E-05 | 104.7% |
| Benzo(b)fluoranthene | | 5.64E-03 | 6.63E-03 | ** BIAS ** | 4.09E-03 | 8.5E-04 | 7.5E-11 | 0.0E+00 | 4.8E-06 | 6.9E-06 | 2.00 | 2 | 4.3 | 2.2E-05 | 118.8% |
| Benzo(k)fluoranthene | | 2.18E-02 | 2.00E-02 | ** BIAS ** | 1.18E-02 | 8.5E-04 | 2.2E-10 | 0.0E+00 | 1.9E-05 | 2.0E-05 | 2.00 | 2 | 4.3 | 8.2E-05 | 155.7% |
| Benzo(a)pyrene | | 1.95E-02 | 1.60E-02 | NSTDV | 9.12E-03 | 8.5E-04 | 1.7E-10 | 0.0E+00 | 1.7E-05 | 1.6E-05 | 2.00 | 2 | 4.3 | 7.3E-05 | 179.4% |
| Indeno(1,2,3-cd)pyrene | | 1.80E-04 | 8.51E-03 | ** BIAS ** | 5.60E-03 | 8.5E-04 | 1.0E-10 | 0.0E+00 | 1.6E-07 | 9.0E-06 | 2.52 | 3 | 3.2 | 9.1E-06 | 36.0% |
| Dibenzo(a,h)anthracene | | 2.25E-04 | 1.06E-02 | ** BIAS ** | 7.00E-03 | 8.5E-04 | 1.3E-10 | 0.0E+00 | 2.0E-07 | 1.1E-05 | 2.52 | 3 | 3.2 | 1.1E-05 | 36.0% |
| Benzo(g,h,i)perylene | | 2.66E-03 | 9.29E-03 | ** BIAS ** | 6.07E-03 | 8.5E-04 | 1.1E-10 | 0.0E+00 | 2.3E-06 | 9.9E-06 | 2.00 | 2 | 4.3 | 1.4E-05 | 50.9% |
| 2-Methylnaphthalene | | 7.44E-03 | 0.00E+00 | NSTDV | 5.22E-03 | 8.5E-04 | 9.6E-11 | 0.0E+00 | 6.3E-06 | 5.0E-06 | 2.00 | 2 | 4.3 | 2.8E-05 | 118.5% |
| 7,12-Dimethbenz(a)anth | | 1.26E-02 | 8.96E-03 | NSTDV | 4.82E-03 | 8.5E-04 | 8.8E-11 | 0.0E+00 | 1.1E-05 | 8.9E-06 | 2.00 | 2 | 4.3 | 4.7E-05 | 218.4% |
| 3-Methylcholanthrene | | 4.67E-02 | 3.48E-02 | NSTDV | 1.92E-02 | 8.5E-04 | 3.5E-10 | 0.0E+00 | 4.0E-05 | 3.5E-05 | 2.00 | 2 | 4.3 | 1.8E-04 | 203.6% |
| | | | | | | | | | | | | | | | 98.6% |

| SPECIES PAH: | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RT (THETAhr) | F-factor (THETAff) | RESULTS: Sr | Br | ν | ν | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Naphthalene | OUT | 4.85E-02 | 0.00E+00 | NSTDV | 3.39E-02 | 8.6E-04 | 1.2E-09 | 0.0E+00 | 4.2E-05 | 4.1E-05 | 2.00 | 2 | 4.3 | 1.8E-04 | 63.3% |
| Acenaphthylene | | 7.43E-04 | 2.76E-03 | ** BIAS ** | 9.49E-04 | 8.6E-04 | 3.3E-11 | 0.0E+00 | 6.4E-07 | 2.6E-06 | 2.01 | 2 | 4.3 | 3.8E-06 | 46.7% |
| Acenaphthene | | 1.63E-03 | 3.70E-03 | ** BIAS ** | 1.26E-03 | 8.6E-04 | 4.4E-11 | 0.0E+00 | 1.4E-06 | 3.5E-06 | 2.00 | 2 | 4.3 | 7.0E-06 | 64.5% |
| Fluorene | | 1.14E-03 | 2.16E-03 | ** BIAS ** | 1.30E-03 | 8.6E-04 | 4.5E-11 | 0.0E+00 | 9.8E-07 | 2.4E-06 | 2.01 | 2 | 4.3 | 4.9E-06 | 43.7% |
| Phenanthrene | | 8.91E-03 | 3.73E-02 | ** BIAS ** | 1.29E-02 | 8.6E-04 | 4.5E-10 | 0.0E+00 | 7.7E-06 | 3.6E-05 | 2.01 | 2 | 4.3 | 4.9E-05 | 43.9% |
| Anthracene | | 2.30E-03 | 2.58E-03 | ** BIAS ** | 1.41E-03 | 8.6E-04 | 4.9E-11 | 0.0E+00 | 2.0E-06 | 2.8E-06 | 2.00 | 2 | 4.3 | 9.0E-06 | 74.0% |
| Fluoranthene | | 1.67E-03 | 7.31E-03 | ** BIAS ** | 2.52E-03 | 8.6E-04 | 8.8E-11 | 0.0E+00 | 1.4E-06 | 7.0E-06 | 2.02 | 2 | 4.3 | 9.3E-06 | 43.0% |
| Pyrene | | 1.63E-03 | 7.34E-03 | ** BIAS ** | 2.53E-03 | 8.6E-04 | 8.8E-11 | 0.0E+00 | 1.4E-06 | 7.0E-06 | 2.02 | 2 | 4.3 | 9.3E-06 | 42.5% |
| Benz(a)anthracene | | 1.14E-03 | 4.60E-03 | ** BIAS ** | 1.59E-03 | 8.6E-04 | 5.5E-11 | 0.0E+00 | 9.8E-07 | 4.4E-06 | 2.01 | 2 | 4.3 | 6.1E-06 | 44.7% |
| Chrysene | | 1.21E-03 | 4.52E-03 | ** BIAS ** | 1.56E-03 | 8.6E-04 | 5.4E-11 | 0.0E+00 | 1.0E-06 | 4.3E-06 | 2.01 | 2 | 4.3 | 6.2E-06 | 46.6% |
| Benzo(b)fluoranthene | | 2.27E-03 | 3.00E-03 | ** BIAS ** | 9.87E-04 | 8.6E-04 | 3.4E-11 | 0.0E+00 | 2.0E-06 | 2.8E-06 | 2.00 | 2 | 4.3 | 8.9E-06 | 104.5% |
| Benzo(k)fluoranthene | | 2.06E-03 | 4.15E-03 | ** BIAS ** | 1.41E-03 | 8.6E-04 | 4.9E-11 | 0.0E+00 | 1.8E-06 | 4.0E-06 | 2.00 | 2 | 4.3 | 8.6E-06 | 70.9% |
| Benzo(a)pyrene | | 5.61E-03 | 4.96E-03 | NSTDV | 1.53E-03 | 8.6E-04 | 5.3E-11 | 0.0E+00 | 4.8E-06 | 4.7E-06 | 2.00 | 2 | 4.3 | 2.1E-05 | 162.2% |
| Indeno(1,2,3-cd)pyrene | | 4.07E-03 | 1.16E-02 | ** BIAS ** | 3.97E-03 | 8.6E-04 | 1.4E-10 | 0.0E+00 | 3.5E-06 | 1.1E-05 | 2.01 | 2 | 4.3 | 1.9E-05 | 54.8% |
| Dibenzo(a,h)anthracene | | 4.93E-03 | 1.36E-02 | ** BIAS ** | 4.65E-03 | 8.6E-04 | 1.6E-10 | 0.0E+00 | 4.2E-06 | 1.3E-05 | 2.01 | 2 | 4.3 | 2.2E-05 | 56.0% |
| Benzo(g,h,i)perylene | | 2.45E-03 | 9.82E-03 | ** BIAS ** | 3.38E-03 | 8.6E-04 | 1.2E-10 | 0.0E+00 | 2.1E-06 | 9.4E-06 | 2.01 | 2 | 4.3 | 1.3E-05 | 44.9% |
| 2-Methylnaphthalene | | 1.42E-02 | 0.00E+00 | NSTDV | 3.50E-03 | 8.6E-04 | 1.2E-10 | 0.0E+00 | 1.2E-05 | 4.3E-06 | 2.00 | 2 | 4.3 | 5.3E-05 | 175.4% |
| 7,12-Dimethylbenz(a)anthracene | | 1.26E-03 | 1.60E-03 | ** BIAS ** | 5.24E-04 | 8.6E-04 | 1.8E-11 | 0.0E+00 | 1.1E-06 | 1.5E-06 | 2.00 | 2 | 4.3 | 4.9E-06 | 108.8% |
| 3-Methylcholanthrene | | 4.13E-04 | 1.82E-03 | ** BIAS ** | 6.28E-04 | 8.6E-04 | 2.2E-11 | 0.0E+00 | 3.6E-07 | 1.7E-06 | 2.02 | 2 | 4.3 | 2.3E-06 | 43.0% |
| | | | | | | | | | | | | | | | 78.2% |

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**VOC/FORM/CN -**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I – BASELINE**


| SPECIES | LOC | RUN #1 | RUN #2 in ppb | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOC: | | | | | | | | | | | | | |
| BENZENE | IN | 0.60 | ND< 0.26 | 0.46 | 3.97E-01 | 2.41E-01 | 151.2% | 14.8% | 151.9% | 1.2E-03 | 1.8E-03 | 44.82% | 10.9% |
| TOLUENE | IN | 3.78 | 1.42 | 1.42 | 2.21E+00 | 1.36E+00 | 153.4% | 10.0% | 153.8% | 7.8E-03 | 1.2E-02 | 47.53% | 0.0% |
| VOC: | | | | | | | | | | | | | |
| BENZENE | OUT | 0.69 | 0.88 | 1.34 | 9.70E-01 | 3.34E-01 | 84.8% | 10.0% | 85.4% | 2.9E-03 | 2.5E-03 | 25.43% | 0.0% |
| TOLUENE | OUT | 43.80 | 23.10 | 30.70 | 3.25E+01 | 1.05E+01 | 79.2% | 10.0% | 79.8% | 1.2E-01 | 9.3E-02 | 23.09% | 0.0% |
| FORMALDEHYDE | IN | 13.05 | 13.95 | 17.16 | 1.47E+01 | 2.16E+00 | 36.6% | 10.0% | 38.0% | 1.7E-02 | 6.5E-03 | 11.05% | 0.0% |
| FORMALDEHYDE | OUT | 10.8 | 24.9 | 12.6 | 1.61E+01 | 7.67E+00 | 119.5% | 10.0% | 119.9% | 1.9E-02 | 2.2E-02 | 36.37% | 0.0% |

| SPECIES | LOC | RUN #1 | RUN #2 in ppb | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYANIDE | IN | ND< 8 | ND< 8 | 9 | @ ND< 8.30E+00 | 5.42E-01 | 16.2% | 25.4% | 30.1% | ND< 8.5E-03 | 2.6E-03 | 4.03% | 100.0% |
| CYANIDE | OUT | 7 | ND< 4 | ND< 8 | @ ND< 8.10E+00 | 2.40E+00 | 73.5% | 20.8% | 76.4% | ND< 8.3E-03 | 6.4E-03 | 21.61% | 100.0% |

[UNAIR.XLW]UNVCFMCN.XLS
8:01 PM
11/8/93

**VOC/FORM/CN -**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I – BASELINE**


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|---|
| VOC: | | | dscfm | | | | | | | |
| FLOW RATE, pitot | In | 244,985 | 244,985 | 251,131 | 247,034 | 3548 | 1.44% | 2049 | 10.00% | 24703 |
| FLOW RATE, pitot | Out | 248,247 | 248,247 | 252,125 | 249,540 | 2239 | 0.90% | 1293 | 10.00% | 24954 |
| Particle Collection, Inlet | | | | | | | | | 0.00% | 0.00 |
| Particle Collection, Outlet | | | | | | | | | 0.00% | 0.00 |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|---|
| FORM | | | | | | | | | | |
| FLOW RATE, pitot | In | 244,985 | 244,985 | 251,131 | 247,034 | 3548 | 1.44% | 2049 | 10.00% | 24703 |
| FLOW RATE, pitot | Out | 248,247 | 248,247 | 252,125 | 249,540 | 2239 | 0.90% | 1293 | 10.00% | 24954 |
| Particle Collection, Inlet | | | | | | | | | 0.00% | 0.00 |
| Particle Collection, Outlet | | | | | | | | | 0.00% | 0.00 |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|---|
| CYANIDE: | | | dscfm | | | | | | | |
| FLOW RATE, pitot | In | 243,544 | 243,544 | 243,544 | 243,544 | 0 | 0.00% | 0 | 10.00% | 24354 |
| FLOW RATE, pitot | Out | 244,808 | 244,808 | 244,808 | 244,808 | 0 | 0.00% | 0 | 10.00% | 24481 |
| Particle Collection, Inlet | | | | | | | | | 0.00% | 0.00 |
| Particle Collection, Outlet | | | | | | | | | 0.00% | 0.00 |

PRELIMINARY

# VOC/FORM/CN
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I – BASELINE
## PAGE 3 OF 3

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOC: | | | | | | | | | | | | | | | |
| BENZENE | IN | 1.39E-01 | 4.33E-02 | NSTDV | 0.00 | 3.0E-03 | 4.8E-09 | 0.0E+00 | 4.2E-04 | 1.8E-04 | 2.00 | 2 | 4.3 | 1.8E-03 | 151.9% |
| TOLUENE | IN | 7.87E-01 | 0.00E+00 | NSTDV | 0.00 | 3.5E-03 | 3.2E-08 | 0.0E+00 | 2.8E-03 | 7.8E-04 | 2.00 | 2 | 4.3 | 1.2E-02 | 153.8% |
| VOC: | | | | | | | | | | | | | | | |
| BENZENE | OUT | 1.93E-01 | 0.00E+00 | NSTDV | 0.00 | 3.0E-03 | 1.2E-08 | 0.0E+00 | 5.8E-04 | 2.9E-04 | 2.00 | 2 | 4.3 | 2.5E-03 | 85.4% |
| TOLUENE | OUT | 6.05E+00 | 0.00E+00 | NSTDV | 0.00 | 3.5E-03 | 4.7E-07 | 0.0E+00 | 2.1E-02 | 1.2E-02 | 2.00 | 2 | 4.3 | 9.3E-02 | 79.8% |
| FORMALDEHYDE | IN | 1.25E+00 | 0.00E+00 | NSTDV | 0.00 | 1.2E-03 | 6.9E-08 | 0.0E+00 | 1.4E-03 | 1.7E-03 | 2.04 | 2 | 4.3 | 6.5E-03 | 38.0% |
| FORMALDEHYDE | OUT | 4.43E+00 | 0.00E+00 | NSTDV | 0.00 | 1.2E-03 | 7.5E-08 | 0.0E+00 | 5.2E-03 | 1.9E-03 | 2.00 | 2 | 4.3 | 2.2E-02 | 119.9% |

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | PART COLL. (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYANIDE | IN | 3.13E-01 | 1.94E+00 | ** BIAS ** | 0.00 | 1.0E-03 | 3.5E-08 | 0.0E+00 | 3.2E-04 | 2.2E-03 | 2.00 | 2 | 4.3 | 2.6E-03 | 30.1% |
| CYANIDE | OUT | 1.38E+00 | 1.48E+00 | ** BIAS ** | 0.00 | 1.0E-03 | 3.4E-08 | 0.0E+00 | 1.4E-03 | 1.7E-03 | 2.00 | 2 | 4.3 | 6.4E-03 | 76.4% |

[UNAIR.XLW]UNVCFMCN.XLS
8:00 PM
11/8/93

DO NOT CITE OR QUOTE

**RADIONUCLIDES**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**


| SPECIES | LOC | | RUN #1 | | RUN #2 in pCi/Nm3 | | RUN #3 | | | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | | ABSOL. VALUE in uCi/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES: | | | | | | | | | | | | | | | | | | | |
| Uranium-233 & -234 | OUT | ND< | 0.06 | ND< | 0.06 | | 0.05 | @ | ND< | 5.7E-02 | 1.63E-03 | 5.3% | 27.3% | 27.8% | ND< | 2.3E-02 | 6.4E-03 | 2.56% | 100.0% |
| Uranium-235 | | ND< | 0.06 | ND< | 0.06 | | 0.05 | @ | ND< | 5.7E-02 | 1.63E-03 | 5.3% | 27.3% | 27.8% | ND< | 2.3E-02 | 6.4E-03 | 2.56% | 100.0% |
| Uranium-238 | | ND< | 0.06 | ND< | 0.06 | ND< | 0.05 | | ND< | 5.6E-02 | 1.63E-03 | 5.4% | 32.2% | 32.6% | ND< | 2.2E-02 | 7.3E-03 | 2.09% | 100.0% |
| Radium-226 | | | 0.11 | | 0.11 | | 0.11 | | | 1.1E-01 | 3.27E-03 | 5.4% | 14.1% | 15.1% | | 4.5E-02 | 6.8E-03 | 2.09% | 0.0% |
| Radium-228 | | | 0.80 | | 0.96 | | 0.76 | | | 8.4E-01 | 1.03E-01 | 31.3% | 14.1% | 34.3% | | 3.4E-01 | 1.2E-01 | 9.25% | 0.0% |
| Lead-210 | | ND< | 0.75 | ND< | 0.73 | | 0.22 | @ | ND< | 7.5E-01 | 3.02E-01 | 100.5% | 27.3% | 104.2% | ND< | 3.0E-01 | 3.1E-01 | 24.34% | 100.0% |
| Polonium-210 | | | 0.06 | ND< | 0.06 | ND< | 0.05 | @ | ND< | 5.6E-02 | 1.63E-03 | 5.3% | 27.1% | 27.6% | ND< | 2.2E-02 | 6.2E-03 | 1.91% | 100.0% |
| Thorium-228 | | ND< | 0.23 | ND< | 0.34 | ND< | 0.16 | | ND< | 2.4E-01 | 8.83E-02 | 90.3% | 33.3% | 96.3% | ND< | 9.7E-02 | 9.3E-02 | 25.82% | 100.0% |
| Thorium-230 | | ND< | 0.17 | ND< | 0.06 | ND< | 0.16 | | ND< | 1.3E-01 | 6.44E-02 | 122.9% | 34.2% | 127.5% | ND< | 5.2E-02 | 6.6E-02 | 37.91% | 100.0% |
| Thorium-232 | | ND< | 0.06 | ND< | 0.11 | ND< | 0.11 | | ND< | 9.2E-02 | 3.03E-02 | 81.8% | 33.1% | 88.2% | ND< | 3.7E-02 | 3.3E-02 | 25.25% | 100.0% |
| | | | | | | | | | | | AVERAGES: | 45.3% | 27.0% | 58.1% | | 9.5E-02 | 6.5E-02 | 13.4% | |

PRELIMINARY

DO NOT CITE OR QUOTE

[UNAIR.XLW]UNRADIO
8:07 PM
11/8/93

PRELIMINARY

# RADIONUCLIDES
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES OUT: | | | | | | | | | | |
| FLOW RATE, pitot | Out | 245,732 | 251,185 | 258,872 | 251,930 | 6602 | 2.62% | 3811 | 10.00% | 25,193 |
| Particle Collection, Outlet | | | | | | | | | 10.00% | |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

[UNAIR.XLW]UNRADIO
8:09 PM
11/8/93

DO NOT CITE OR QUOTE

**RADIONUCLIDES**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**




| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RT (THETAhr) | F-factor (THETAff) | RESULTS: Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES: | | | | | | | | | | | | | | | |
| Uranium-233 & -234 | OUT | 9.43E-04 | 1.34E-02 | ** BIAS ** | 5.74E-03 | 4.0E-01 | 9.1E-08 | 0.0E+00 | 5.1E-04 | 6.3E-03 | 6.84 | 7 | 2.37 | 6.4E-03 | 27.8% |
| Uranium-235 | | 9.43E-04 | 1.34E-02 | ** BIAS ** | 5.74E-03 | 4.0E-01 | 9.1E-08 | 0.0E+00 | 5.1E-04 | 6.3E-03 | 6.84 | 7 | 2.37 | 6.4E-03 | 27.8% |
| Uranium-238 | | 9.43E-04 | 1.62E-02 | ** BIAS ** | 5.60E-03 | 4.0E-01 | 8.9E-08 | 0.0E+00 | 5.1E-04 | 7.2E-03 | 6.53 | 7 | 2.37 | 7.3E-03 | 32.6% |
| Radium-226 | | 1.89E-03 | 0.00E+00 | ** BIAS ** | 1.12E-02 | 4.0E-01 | 1.8E-07 | 0.0E+00 | 1.0E-03 | 6.3E-03 | 6.53 | 7 | 2.37 | 6.8E-03 | 15.1% |
| Radium-228 | | 5.97E-02 | 0.00E+00 | ** BIAS ** | 8.40E-02 | 4.0E-01 | 1.3E-06 | 0.0E+00 | 2.4E-02 | 4.7E-02 | 2.19 | 2 | 4.3 | 1.2E-01 | 34.3% |
| Lead-210 | | 1.74E-01 | 1.74E-01 | ** BIAS ** | 7.47E-02 | 4.0E-01 | 1.2E-06 | 0.0E+00 | 7.0E-02 | 8.1E-02 | 2.02 | 2 | 4.3 | 3.1E-01 | 104.2% |
| Polonium-210 | | 9.43E-04 | 1.30E-02 | ** BIAS ** | 5.63E-03 | 4.0E-01 | 8.9E-08 | 0.0E+00 | 5.1E-04 | 6.1E-03 | 6.59 | 7 | 2.37 | 6.2E-03 | 27.6% |
| Thorium-228 | | 5.10E-02 | 7.33E-02 | ** BIAS ** | 2.43E-02 | 4.0E-01 | 3.9E-07 | 0.0E+00 | 2.0E-02 | 3.2E-02 | 2.02 | 2 | 4.3 | 9.3E-02 | 96.3% |
| Thorium-230 | | 3.72E-02 | 4.06E-02 | ** BIAS ** | 1.30E-02 | 4.0E-01 | 2.1E-07 | 0.0E+00 | 1.5E-02 | 1.8E-02 | 2.01 | 2 | 4.3 | 6.6E-02 | 127.5% |
| Thorium-232 | | 1.75E-02 | 2.76E-02 | ** BIAS ** | 9.25E-03 | 4.0E-01 | 1.5E-07 | 0.0E+00 | 7.0E-03 | 1.2E-02 | 2.03 | 2 | 4.3 | 3.3E-02 | 88.2% |
| | | | | | | | | | | | | | | | 58.1% |



[UNAIR.XLW]UNRADIO
8:06 PM
11/8/93

PRELIMINARY

# METALS/AN - COAL
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE I -- BASELINE


| SPECIES | LOC | RUN #1 | RUN #2 In mg/Kg | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE In lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS (C&T): | | | | | | | | | | | | | |
| ARSENIC | COAL | ND< 0.5 | ND< 0.5 | ND< 0.5 | ND< 5.0E-01 | 0.00E+00 | 2.2% | 29.3% | 29.4% | ND< 4.4E-02 | 1.3E-02 | 0.00% | 100.0% |
| BARIUM(1) | | 28 | 21 | | 2.5E+01 | 4.95E+00 | 181.6% | 5.0% | 181.7% | 2.2E+00 | 3.9E+00 | 28.57% | 0.0% |
| BERYLLIUM | | 0.21 | 0.24 | 0.23 | 2.2E-01 | 1.53E-02 | 17.1% | 5.0% | 17.8% | 2.0E-02 | 3.5E-03 | 4.97% | 0.0% |
| CADMIUM | | 0.09 | ND< 0.05 | ND< 0.05 | @ ND< 5.0E-02 | 2.31E-02 | 114.8% | 24.1% | 117.3% | ND< 4.4E-03 | 5.2E-03 | 26.67% | 100.0% |
| CHROMIUM | | 0.8 | 1.3 | 1.1 | 1.1E+00 | 2.52E-01 | 57.6% | 5.0% | 57.8% | 9.6E-02 | 5.5E-02 | 16.36% | 0.0% |
| COBALT | | 0.8 | 1.0 | 1.0 | 9.3E-01 | 1.15E-01 | 30.8% | 5.0% | 31.2% | 8.2E-02 | 2.6E-02 | 9.52% | 0.0% |
| COPPER | | 2.7 | 2.8 | 2.7 | 2.7E+00 | 5.77E-02 | 4.3% | 5.0% | 6.6% | 2.4E-01 | 1.6E-02 | 1.65% | 0.0% |
| LEAD | | 2.1 | 2.5 | 1.6 | 2.1E+00 | 4.51E-01 | 54.2% | 5.0% | 54.5% | 1.8E-01 | 9.9E-02 | 15.05% | 0.0% |
| MANGANESE | | 3.4 | 5.9 | 3.4 | 4.2E+00 | 1.44E+00 | 84.7% | 5.0% | 84.9% | 3.7E-01 | 3.2E-01 | 26.25% | 0.0% |
| MERCURY | | ND< 0.1 | 0.1 | ND< 0.1 | @ ND< 1.0E-01 | 0.00E+00 | 2.2% | 24.1% | 24.2% | ND< 8.8E-03 | 2.1E-03 | 0.00% | 100.0% |
| MOLYBDENUM | | ND< 0.1 | ND< 0.1 | 0.2 | 1.0E-01 | 8.66E-02 | 215.2% | 24.1% | 216.5% | 8.8E-03 | 1.9E-02 | 66.67% | 33.3% |
| NICKEL | | 0.4 | 0.8 | 0.5 | 6.0E-01 | 2.08E-01 | 86.7% | 5.0% | 86.8% | 5.3E-02 | 4.6E-02 | 26.07% | 0.0% |
| SELENIUM | | ND< 0.05 | ND< 0.05 | ND< 0.05 | ND< 5.0E-02 | 0.00E+00 | 2.2% | 29.3% | 29.4% | ND< 4.4E-03 | 1.3E-03 | 0.00% | 100.0% |
| PHOSPHORUS | | 510 | 350 | 370 | 4.1E+02 | 8.72E+01 | 52.9% | 5.0% | 53.1% | 3.6E+01 | 1.9E+01 | 16.26% | 0.0% |
| VANADIUM | | 2.6 | 3.5 | 2.8 | 3.0E+00 | 4.73E-01 | 39.6% | 5.0% | 39.9% | 2.6E-01 | 1.0E-01 | 11.99% | 0.0% |
| | | | | | | AVERAGES: | 63.1% | 12.1% | 68.7% | 2.6E+00 | 1.6E+00 | 16.67% | |

Note: (1) Barium result for 11/17 COAL was discarded.

ANIONS (C&T): COAL

| SPECIES | RUN #1 | RUN #2 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE In lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorine, as Cl- (2) | 600 | 600 | | 6.0E+02 | 0.00E+00 | 6.5% | 5.0% | 8.2% | 5.29E+01 | 4.3E+00 | 0.00% | 0.0% |
| Fluorine, as F- | 79 | 89 | 85 | 8.4E+01 | 5.03E+00 | 15.0% | 5.0% | 15.8% | 7.44E+00 | 1.2E+00 | 4.22% | 0.0% |
| Phosphorus, as PO4 3- | 1,564 | 1,073 | 1,135 | 1.3E+03 | 2.67E+02 | 52.9% | 5.0% | 53.1% | 1.11E+02 | 5.9E+01 | 16.26% | 0.0% |
| Sulfur, as SO4 2- | 14,082 | 13,184 | 12,285 | 1.3E+04 | 8.99E+02 | 17.1% | 5.0% | 17.8% | 1.16E+03 | 2.1E+02 | 4.54% | 0.0% |
| | | | | | AVERAGES: | 22.9% | 5.8% | 23.7% | 3.3E+02 | 6.8E+01 | 6.26% | |

(2) Chlorine result for 11/18 COAL was not used in average.

DO NOT CITE OR QUOTE

[UNPROC.XLW]UNCOAL.XLS
2:52 PM
1/11/94

**METALS/AN - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| FUEL METALS: | | | | | | | | | |
| HHV, Btu/lb (as rec'd) | 11,114 | 11,154 | 11,206 | 11,158 | 46.13 | 0.41% | 26.63 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1156.85 | 1.31% | 667.91 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | -5.00% | -4.78E+05 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| FUEL ANIONS: | | | | | | | | | |
| HHV, Btu/lb | 11,114 | 11,154 | 11,206 | 11,158 | 46.13 | 0.41% | 26.63 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1156.85 | 1.31% | 667.91 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | -5.00% | -4.78E+05 |

[UNPROC.XLW]UNCOAL.XLS
2:49 PM
1/11/94

**METALS/AN - COAL**
***UNCERTAINTY ANALYSIS***
**SITE 115, PHASE I – BASELINE**
**PAGE 3 OF 3**

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RT (THETAhr) | XXXXXX (THETAhhv) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS (C&T): | | | | | | | | | | | | | | |
| ARSENIC | COAL | 0.00E+00 | 1.44E-01 | ** BIAS ** | 8.8E-02 | 4.6E-09 | 0.0E+00 | 2.2E-04 | 1.3E-02 | 2.00 | 2 | 4.3 | 1.3E-02 | 29.4% |
| BARIUM(1) | | 3.50E+00 | 0.00E+00 | NSTDV | 8.8E-02 | 2.3E-07 | 0.0E+00 | 3.1E-01 | 1.1E-01 | 1.00 | 1 | 12.7 | 3.9E+00 | 181.7% |
| BERYLLIUM | | 8.82E-03 | 0.00E+00 | NSTDV | 8.8E-02 | 2.1E-09 | 0.0E+00 | 7.8E-04 | 9.9E-04 | 2.07 | 2 | 4.3 | 3.5E-03 | 17.8% |
| CADMIUM | | 1.33E-02 | 1.18E-02 | NSTDV | 8.8E-02 | 4.6E-10 | 0.0E+00 | 1.2E-03 | 1.1E-03 | 2.00 | 2 | 4.3 | 5.2E-03 | 117.3% |
| CHROMIUM | | 1.45E-01 | 0.00E+00 | NSTDV | 8.8E-02 | 1.0E-08 | 0.0E+00 | 1.3E-02 | 4.8E-03 | 2.01 | 2 | 4.3 | 5.5E-02 | 57.8% |
| COBALT | | 6.67E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 8.6E-09 | 0.0E+00 | 5.9E-03 | 4.1E-03 | 2.02 | 2 | 4.3 | 2.6E-02 | 31.2% |
| COPPER | | 3.33E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 2.5E-08 | 0.0E+00 | 3.2E-03 | 1.2E-02 | 2.66 | 3 | 3.18 | 1.6E-02 | 6.6% |
| LEAD | | 2.60E-01 | 0.00E+00 | NSTDV | 8.8E-02 | 1.9E-08 | 0.0E+00 | 2.3E-02 | 9.1E-03 | 2.01 | 2 | 4.3 | 9.9E-02 | 54.5% |
| MANGANESE | | 8.33E-01 | 0.00E+00 | NSTDV | 8.8E-02 | 3.9E-08 | 0.0E+00 | 7.3E-02 | 1.9E-02 | 2.00 | 2 | 4.3 | 3.2E-01 | 84.9% |
| MERCURY | | 0.00E+00 | 2.36E-02 | ** BIAS ** | 8.8E-02 | 9.2E-10 | 0.0E+00 | 4.5E-05 | 2.1E-03 | 2.00 | 2 | 4.3 | 2.1E-03 | 24.2% |
| MOLYBDENUM | | 5.00E-02 | 2.36E-02 | NSTDV | 8.8E-02 | 9.2E-10 | 0.0E+00 | 4.4E-03 | 2.1E-03 | 2.00 | 2 | 4.3 | 1.9E-02 | 216.5% |
| NICKEL | | 1.20E-01 | 0.00E+00 | NSTDV | 8.8E-02 | 5.5E-09 | 0.0E+00 | 1.1E-02 | 2.6E-03 | 2.00 | 2 | 4.3 | 4.6E-02 | 86.8% |
| SELENIUM | | 0.00E+00 | 1.44E-02 | ** BIAS ** | 8.8E-02 | 4.6E-10 | 0.0E+00 | 2.2E-05 | 1.3E-03 | 2.00 | 2 | 4.3 | 1.3E-03 | 29.4% |
| PHOSPHORUS | | 5.03E+01 | 0.00E+00 | NSTDV | 8.8E-02 | 3.8E-06 | 0.0E+00 | 4.4E+00 | 1.8E+00 | 2.01 | 2 | 4.3 | 1.9E+01 | 53.1% |
| VANADIUM | | 2.73E-01 | 0.00E+00 | NSTDV | 8.8E-02 | 2.7E-08 | 0.0E+00 | 2.4E-02 | 1.3E-02 | 2.01 | 2 | 4.3 | 1.0E-01 | 39.9% |
| | | | | | | | | | | | | | | 68.7% |

| ANIONS (C&T): | COAL | CONC. DELTA P DETERMINATION NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. | HEAT RT | XXXXX | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorine, as Cl- (2) | | 0.00E+00 | 0.00E+00 | *ND BIAS* | 8.8E-02 | 5.5E-06 | 0.0E+00 | 2.7E-01 | 2.6E+00 | 1.00 | 1 | 12.7 | 4.3E+00 | 8.2% |
| Fluorine, as F- | | 2.91E+00 | 0.00E+00 | NSTDV | 8.8E-02 | 7.8E-07 | 0.0E+00 | 2.6E-01 | 3.7E-01 | 2.09 | 2 | 4.3 | 1.2E+00 | 15.8% |
| Phosphorus, as PO4 3- | | 1.54E+02 | 0.00E+00 | NSTDV | 8.8E-02 | 1.2E-05 | 0.0E+00 | 1.4E+01 | 5.5E+00 | 2.01 | 2 | 4.3 | 5.9E+01 | 53.1% |
| Sulfur, as SO4 2- | | 5.19E+02 | 0.00E+00 | NSTDV | 8.8E-02 | 1.2E-04 | 0.0E+00 | 4.6E+01 | 5.8E+01 | 2.07 | 2 | 4.3 | 2.1E+02 | 17.8% |
| | | | | | | | | | | | | | | 23.7% |

[UNPROC.XLW]UNCOAL.XLS
2:51 PM
1/11/94

PRELIMINARY

DO NOT CITE OR QUOTE

METALS/AN - FLYASH
UNCERTAINTY ANALYSIS
SITE 115, PHASE I -- BASELINE


| SPECIES | LOC | RUN #1 | RUN #2 In mg/Kg | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | |
| ARSENIC | FLY | 2.7 | 7.0 | 1.6 | 3.8E+00 | 2.85E+00 | 188.2% | 21.0% | 189.4% | 2.5E-02 | 4.8E-02 | 57.23% | 0.0% |
| BARIUM | ASH | 1800 | 1600 | 1500 | 1.6E+03 | 1.53E+02 | 23.4% | 21.0% | 31.5% | 1.1E+01 | 3.5E+00 | 6.80% | 0.0% |
| BERYLLIUM | | 1.8 | 1.6 | 1.5 | 1.6E+00 | 1.53E-01 | 23.4% | 21.0% | 31.5% | 1.1E-02 | 3.5E-03 | 6.80% | 0.0% |
| CADMIUM | | ND< 0.25 | ND< 0.25 | 0.30 @ | ND< 2.5E-01 | 2.89E-02 | 28.9% | 31.6% | 42.8% | ND< 1.7E-03 | 7.2E-04 | 6.67% | 100.0% |
| CHROMIUM | | 8.5 | 7.3 | 7.0 | 7.6E+00 | 7.94E-01 | 26.1% | 21.0% | 33.5% | 5.1E-02 | 1.7E-02 | 7.89% | 0.0% |
| COBALT | | 5.6 | 4.4 | 4.5 | 4.8E+00 | 6.66E-01 | 34.4% | 21.0% | 40.3% | 3.3E-02 | 1.3E-02 | 10.57% | 0.0% |
| COPPER | | 25 | 27 | 18 | 2.3E+01 | 4.73E+00 | 50.4% | 21.0% | 54.6% | 1.6E-01 | 8.6E-02 | 15.24% | 0.0% |
| LEAD | | 28 | 24 | 20 | 2.4E+01 | 4.00E+00 | 41.5% | 21.0% | 46.5% | 1.6E-01 | 7.5E-02 | 11.11% | 0.0% |
| MANGANESE | | 66 | 70 | 69 | 6.8E+01 | 2.08E+00 | 6.0% | 21.0% | 21.9% | 4.6E-01 | 1.0E-01 | 2.28% | 0.0% |
| MERCURY | | 0.3 | 0.2 | ND< 0.1 | 1.5E-01 | 1.00E-01 | 165.7% | 23.8% | 167.3% | 1.0E-03 | 1.7E-03 | 44.44% | 11.1% |
| MOLYBDENUM | | 3.8 | 3.8 | 3.4 | 3.7E+00 | 2.31E-01 | 15.9% | 21.0% | 26.4% | 2.5E-02 | 6.5E-03 | 4.85% | 0.0% |
| NICKEL | | 5.9 | 3.0 | 2.8 | 3.9E+00 | 1.73E+00 | 110.6% | 21.0% | 112.5% | 2.6E-02 | 3.0E-02 | 34.19% | 0.0% |
| SELENIUM | | 4.2 | 3.9 | 3.8 | 4.0E+00 | 2.08E-01 | 13.4% | 21.0% | 24.9% | 2.7E-02 | 6.7E-03 | 3.92% | 0.0% |
| PHOSPHORUS | | 3900 | 3300 | 2900 | 3.4E+03 | 5.03E+02 | 37.3% | 21.0% | 42.8% | 2.3E+01 | 9.7E+00 | 10.56% | 0.0% |
| VANADIUM | | 32 | 25 | 21 | 2.6E+01 | 5.57E+00 | 53.3% | 21.0% | 57.3% | 1.8E-01 | 1.0E-01 | 15.38% | 0.0% |
| | | | | | | AVERAGES: | 54.6% | 21.9% | 61.5% | 2.3E+00 | 9.1E-01 | 15.86% | |
| ANIONS: | FLY ASH | | | | | | | | | | | | |
| Chlorine, as Cl- | | 13 | 8.2 | 13 | 1.1E+01 | 2.77E+00 | 60.5% | 21.0% | 64.0% | 7.7E-02 | 4.9E-02 | 18.71% | 0.0% |
| Fluorine, as F- | | 20 | 18 | 34 | 2.4E+01 | 8.72E+00 | 90.3% | 21.0% | 92.7% | 1.6E-01 | 1.5E-01 | 27.78% | 0.0% |
| Phosphorus, as PO4 3- | | ND< 20 | ND< 20 | ND< 20 | ND< 2.0E+01 | 0.00E+00 | 3.1% | 35.7% | 35.8% | ND< 1.3E-01 | 4.8E-02 | 0.00% | 100.0% |
| Sulfur, as SO4 2- | | 1000 | 1100 | 840 | 9.8E+02 | 1.31E+02 | 33.4% | 21.0% | 39.4% | 6.6E+00 | 2.6E+00 | 9.52% | 0.0% |
| | | | | | | AVERAGES: | 46.8% | 24.7% | 58.0% | 1.7E+00 | 7.1E-01 | 14.00% | |

[UNPROC.XLW]UNFLYASH.XLS
2:54 PM
1/11/94

# METALS/AN - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| FLY ASH METALS: | | | | | | | | | |
| FLY ASH RATE,lb/MWhr | 64.79 | 66.39 | 65.30 | 65.49 | 0.81 | 1.24% | 0.47 | 21% | 13.75 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.577 | 0% | 0.00 |
| Ash Flow Rate, lb/hr | 6609 | 6838 | 6791 | 6746 | 121.0 | 1.79% | 69.8 | 0% | 0.00 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| FLY ASH ANIONS: | | | | | | | | | |
| Norm. Ash Flow, lba/lbf | 0.0761 | 0.0769 | 0.0765 | 0.0765 | 0.0004 | 0.52% | 0.0002 | 0.00% | 0.00 |
| HHV, Btu/lb | 11,114 | 11,154 | 11,206 | 11,158 | 46.13 | 0.41% | 26.63 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1157 | 1.31% | 668 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | 5.00% | 4.78E+05 |
| Ash Flow Rate, lb/hr | 6609 | 6838 | 6791 | 6746 | 121 | 1.79% | 69.8 | 0.00% | 0.00 |
| FLY ASH RATE,lb/MWhr | 64.79 | 66.39 | 65.30 | 65.49 | 0.81 | 1.24% | 0.47 | 21.00% | 13.75 |

[UNPROC.XLW]UNFLYASH.XLS
2:52 PM
1/11/94

PRELIMINARY

# METALS/AN - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE
## PAGE 3 OF 3

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | Fly Ash Rt (THETAhr) | xxxxxx (THETAhhv) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | | |
| ARSENIC | FLY | 1.65E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 3.9E-04 | 0.0E+00 | 1.1E-02 | 5.3E-03 | 2.00 | 2 | 4.3 | 4.8E-02 | 189.4% |
| BARIUM | ASH | 8.82E+01 | 0.00E+00 | NSTDV | 6.7E-03 | 1.7E-01 | 0.0E+00 | 6.0E-01 | 2.3E+00 | 2.07 | 2 | 4.3 | 3.5E+00 | 31.5% |
| BERYLLIUM | | 8.82E-02 | 0.00E+00 | NSTDV | 6.7E-03 | 1.7E-04 | 0.0E+00 | 6.0E-04 | 2.3E-03 | 2.07 | 2 | 4.3 | 3.5E-03 | 31.5% |
| CADMIUM | | 1.67E-02 | 5.89E-02 | ** BIAS ** | 6.7E-03 | 2.6E-05 | 0.0E+00 | 1.1E-04 | 5.3E-04 | 2.05 | 2 | 4.3 | 7.2E-04 | 42.8% |
| CHROMIUM | | 4.58E-01 | 0.00E+00 | NSTDV | 6.7E-03 | 7.8E-04 | 0.0E+00 | 3.1E-03 | 1.1E-02 | 2.06 | 2 | 4.3 | 1.7E-02 | 33.5% |
| COBALT | | 3.84E-01 | 0.00E+00 | NSTDV | 6.7E-03 | 5.0E-04 | 0.0E+00 | 2.6E-03 | 6.8E-03 | 2.03 | 2 | 4.3 | 1.3E-02 | 40.3% |
| COPPER | | 2.73E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 2.4E-03 | 0.0E+00 | 1.8E-02 | 3.3E-02 | 2.02 | 2 | 4.3 | 8.6E-02 | 54.6% |
| LEAD | | 2.31E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 2.5E-03 | 0.0E+00 | 1.6E-02 | 3.4E-02 | 2.02 | 2 | 4.3 | 7.5E-02 | 46.5% |
| MANGANESE | | 1.20E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 7.0E-03 | 0.0E+00 | 8.8E-03 | 9.7E-02 | 2.65 | 3 | 3.18 | 1.0E-01 | 21.9% |
| MERCURY | | 5.77E-02 | 1.67E-02 | NSTDV | 6.7E-03 | 1.5E-05 | 0.0E+00 | 3.9E-04 | 2.4E-04 | 2.00 | 2 | 4.3 | 1.7E-03 | 167.3% |
| MOLYBDENUM | | 1.33E-01 | 0.00E+00 | NSTDV | 6.7E-03 | 3.8E-04 | 0.0E+00 | 9.2E-04 | 5.2E-03 | 2.16 | 2 | 4.3 | 6.5E-03 | 26.4% |
| NICKEL | | 1.00E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 4.0E-04 | 0.0E+00 | 6.8E-03 | 5.5E-03 | 2.00 | 2 | 4.3 | 3.0E-02 | 112.5% |
| SELENIUM | | 1.20E-01 | 0.00E+00 | NSTDV | 6.7E-03 | 4.1E-04 | 0.0E+00 | 8.3E-04 | 5.6E-03 | 2.22 | 2 | 4.3 | 6.7E-03 | 24.9% |
| PHOSPHORUS | | 2.91E+02 | 0.00E+00 | NSTDV | 6.7E-03 | 3.5E-01 | 0.0E+00 | 2.0E+00 | 4.8E+00 | 2.03 | 2 | 4.3 | 9.7E+00 | 42.8% |
| VANADIUM | | 3.21E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 2.7E-03 | 0.0E+00 | 2.2E-02 | 3.7E-02 | 2.01 | 2 | 4.3 | 1.0E-01 | 57.3% |
| | | | | | | | | | | | | | | 61.5% |

| ANIONS: | FLY ASH | CONC. DELTA P DETERMINATION NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. | Fly Ash Rt | xxxxxx | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorine, as Cl- | | 1.60E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 1.2E-03 | 0.0E+00 | 1.1E-02 | 1.6E-02 | 2.01 | 2 | 4.3 | 4.9E-02 | 64.0% |
| Fluorine, as F- | | 5.03E+00 | 0.00E+00 | NSTDV | 6.7E-03 | 2.5E-03 | 0.0E+00 | 3.4E-02 | 3.4E-02 | 2.00 | 2 | 4.3 | 1.5E-01 | 92.7% |
| Phosphorus, as PO4 3- | | 0.00E+00 | 5.77E+00 | ** BIAS ** | 6.7E-03 | 2.1E-03 | 0.0E+00 | 9.7E-04 | 4.8E-02 | 2.00 | 2 | 4.3 | 4.8E-02 | 35.8% |
| Sulfur, as SO4 2- | | 7.57E+01 | 0.00E+00 | NSTDV | 6.7E-03 | 1.0E-01 | 0.0E+00 | 5.1E-01 | 1.4E+00 | 2.03 | 2 | 4.3 | 2.6E+00 | 39.4% |
| | | | | | | | | | | | | | | 58.0% |

[UNPROC.XLW]UNFLYASH.XLS
2:53 PM
1/11/94

DO NOT CITE OR QUOTE

# METALS/AN - BOTTOM ASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| SPECIES | LOC | RUN #1 | RUN #2 In mg/Kg | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE In lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | |
| ARSENIC | BOT | 1.3 | 1.3 | 1.5 | 1.3E+00 | 1.05E-01 | 19.6% | 22.6% | 29.9% | 2.0E-03 | 5.9E-04 | 5.84% | 0.0% |
| BARIUM | ASH | 860 | 741 | 880 | 8.3E+02 | 7.55E+01 | 22.8% | 22.6% | 32.1% | 1.2E+00 | 3.9E-01 | 6.96% | 0.0% |
| BERYLLIUM | | 1.0 | 0.8 | 1.0 | 9.3E-01 | 1.15E-01 | 30.8% | 22.6% | 38.2% | 1.4E-03 | 5.3E-04 | 9.52% | 0.0% |
| CADMIUM | | ND< 0.25 | ND< 0.3 | ND< 0.3 | ND< 2.5E-01 | 0.00E+00 | 2.2% | 36.6% | 36.7% | ND< 3.7E-04 | 1.4E-04 | 0.00% | 100.0% |
| CHROMIUM | | 2.7 | 2.4 | 2.5 | 2.5E+00 | 1.53E-01 | 15.1% | 22.6% | 27.2% | 3.7E-03 | 1.0E-03 | 4.37% | 0.0% |
| COBALT | | 2.2 | 1.8 | 2.3 | 2.1E+00 | 2.65E-01 | 31.4% | 22.6% | 38.6% | 3.1E-03 | 1.2E-03 | 9.52% | 0.0% |
| COPPER | | 10 | 7.6 | 8.2 | 8.6E+00 | 1.30E+00 | 37.5% | 22.6% | 43.7% | 1.3E-02 | 5.6E-03 | 11.30% | 0.0% |
| LEAD | | 11 | 8.7 | 7.7 | 9.1E+00 | 1.69E+00 | 46.1% | 22.6% | 51.3% | 1.3E-02 | 6.9E-03 | 13.63% | 0.0% |
| MANGANESE | | 40 | 33 | 34 | 3.6E+01 | 4.09E+00 | 28.6% | 22.6% | 36.4% | 5.2E-02 | 1.9E-02 | 8.82% | 0.0% |
| MERCURY | | ND< 0.1 | 0.3 | ND< 0.1 | 1.3E-01 | 1.39E-01 | 264.8% | 28.9% | 266.4% | 1.9E-04 | 5.1E-04 | 82.05% | 25.6% |
| MOLYBDENUM | | 0.7 | 0.4 | ND< 0.7 @ | ND< 7.0E-01 | 1.54E-01 | 54.9% | 28.0% | 61.6% | ND< 1.0E-03 | 6.4E-04 | 12.74% | 100.0% |
| NICKEL | | 2.2 | ND< 1.6 | ND< 1.6 @ | ND< 1.6E+00 | 3.46E-01 | 53.8% | 32.6% | 62.9% | ND< 2.4E-03 | 1.5E-03 | 12.50% | 100.0% |
| SELENIUM | | ND< 2.5 | ND< 2.5 | ND< 2.5 | ND< 2.5E+00 | 0.00E+00 | 2.2% | 36.6% | 36.7% | ND< 3.7E-03 | 1.4E-03 | 0.00% | 100.0% |
| PHOSPHORUS | | 1908 | 1600 | 1806 | 1.8E+03 | 1.57E+02 | 22.1% | 22.6% | 31.6% | 2.6E+00 | 8.2E-01 | 6.45% | 0.0% |
| VANADIUM | | 12 | 9 | 11 | 1.1E+01 | 1.32E+00 | 30.2% | 22.6% | 37.7% | 1.6E-02 | 6.0E-03 | 8.79% | 0.0% |
| | | | | | | AVERAGES: | 44.1% | 25.9% | 55.4% | 2.6E-01 | 8.4E-02 | 12.83% | |
| ANIONS: | BOT ASH | | | | | | | | | | | | |
| Chlorine, as Cl- | | 47 | 41 | 51 | 4.7E+01 | 5.12E+00 | 27.4% | 22.6% | 35.5% | 6.9E-02 | 2.4E-02 | 7.73% | 0.0% |
| Fluorine, as F- | | ND< 28 | ND< 25 | ND< 31 | ND< 2.8E+01 | 3.07E+00 | 27.4% | 36.7% | 45.8% | ND< 4.1E-02 | 1.9E-02 | 7.73% | 100.0% |
| Phosphorus, as PO4 3- | | ND< 189 | ND< 165 | ND< 206 | ND< 1.9E+02 | 2.05E+01 | 27.4% | 36.7% | 45.8% | ND< 2.8E-01 | 1.3E-01 | 7.73% | 100.0% |
| Sulfur, as SO4 2- | | 189 | 759 | 617 | 5.2E+02 | 2.97E+02 | 141.3% | 22.6% | 143.1% | 7.7E-01 | 1.1E+00 | 42.50% | 0.0% |
| | | | | | | AVERAGES: | 55.8% | 29.6% | 67.5% | 2.9E-01 | 3.2E-01 | 16.42% | |

# METALS/AN - BOTTOM ASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| BOTTOM ASH METALS: | | | | | | | | | |
| Norm. Ash Flow, lba/lbf | 0.0167 | 0.0167 | 0.0167 | 0.0167 | 0.0000 | 0.15% | 0.0000 | 22.00% | 0.0037 |
| HHV, Btu/lb | 11,114 | 11,154 | 11,206 | 11,158 | 46.13 | 0.41% | 26.63 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1157 | 1.31% | 668 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | -5.00% | -4.78E+05 |
| Ash Flow Rate, lb/hr | 1,450 | 1,489 | 1,484 | 1,474 | 21.38 | 1.45% | 12.35 | 0.00% | 0.00 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| BOTTOM ASH ANIONS: | | | | | | | | | |
| Norm. Ash Flow, lba/lbf | 0.0167 | 0.0167 | 0.0167 | 0.0167 | 0.0000 | 0.15% | 0.0000 | 22.00% | 0.0037 |
| HHV, Btu/lb | 11,114 | 11,154 | 11,206 | 11,158 | 46.1 | 0.41% | 26.6 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1157 | 1.31% | 668 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | -5.00% | -4.78E+05 |
| Ash Flow Rate, lb/hr | 1450 | 1489 | 1484 | 1474 | 21.38 | 1.45% | 12.35 | 0.00% | 0.00 |

[UNPROC.XLW]UNBOTASH.XLS
6:38 PM
1/12/94

METALS/AN - BOTTOM ASH
UNCERTAINTY ANALYSIS
SITE 115, PHASE I -- BASELINE
PAGE 3 OF 3

PRELIMINARY

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RATE (THETAhr) | ASH RATE (THETAhhv) | RESULTS: Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | | |
| ARSENIC | BOT | 6.07E-02 | 0.00E+00 | NSTDV | 1.5E-03 | 2.1E-10 | 1.2E-01 | 9.0E-05 | 4.5E-04 | 2.05 | 2 | 4.3 | 5.9E-04 | 29.9% |
| BARIUM | ASH | 4.36E+01 | 0.00E+00 | NSTDV | 1.5E-03 | 1.3E-07 | 7.3E+01 | 6.5E-02 | 2.8E-01 | 2.04 | 2 | 4.3 | 3.9E-01 | 32.1% |
| BERYLLIUM | | 6.67E-02 | 0.00E+00 | NSTDV | 1.5E-03 | 1.4E-10 | 8.2E-02 | 9.9E-05 | 3.1E-04 | 2.02 | 2 | 4.3 | 5.3E-04 | 38.2% |
| CADMIUM | | 0.00E+00 | 7.22E-02 | ** BIAS ** | 1.5E-03 | 3.9E-11 | 2.2E-02 | 1.9E-06 | 1.4E-04 | 2.12 | 2 | 4.3 | 1.4E-04 | 36.7% |
| CHROMIUM | | 8.81E-02 | 0.00E+00 | NSTDV | 1.5E-03 | 3.9E-10 | 2.2E-01 | 1.3E-04 | 8.4E-04 | 2.09 | 2 | 4.3 | 1.0E-03 | 27.2% |
| COBALT | | 1.53E-01 | 0.00E+00 | NSTDV | 1.5E-03 | 3.2E-10 | 1.9E-01 | 2.3E-04 | 7.0E-04 | 2.02 | 2 | 4.3 | 1.2E-03 | 38.6% |
| COPPER | | 7.49E-01 | 0.00E+00 | NSTDV | 1.5E-03 | 1.3E-09 | 7.6E-01 | 1.1E-03 | 2.9E-03 | 2.01 | 2 | 4.3 | 5.6E-03 | 43.7% |
| LEAD | | 9.77E-01 | 0.00E+00 | NSTDV | 1.5E-03 | 1.4E-09 | 8.1E-01 | 1.4E-03 | 3.0E-03 | 2.01 | 2 | 4.3 | 6.9E-03 | 51.3% |
| MANGANESE | | 2.36E+00 | 0.00E+00 | NSTDV | 1.5E-03 | 5.5E-09 | 3.1E+00 | 3.5E-03 | 1.2E-02 | 2.02 | 2 | 4.3 | 1.9E-02 | 36.4% |
| MERCURY | | 8.00E-02 | 2.36E-02 | NSTDV | 1.5E-03 | 2.0E-11 | 1.1E-02 | 1.2E-04 | 5.5E-05 | 2.00 | 2 | 4.3 | 5.1E-04 | 266.4% |
| MOLYBDENUM | | 8.92E-02 | 1.17E-01 | ** BIAS ** | 1.5E-03 | 1.1E-10 | 6.2E-02 | 1.3E-04 | 2.9E-04 | 2.01 | 2 | 4.3 | 6.4E-04 | 61.6% |
| NICKEL | | 2.00E-01 | 3.77E-01 | ** BIAS ** | 1.5E-03 | 2.5E-10 | 1.4E-01 | 3.0E-04 | 7.7E-04 | 2.01 | 2 | 4.3 | 1.5E-03 | 62.9% |
| SELENIUM | | 0.00E+00 | 7.22E-01 | ** BIAS ** | 1.5E-03 | 3.9E-10 | 2.2E-01 | 1.9E-05 | 1.4E-03 | 2.12 | 2 | 4.3 | 1.4E-03 | 36.7% |
| PHOSPHORUS | | 9.05E+01 | 0.00E+00 | NSTDV | 1.5E-03 | 2.7E-07 | 1.6E+02 | 1.3E-01 | 5.9E-01 | 2.04 | 2 | 4.3 | 8.2E-01 | 31.6% |
| VANADIUM | | 7.59E-01 | 0.00E+00 | NSTDV | 1.5E-03 | 1.7E-09 | 9.6E-01 | 1.1E-03 | 3.6E-03 | 2.02 | 2 | 4.3 | 6.0E-03 | 37.7% |
| | | | | | | | | | | | | | | 55.4% |

| ANIONS: | BOT ASH | CONC. DELTA P DETERMINATION NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. | HEAT RT | ASH FLOW | RESULTS: Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorine, as Cl- | | 2.96E+00 | 0.00E+00 | NSTDV | 1.5E-03 | 7.2E-09 | 4.1E+00 | 4.4E-03 | 1.6E-02 | 2.03 | 2 | 4.3 | 2.4E-02 | 35.5% |
| Fluorine, as F- | | 1.77E+00 | 8.11E+00 | ** BIAS ** | 1.5E-03 | 4.3E-09 | 2.5E+00 | 2.6E-03 | 1.5E-02 | 2.03 | 2 | 4.3 | 1.9E-02 | 45.8% |
| Phosphorus, as PO4 3- | | 1.18E+01 | 5.41E+01 | ** BIAS ** | 1.5E-03 | 2.9E-08 | 1.6E+01 | 1.7E-02 | 1.0E-01 | 2.03 | 2 | 4.3 | 1.3E-01 | 45.8% |
| Sulfur, as SO4 2- | | 1.71E+02 | 0.00E+00 | NSTDV | 1.5E-03 | 8.1E-08 | 4.6E+01 | 2.5E-01 | 1.7E-01 | 2.00 | 2 | 4.3 | 1.1E+00 | 143.1% |
| | | | | | | | | | | | | | | 67.5% |

[UNPROC.XLW]UNBOTASH.XLS
2:58 PM
1/11/94

DO NOT CITE OR QUOTE

INAA - COAL
UNCERTAINTY ANALYSIS
SITE 115, PHASE I – BASELINE


| SPECIES | LOC | RUN #1 | RUN #2 in mg/Kg | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS (INAA): | | | | | | | | | | | | | |
| ARSENIC | COAL | 0.55 | 0.40 | 0.49 | 4.75E-01 | 7.55E-02 | 39.5% | 5.0% | 39.9% | 0.042 | 1.7E-02 | 11.23% | 0.0% |
| BARIUM | | 350 | 525 | 383 | 4.19E+02 | 9.31E+01 | 55.2% | 5.0% | 55.4% | 37.0 | 2.0E+01 | 16.83% | 0.0% |
| CADMIUM | | 0.13 | 0.09 | 0.11 | 1.09E-01 | 2.18E-02 | 49.8% | 5.0% | 50.0% | 0.010 | 4.8E-03 | 13.68% | 0.0% |
| CHROMIUM | | 3.00 | 3.50 | 2.05 | 2.85E+00 | 7.37E-01 | 64.2% | 5.0% | 64.4% | 0.251 | 1.6E-01 | 18.71% | 0.0% |
| COBALT | | 0.74 | 0.75 | 0.70 | 7.25E-01 | 2.65E-02 | 9.3% | 5.0% | 10.6% | 0.064 | 6.8E-03 | 2.76% | 0.0% |
| MERCURY | | 0.025 | 0.026 | 0.013 | 2.13E-02 | 7.23E-03 | 84.3% | 5.0% | 84.4% | 0.002 | 1.6E-03 | 26.04% | 0.0% |
| MOLYBDENUM | | 0.89 | 1.20 | 0.95 | 1.01E+00 | 1.64E-01 | 40.4% | 5.0% | 40.7% | 0.089 | 3.6E-02 | 12.28% | 0.0% |
| SELENIUM | | 0.75 | 0.77 | 0.93 | 8.17E-01 | 9.87E-02 | 30.1% | 5.0% | 30.5% | 0.072 | 2.2E-02 | 9.25% | 0.0% |
| CHLORIDE | | 19 | 22 | 26 | 2.23E+01 | 3.51E+00 | 39.1% | 5.0% | 39.4% | 2.0 | 7.8E-01 | 10.95% | 0.0% |
| | | | | | | AVERAGES: | 45.8% | 5.0% | 46.2% | 4.4E+00 | 2.4E+00 | 13.5% | |

[UNPROC.XLW]UNINAA
8:28 PM
11/8/93

**INAA - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| METALS FUEL NAA: | | | | | | | | | |
| HHV, Btu/lb | 11,114 | 11,154 | 11,206 | 11,158 | 46.13 | 0.41% | 26.63 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1156.85 | 1.31% | 667.91 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | -5.00% | -4.78E+05 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

[UNPROC.XLW]UNINAA
8:29 PM
11/8/93

**INAA - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**
**PAGE 3 OF 3**

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RT (THETAhr) | xxxxxx (THETAhhv) | RESULTS: Sr | Br | νr | νr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS (INAA): | | | | | | | | | | | | | | |
| ARSENIC | COAL | 4.36E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 4.4E-09 | 0.0E+00 | 3.8E-03 | 2.1E-03 | 2.01 | 2 | 4.3 | 1.7E-02 | 39.9% |
| BARIUM | | 5.37E+01 | 0.00E+00 | NSTDV | 8.8E-02 | 3.9E-06 | 0.0E+00 | 4.7E+00 | 1.8E+00 | 2.01 | 2 | 4.3 | 2.0E+01 | 55.4% |
| CADMIUM | | 1.26E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 1.0E-09 | 0.0E+00 | 1.1E-03 | 4.8E-04 | 2.01 | 2 | 4.3 | 4.8E-03 | 50.0% |
| CHROMIUM | | 4.25E-01 | 0.00E+00 | NSTDV | 8.8E-02 | 2.6E-08 | 0.0E+00 | 3.8E-02 | 1.3E-02 | 2.00 | 2 | 4.3 | 1.6E-01 | 64.4% |
| COBALT | | 1.53E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 6.7E-09 | 0.0E+00 | 1.4E-03 | 3.2E-03 | 2.24 | 2 | 4.3 | 6.8E-03 | 10.6% |
| MERCURY | | 4.18E-03 | 0.00E+00 | NSTDV | 8.8E-02 | 2.0E-10 | 0.0E+00 | 3.7E-04 | 9.4E-05 | 2.00 | 2 | 4.3 | 1.6E-03 | 84.4% |
| MOLYBDENUM | | 9.49E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 9.4E-09 | 0.0E+00 | 8.4E-03 | 4.5E-03 | 2.01 | 2 | 4.3 | 3.6E-02 | 40.7% |
| SELENIUM | | 5.70E-02 | 0.00E+00 | NSTDV | 8.8E-02 | 7.5E-09 | 0.0E+00 | 5.0E-03 | 3.6E-03 | 2.02 | 2 | 4.3 | 2.2E-02 | 30.5% |
| CHLORIDE | | 2.03E+00 | 0.00E+00 | NSTDV | 8.8E-02 | 2.1E-07 | 0.0E+00 | 1.8E-01 | 9.8E-02 | 2.01 | 2 | 4.3 | 7.8E-01 | 39.4% |
| | | | | | | | | | | | | | | 46.2% |

[UNPROC.XLW]UNINAA
8:27 PM
11/8/93

PRELIMINARY

DO NOT CITE OR QUOTE

**RADIONUCLIDES - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**
**PAGE 1 OF 3**

| SPECIES | LOC | RUN #1 | RUN #2 in pCi/g | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in uCi/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES: | | | | | | | | | | | | | |
| Uranium-233 & -234 | COAL | 0.16 | 0.13 | 0.11 | 1.3E-01 | 2.52E-02 | 46.9% | 5.0% | 47.2% | 4.7E+00 | 2.2E+00 | 13.33% | 0.0% |
| Uranium-235 | | ND< 0.01 | ND< 0.01 | 0.02 | 1.0E-02 | 8.66E-03 | 215.2% | 24.1% | 216.5% | 3.6E-01 | 7.7E-01 | 66.67% | 33.3% |
| Uranium-238 | | 0.12 | 0.05 | 0.11 | 9.3E-02 | 3.79E-02 | 100.8% | 5.0% | 100.9% | 3.3E+00 | 3.3E+00 | 30.95% | 0.0% |
| Radium-226 | | 0.29 | 0.31 | 0.24 | 2.8E-01 | 3.61E-02 | 32.0% | 5.0% | 32.4% | 1.0E+01 | 3.2E+00 | 9.52% | 0.0% |
| Radium-228 | | 0.35 | 0.20 | 0.16 | 2.4E-01 | 1.00E-01 | 105.2% | 5.0% | 105.3% | 8.4E+00 | 8.9E+00 | 31.92% | 0.0% |
| Lead-210 | | 0.37 | ND< 0.69 | 0.77 # | 5.0E-01 | 2.38E-01 | 119.7% | 23.8% | 122.0% | 1.8E+01 | 2.1E+01 | 37.04% | 23.2% |
| Polonium-210 | | 0.1 | ND< 0.1 | 0.2 | 1.2E-01 | 7.64E-02 | 162.6% | 15.1% | 163.4% | 4.1E+00 | 6.8E+00 | 47.62% | 14.3% |
| Thorium-228 | | 0.09 | 0.08 | 0.12 | 9.7E-02 | 2.08E-02 | 53.5% | 5.0% | 53.8% | 3.4E+00 | 1.8E+00 | 16.09% | 0.0% |
| Thorium-230 | | 0.12 | 0.17 | 0.30 | 2.0E-01 | 9.29E-02 | 117.4% | 5.0% | 117.5% | 7.0E+00 | 8.2E+00 | 35.03% | 0.0% |
| Thorium-232 | | 0.12 | 0.04 | 0.15 | 1.0E-01 | 5.69E-02 | 136.7% | 5.0% | 136.8% | 3.7E+00 | 5.0E+00 | 40.86% | 0.0% |
| | | | | | | AVERAGES: | 109.0% | 9.8% | 109.6% | 6.3E+00 | 6.2E+00 | 32.9% | |

[UNPROC.XLW]UNCOLRAD.XLS
6:38 PM
1/12/94

## RADIONUCLIDES - COAL
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE



| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| COAL RADIONUCLIDES: | | | | | | | | | |
| HHV, Btu/lb | 12,565 | 12,565 | 12,565 | 12,565 | 0.00 | 0.00% | 0.00 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 77,114 | 78,963 | 78,815 | 78,297 | 1027.47 | 1.31% | 593.21 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.50E+06 | 9.63E+06 | 9.52E+06 | 9.55E+06 | 7.13E+04 | 0.75% | 4.12E+04 | -5.00% | -4.78E+05 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

[UNPROC.XLW]UNCOLRAD.XLS
3:07 PM
1/11/94

PRELIMINARY

# RADIONUCLIDES - COAL
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE I -- BASELINE


| SPECIES | LOC | CONC. DELTA P DETERMINATION | | | THETA CALCULATIONS FOR: | | | RESULTS: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | CONC. | HEAT RT | XXXXXX | Sr | Br | vr | vr | t | Ur | % Ur |
| RADIONUCLIDES: | | (Spc') | (Bpc) | | (THETAc) | (THETAhr) | (THETAhhv) | | | | | | | |
| Uranium-233 & -234 | COAL | 1.45E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 5.0E-07 | 0.0E+00 | 5.2E-01 | 2.4E-01 | 2.01 | 2 | 4.3 | 2.2E+00 | 47.2% |
| Uranium-235 | | 5.00E-03 | 2.36E-03 | NSTDV | 3.6E+01 | 3.7E-08 | 0.0E+00 | 1.8E-01 | 8.6E-02 | 2.00 | 2 | 4.3 | 7.7E-01 | 216.5% |
| Uranium-238 | | 2.19E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 3.5E-07 | 0.0E+00 | 7.8E-01 | 1.7E-01 | 2.00 | 2 | 4.3 | 3.3E+00 | 100.9% |
| Radium-226 | | 2.08E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 1.0E-06 | 0.0E+00 | 7.4E-01 | 5.0E-01 | 2.01 | 2 | 4.3 | 3.2E+00 | 32.4% |
| Radium-228 | | 5.78E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 8.8E-07 | 0.0E+00 | 2.1E+00 | 4.2E-01 | 2.00 | 2 | 4.3 | 8.9E+00 | 105.3% |
| Lead-210 | | 1.38E-01 | 1.15E-01 | NSTDV | 3.6E+01 | 1.8E-06 | 0.0E+00 | 4.9E+00 | 4.2E+00 | 2.00 | 2 | 4.3 | 2.1E+01 | 122.0% |
| Polonium-210 | | 4.41E-02 | 1.67E-02 | NSTDV | 3.6E+01 | 4.3E-07 | 0.0E+00 | 1.6E+00 | 6.3E-01 | 2.00 | 2 | 4.3 | 6.8E+00 | 163.4% |
| Thorium-228 | | 1.20E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 3.6E-07 | 0.0E+00 | 4.3E-01 | 1.7E-01 | 2.00 | 2 | 4.3 | 1.8E+00 | 53.8% |
| Thorium-230 | | 5.36E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 7.3E-07 | 0.0E+00 | 1.9E+00 | 3.5E-01 | 2.00 | 2 | 4.3 | 8.2E+00 | 117.5% |
| Thorium-232 | | 3.28E-02 | 0.00E+00 | NSTDV | 3.6E+01 | 3.8E-07 | 0.0E+00 | 1.2E+00 | 1.8E-01 | 2.00 | 2 | 4.3 | 5.0E+00 | 136.8% |
| | | | | | | | | | | | | | | 109.6% |



DO NOT CITE OR QUOTE

# RADIONUCLIDES - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE



| SPECIES | LOC | RUN #1 | RUN #2 in pCi/g | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in uCi/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES: | | | | | | | | | | | | | |
| Uranium-233 & -234 | FLY | 2.6 | 2.3 | 2.0 | 2.3E+00 | 3.00E-01 | 32.6% | 21.0% | 38.7% | 7.04E+00 | 2.7E+00 | 8.70% | 0.0% |
| Uranium-235 | ASH | 0.2 | 0.1 | ND< 0.1 | 1.2E-01 | 7.64E-02 | 162.7% | 25.4% | 164.6% | 3.57E-01 | 5.9E-01 | 47.62% | 14.3% |
| Uranium-238 | | 2.6 | 2.4 | 2.2 | 2.4E+00 | 2.00E-01 | 20.9% | 21.0% | 29.7% | 7.35E+00 | 2.2E+00 | 5.56% | 0.0% |
| Radium-226 | | 3.2 | 2.7 | 2.5 | 2.8E+00 | 3.61E-01 | 32.1% | 21.0% | 38.4% | 8.58E+00 | 3.3E+00 | 9.52% | 0.0% |
| Radium-228 | | 2.0 | 1.6 | 1.7 | 1.8E+00 | 2.08E-01 | 29.4% | 21.0% | 36.2% | 5.41E+00 | 2.0E+00 | 8.81% | 0.0% |
| Lead-210 | | 0.8 | 1.1 | 1.3 | 1.1E+00 | 2.52E-01 | 58.7% | 21.0% | 62.3% | 3.27E+00 | 2.0E+00 | 16.67% | 0.0% |
| Polonium-210 | | 1.4 | 1.2 | 1.8 | 1.5E+00 | 3.06E-01 | 51.8% | 21.0% | 55.9% | 4.49E+00 | 2.5E+00 | 15.15% | 0.0% |
| Thorium-228 | | 2.8 | 2.5 | 2.2 | 2.5E+00 | 3.00E-01 | 30.0% | 21.0% | 36.6% | 7.66E+00 | 2.8E+00 | 8.00% | 0.0% |
| Thorium-230 | | 3.2 | 2.2 | 2.1 | 2.5E+00 | 6.08E-01 | 60.5% | 21.0% | 64.1% | 7.66E+00 | 4.9E+00 | 18.67% | 0.0% |
| Thorium-232 | | 2.7 | 2.7 | 2.4 | 2.6E+00 | 1.73E-01 | 16.8% | 21.0% | 26.9% | 7.96E+00 | 2.1E+00 | 5.13% | 0.0% |
| | | | | | | AVERAGES: | 49.6% | 21.4% | 55.3% | 6.0E+00 | 2.5E+00 | 14.4% | |

[UNPROC.XLW]UNFLYRAD
8:36 PM
11/8/93

# RADIONUCLIDES - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| FLY ASH RADIONUCLIDES: | | | | | | | | | |
| FLY ASH RATE,lb/MWhr | 64.79 | 66.39 | 65.30 | 65.49 | 0.81 | 1.24% | 0.47 | 21.00% | 13.75 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| Ash Flow Rate, lb/hr | 6609 | 6838 | 6791 | 6746 | 121 | 1.79% | 69.8 | 0.00% | 0.00 |
| | | | | DEGREES | | | | | |
| | | | | FREEDOM | T-VALUE | | | | |
| | | | | 1 | 12.71 | | | | |
| | | | | 2 | 4.30 | | | | |
| | | | | 3 | 3.18 | | | | |
| | | | | 4 | 2.78 | | | | |
| | | | | 5 | 2.57 | | | | |
| | | | | 6 | 2.45 | | | | |
| | | | | 7 | 2.37 | | | | |
| | | | | 8 | 2.31 | | | | |

[UNPROC.XLW]UNFLYRAD
8:38 PM
11/8/93

# RADIONUCLIDES - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE I -- BASELINE


| SPECIES | LOC | CONC. DELTA P DETERMINATION | | | THETA CALCULATIONS FOR: | | | RESULTS: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | CONC. | Ash Flow | XXXXXX | Sr | Br | vr | vr | t | Ur | % Ur |
| RADIONUCLIDES: | | (Spc') | (Bpc) | | (THETAc) | (THETAhr) | (THETAhhv) | | | | | | | |
| Uranium-233 & -234 | FLY | 1.73E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 1.1E-01 | 0.0E+00 | 5.3E-01 | 1.5E+00 | 2.04 | 2 | 4.3 | 2.7E+00 | 38.7% |
| Uranium-235 | ASH | 4.41E-02 | 1.67E-02 | NSTDV | 3.1E+00 | 5.5E-03 | 0.0E+00 | 1.4E-01 | 9.1E-02 | 2.00 | 2 | 4.3 | 5.9E-01 | 164.6% |
| Uranium-238 | | 1.15E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 1.1E-01 | 0.0E+00 | 3.6E-01 | 1.5E+00 | 2.09 | 2 | 4.3 | 2.2E+00 | 29.7% |
| Radium-226 | | 2.08E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 1.3E-01 | 0.0E+00 | 6.4E-01 | 1.8E+00 | 2.04 | 2 | 4.3 | 3.3E+00 | 38.4% |
| Radium-228 | | 1.20E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 8.3E-02 | 0.0E+00 | 3.7E-01 | 1.1E+00 | 2.04 | 2 | 4.3 | 2.0E+00 | 36.2% |
| Lead-210 | | 1.45E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 5.0E-02 | 0.0E+00 | 4.5E-01 | 6.9E-01 | 2.01 | 2 | 4.3 | 2.0E+00 | 62.3% |
| Polonium-210 | | 1.76E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 6.9E-02 | 0.0E+00 | 5.4E-01 | 9.4E-01 | 2.01 | 2 | 4.3 | 2.5E+00 | 55.9% |
| Thorium-228 | | 1.73E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 1.2E-01 | 0.0E+00 | 5.3E-01 | 1.6E+00 | 2.04 | 2 | 4.3 | 2.8E+00 | 36.6% |
| Thorium-230 | | 3.51E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 1.2E-01 | 0.0E+00 | 1.1E+00 | 1.6E+00 | 2.01 | 2 | 4.3 | 4.9E+00 | 64.1% |
| Thorium-232 | | 1.00E-01 | 0.00E+00 | NSTDV | 3.1E+00 | 1.2E-01 | 0.0E+00 | 3.1E-01 | 1.7E+00 | 2.14 | 2 | 4.3 | 2.1E+00 | 26.9% |
| | | | | | | | | | | | | | | 55.3% |

[UNPROC.XLW]UNFLYRAD
8:35 PM
11/8/93

RADIONUCLIDES - BOTTOM ASH
UNCERTAINTY ANALYSIS
SITE 115, PHASE I -- BASELINE
PAGE 1 OF 3

| SPECIES | LOC | RUN #1 | RUN #2 In pCi/g | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in uCi/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND. TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES: | | | | | | | | | | | | | |
| Uranium-233 & -234 | BOT | 2.1 | 2.4 | 2.1 | 2.2E+00 | 1.77E-01 | 20.4% | 22.6% | 30.4% | 1.5 | 4.4E-01 | 6.27% | 0.0% |
| Uranium-235 | ASH | 0.1 | 0.1 | 0.1 | 1.0E-01 | 4.77E-04 | 1.9% | 22.6% | 22.6% | 0.07 | 1.5E-02 | 0.37% | 0.0% |
| Uranium-238 | | 2.0 | 2.3 | 2.3 | 2.2E+00 | 1.77E-01 | 20.2% | 22.6% | 30.3% | 1.5 | 4.4E-01 | 6.23% | 0.0% |
| Radium-226 | | 2.2 | 3.1 | 2.9 | 2.7E+00 | 4.73E-01 | 43.0% | 22.6% | 48.6% | 1.8 | 8.9E-01 | 13.02% | 0.0% |
| Radium-228 | | 1.8 | 2.0 | 2.1 | 2.0E+00 | 1.49E-01 | 19.1% | 22.6% | 29.6% | 1.31 | 3.9E-01 | 5.57% | 0.0% |
| Lead-210 | | 0.7 | 0.9 | 0.6 | 7.3E-01 | 1.53E-01 | 51.8% | 22.6% | 56.5% | 0.49 | 2.8E-01 | 15.15% | 0.0% |
| Polonium-210 | | 0.6 | 0.2 | 0.3 | 3.7E-01 | 2.08E-01 | 141.2% | 22.6% | 143.0% | 0.25 | 3.5E-01 | 42.43% | 0.0% |
| Thorium-228 | | 3.2 | 2.9 | 3.2 | 3.1E+00 | 1.73E-01 | 14.1% | 22.6% | 26.6% | 2.1 | 5.5E-01 | 4.30% | 0.0% |
| Thorium-230 | | 3.2 | 2.8 | 3.0 | 3.0E+00 | 2.00E-01 | 16.7% | 22.6% | 28.1% | 2.0 | 5.6E-01 | 4.46% | 0.0% |
| Thorium-232 | | 3.4 | 3.3 | 3.0 | 3.2E+00 | 2.08E-01 | 16.1% | 22.6% | 27.7% | 2.2 | 6.0E-01 | 4.81% | 0.0% |
| | | | | | | AVERAGES: | 34.5% | 22.6% | 44.3% | 1.3E+00 | 4.5E-01 | 10.3% | |

[UNPROC.XLW]UNBOTASHRAD
3:10 PM
1/11/94

PRELIMINARY

DO NOT CITE OR QUOTE

**RADIONUCLIDES - BOTTOM ASH**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| BOTTOM ASH RADIONUCLIDES: | | | | | | | | | |
| Norm. Ash Flow, lba/lbf | 0.0167 | 0.0167 | 0.0167 | 0.0167 | 0.0000 | 0.15% | 0.0000 | 22.00% | 0.0037 |
| HHV, Btu/lb | 11,114 | 11,154 | 11,206 | 11,158 | 46.13 | 0.41% | 26.63 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 86,837 | 88,919 | 88,752 | 88,169 | 1157 | 1.31% | 668 | 0.00% | 0.00 |
| LOAD, MW | 102 | 103 | 104 | 103 | 1.00 | 0.97% | 0.58 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.46E+06 | 9.63E+06 | 9.56E+06 | 9.55E+06 | 8.43E+04 | 0.88% | 4.87E+04 | -5.00% | -4.78E+05 |
| Ash Flow Rate, lb/hr | 1,450 | 1,489 | 1,484 | 1,474 | 21.4 | 1.45% | 12.35 | 0.00% | 0.00 |
| | | | | DEGREES FREEDOM | T-VALUE | | | | |
| | | | | 1 | 12.71 | | | | |
| | | | | 2 | 4.30 | | | | |
| | | | | 3 | 3.18 | | | | |
| | | | | 4 | 2.78 | | | | |
| | | | | 5 | 2.57 | | | | |
| | | | | 6 | 2.45 | | | | |
| | | | | 7 | 2.37 | | | | |

[UNPROC.XLW]UNBOTASHRAD
3:12 PM
1/11/94

**RADIONUCLIDES - BOTTOM ASH**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE I -- BASELINE**


| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RT (THETAhr) | Ash Flow (THETAhhv) | RESULTS: Sr | Br | νr | νr | t: | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIONUCLIDES: | | | | | | | | | | | | | | |
| Uranium-233 & -234 | BOT | 1.02E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 1.5E-07 | 8.7E+01 | 6.9E-02 | 3.3E-01 | 2.05 | 2 | 4.3 | 4.4E-01 | 30.4% |
| Uranium-235 | ASH | 2.75E-04 | 0.00E+00 | NSTDV | 6.7E-01 | 7.0E-09 | 4.0E+00 | 3.9E-04 | 1.5E-02 | 3.22 | 3 | 3.18 | 1.5E-02 | 22.6% |
| Uranium-238 | | 1.02E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 1.5E-07 | 8.7E+01 | 6.9E-02 | 3.3E-01 | 2.05 | 2 | 4.3 | 4.4E-01 | 30.3% |
| Radium-226 | | 2.73E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 1.9E-07 | 1.1E+02 | 1.8E-01 | 4.1E-01 | 2.01 | 2 | 4.3 | 8.9E-01 | 48.6% |
| Radium-228 | | 8.63E-02 | 0.00E+00 | NSTDV | 6.7E-01 | 1.4E-07 | 7.8E+01 | 5.8E-02 | 3.0E-01 | 2.05 | 2 | 4.3 | 3.9E-01 | 29.6% |
| Lead-210 | | 8.82E-02 | 0.00E+00 | NSTDV | 6.7E-01 | 5.1E-08 | 2.9E+01 | 5.9E-02 | 1.1E-01 | 2.01 | 2 | 4.3 | 2.8E-01 | 56.5% |
| Polonium-210 | | 1.20E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 2.6E-08 | 1.5E+01 | 8.0E-02 | 5.5E-02 | 2.00 | 2 | 4.3 | 3.5E-01 | 143.0% |
| Thorium-228 | | 1.00E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 2.2E-07 | 1.2E+02 | 6.8E-02 | 4.7E-01 | 2.10 | 2 | 4.3 | 5.5E-01 | 26.6% |
| Thorium-230 | | 1.16E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 2.1E-07 | 1.2E+02 | 7.8E-02 | 4.5E-01 | 2.07 | 2 | 4.3 | 5.6E-01 | 28.1% |
| Thorium-232 | | 1.20E-01 | 0.00E+00 | NSTDV | 6.7E-01 | 2.3E-07 | 1.3E+02 | 8.1E-02 | 4.9E-01 | 2.08 | 2 | 4.3 | 6.0E-01 | 27.7% |

44.3%

[UNPROC.XLW]UNBOTASHRAD
3:10 PM
1/11/94

# METALS
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION
## PAGE 1 OF 3

| SPECIES | LOC | RUN #1 | RUN #2 in ug/Nm3 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | |
| ARSENIC | IN | 22.6 | 18.1 | 7.7 | 1.62E+01 | 7.64E+00 | 117.5% | 15.7% | 118.5% | 1.43E-02 | 1.7E-02 | 34.77% | 0.0% |
| BARIUM | | 268 | 167 | 286 | 2.41E+02 | 6.40E+01 | 66.1% | 15.7% | 67.9% | 2.13E-01 | 1.4E-01 | 20.27% | 0.0% |
| BERYLLIUM | | 9.4 | 8.0 | 10.7 | 9.36E+00 | 1.36E+00 | 36.1% | 15.7% | 39.4% | 8.29E-03 | 3.3E-03 | 9.89% | 0.0% |
| CADMIUM | | 2.57 | 1.99 | 3.00 | 2.52E+00 | 5.05E-01 | 49.8% | 15.7% | 52.2% | 2.23E-03 | 1.2E-03 | 13.98% | 0.0% |
| CHROMIUM | | 57.3 | 55.1 | 78.7 | 6.37E+01 | 1.30E+01 | 50.8% | 15.7% | 53.2% | 3.64E-02 | 3.0E-02 | 15.68% | 0.0% |
| COBALT | | 35.2 | 25.9 | 37.9 | 3.30E+01 | 6.29E+00 | 47.4% | 15.7% | 49.9% | 2.92E-02 | 1.5E-02 | 14.31% | 0.0% |
| COPPER | | 228 | 203 | 341 | 2.58E+02 | 7.36E+01 | 71.0% | 15.7% | 72.7% | 2.28E-01 | 1.7E-01 | 21.66% | 0.0% |
| LEAD | | 18.8 | 65.0 | 87.2 | 5.70E+01 | 3.49E+01 | 152.1% | 15.7% | 152.9% | 5.04E-02 | 7.7E-02 | 44.66% | 0.0% |
| MANGANESE | | 101 | 87 | 144 | 1.11E+02 | 2.99E+01 | 67.0% | 15.7% | 68.8% | 9.80E-02 | 6.7E-02 | 20.20% | 0.0% |
| MERCURY | | 4.28 | 1.67 | 1.14 | 2.36E+00 | 1.68E+00 | 176.5% | 15.7% | 177.2% | 2.09E-03 | 3.7E-03 | 53.98% | 0.0% |
| MOLYBDENUM | | 15.9 | 15.6 | 12.8 | 1.48E+01 | 1.74E+00 | 29.3% | 15.7% | 33.2% | 1.31E-02 | 4.3E-03 | 9.00% | 0.0% |
| NICKEL | | 33.7 | 29.1 | 47.6 | 3.68E+01 | 9.63E+00 | 65.0% | 15.7% | 66.9% | 3.26E-02 | 2.2E-02 | 19.55% | 0.0% |
| SELENIUM | | 22.8 | 17.1 | ND< 10.0 | 1.50E+01 | 9.11E+00 | 150.9% | 19.2% | 152.2% | 1.33E-02 | 2.0E-02 | 44.43% | 11.1% |
| PHOSPHORUS | | 11962 | 9571 | 13453 | 1.17E+04 | 1.96E+03 | 41.8% | 15.7% | 44.6% | 1.03E+01 | 4.6E+00 | 11.95% | 0.0% |
| VANADIUM | | 152 | 124 | 176 | 1.51E+02 | 2.62E+01 | 43.2% | 15.7% | 46.0% | 1.33E-01 | 6.1E-02 | 11.94% | 0.0% |
| CALCIUM | | 1878 | 550 | 890 | 1.11E+03 | 6.90E+02 | 154.9% | 15.7% | 155.7% | 9.79E-01 | 1.5E+00 | 46.52% | 0.0% |
| SODIUM | | 7213 | 1555 | 1345 | 3.37E+03 | 3.33E+03 | 245.3% | 15.7% | 245.8% | 2.98E+00 | 7.3E+00 | 75.98% | 0.0% |
| | | | | | | AVERAGES: | 92.0% | 15.9% | 93.9% | 8.93E-01 | 8.29E-01 | 27.6% | |

| SPECIES | LOC | RUN #1 | RUN #2 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | |
| ARSENIC | OUT | 0.23 | 0.20 | 0.13 | 1.88E-01 | 4.75E-02 | 62.8% | 9.9% | 63.6% | 1.69E-04 | 1.1E-04 | 18.94% | 0.0% |
| BARIUM | | 2.82 | 0.03 | 1.08 | 1.31E+00 | 1.41E+00 | 267.5% | 9.9% | 267.7% | 1.18E-03 | 3.1E-03 | 76.91% | 0.0% |
| BERYLLIUM | | ND< 0.03 | ND< 0.03 | ND< 0.03 | ND< 2.81E-02 | 1.14E-03 | 8.0% | 30.5% | 31.6% | ND< 2.53E-05 | 8.0E-06 | 2.77% | 100.0% |
| CADMIUM | | ND< 0.08 | ND< 0.09 | ND< 0.08 | ND< 8.44E-02 | 3.41E-03 | 8.0% | 30.5% | 31.6% | ND< 7.58E-05 | 2.4E-05 | 2.77% | 100.0% |
| CHROMIUM | | 0.42 | 0.26 | 0.43 | 3.72E-01 | 9.47E-02 | 63.3% | 9.9% | 64.1% | 3.34E-04 | 2.1E-04 | 19.57% | 0.0% |
| COBALT | | ND< 0.28 | ND< 0.29 | ND< 0.27 | ND< 2.81E-01 | 1.14E-02 | 8.0% | 30.5% | 31.6% | ND< 2.53E-04 | 8.0E-05 | 2.77% | 100.0% |
| COPPER | | 2.00 | 1.43 | 1.56 | 1.67E+00 | 2.98E-01 | 44.6% | 9.9% | 45.7% | 1.50E-03 | 6.8E-04 | 13.42% | 0.0% |
| LEAD | | 0.48 | 0.50 | 0.51 | 4.96E-01 | 1.65E-02 | 6.8% | 9.9% | 12.0% | 4.45E-04 | 5.3E-05 | 2.28% | 0.0% |
| MANGANESE | | 0.28 | 2.72 | 0.30 | 1.10E+00 | 1.40E+00 | 317.1% | 9.9% | 317.3% | 9.87E-04 | 3.1E-03 | 98.25% | 0.0% |
| MERCURY | | 0.79 | 0.56 | ND< 0.40 | 5.15E-01 | 2.95E-01 | 142.4% | 16.4% | 143.4% | 4.63E-04 | 6.6E-04 | 40.52% | 13.1% |
| MOLYBDENUM | | 0.56 | 0.23 | 0.22 | 3.38E-01 | 1.96E-01 | 144.1% | 9.9% | 144.5% | 3.03E-04 | 4.4E-04 | 44.60% | 0.0% |
| NICKEL | | 0.56 | 0.58 | 0.54 | 5.62E-01 | 2.28E-02 | 8.0% | 9.9% | 12.7% | 5.05E-04 | 6.4E-05 | 2.77% | 0.0% |
| SELENIUM | | ND< 0.08 | ND< 0.08 | ND< 0.08 | ND< 7.87E-02 | 3.19E-03 | 8.0% | 30.5% | 31.6% | ND< 7.07E-05 | 2.2E-05 | 2.77% | 100.0% |
| PHOSPHORUS | | 5.92 | 10.52 | ND< 1.62 | 5.75E+00 | 4.86E+00 | 210.0% | 11.0% | 210.3% | 5.16E-03 | 1.1E-02 | 57.29% | 4.7% |
| VANADIUM | | 0.37 | 0.29 | 0.40 | 3.54E-01 | 5.70E-02 | 40.1% | 9.9% | 41.3% | 3.18E-04 | 1.3E-04 | 11.67% | 0.0% |
| CALCIUM | | 36.6 | 23.4 | 45.8 | 3.53E+01 | 1.13E+01 | 79.5% | 9.9% | 80.2% | 3.17E-02 | 2.5E-02 | 22.48% | 0.0% |
| SODIUM | | 394 | 205 | 755 | 4.51E+02 | 2.79E+02 | 153.9% | 9.9% | 154.2% | 4.05E-01 | 6.2E-01 | 44.83% | 0.0% |
| | | | | | | AVERAGES: | 92.5% | 15.2% | 99.0% | 2.64E-02 | 3.9E-02 | 27.3% | |

[UNAIR2.XLW]UNMETALS.XLS
6:03 PM
11/9/93

PRELIMINARY

DO NOT CITE OR QUOTE

# METALS
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| METALS IN: | | | | | | | | | |
| FLOW RATE, pitot | 251,864 | 253,663 | 255,611 | 253,712 | 1874 | 0.74% | 1082 | 7.00% | 17760 |
| Particle Collection Bias | | | | | | | | 14.00% | |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| METALS OUT: | | | | | | | | | |
| FLOW RATE, pitot | 253,546 | 257,267 | 261,785 | 257,533 | 4126 | 1.60% | 2382 | 7.00% | 18027 |
| Particle Collection Bias | | | | | | | | 7.00% | |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |
| 7 | 2.37 |
| 8 | 2.31 |

[UNAIR2.XLW]UNMETALS.XLS
6:06 PM
11/9/93

# METALS
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE II -- UREA INJECTION


| SPECIES<br>METALS: | LOC | CONC. DELTA P DETERMINATION<br>NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR:<br>CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXXX (THETAff) | RESULTS:<br>Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | IN | 4.41E+00 | 0.00E+00 | NSTDV | 2.26E+00 | 8.8E-04 | 5.6E-08 | 0.0E+00 | 3.9E-03 | 2.2E-03 | 2.00 | 2 | 4.3 | 1.7E-02 | 118.5% |
| BARIUM | | 3.70E+01 | 0.00E+00 | NSTDV | 3.37E+01 | 8.8E-04 | 8.4E-07 | 0.0E+00 | 3.3E-02 | 3.3E-02 | 2.00 | 2 | 4.3 | 1.4E-01 | 67.9% |
| BERYLLIUM | | 7.85E-01 | 0.00E+00 | ** BIAS ** | 1.31E+00 | 8.8E-04 | 3.3E-08 | 0.0E+00 | 7.0E-04 | 1.3E-03 | 2.01 | 2 | 4.3 | 3.3E-03 | 39.4% |
| CADMIUM | | 2.92E-01 | 0.00E+00 | ** BIAS ** | 3.53E-01 | 8.8E-04 | 8.8E-09 | 0.0E+00 | 2.6E-04 | 3.5E-04 | 2.01 | 2 | 4.3 | 1.2E-03 | 52.2% |
| CHROMIUM | | 7.52E+00 | 0.00E+00 | ** BIAS ** | 8.92E+00 | 8.8E-04 | 2.2E-07 | 0.0E+00 | 6.7E-03 | 8.8E-03 | 2.01 | 2 | 4.3 | 3.0E-02 | 53.2% |
| COBALT | | 3.63E+00 | 0.00E+00 | ** BIAS ** | 4.62E+00 | 8.8E-04 | 1.2E-07 | 0.0E+00 | 3.2E-03 | 4.6E-03 | 2.01 | 2 | 4.3 | 1.5E-02 | 49.9% |
| COPPER | | 4.25E+01 | 0.00E+00 | NSTDV | 3.61E+01 | 8.8E-04 | 9.0E-07 | 0.0E+00 | 3.8E-02 | 3.6E-02 | 2.00 | 2 | 4.3 | 1.7E-01 | 72.7% |
| LEAD | | 2.01E+01 | 0.00E+00 | NSTDV | 7.98E+00 | 8.8E-04 | 2.0E-07 | 0.0E+00 | 1.8E-02 | 7.9E-03 | 2.00 | 2 | 4.3 | 7.7E-02 | 152.9% |
| MANGANESE | | 1.72E+01 | 0.00E+00 | NSTDV | 1.55E+01 | 8.8E-04 | 3.9E-07 | 0.0E+00 | 1.5E-02 | 1.5E-02 | 2.00 | 2 | 4.3 | 6.7E-02 | 68.8% |
| MERCURY | | 9.69E-01 | 0.00E+00 | NSTDV | 3.31E-01 | 8.8E-04 | 8.2E-09 | 0.0E+00 | 8.6E-04 | 3.3E-04 | 2.00 | 2 | 4.3 | 3.7E-03 | 177.2% |
| MOLYBDENUM | | 1.00E+00 | 0.00E+00 | ** BIAS ** | 2.07E+00 | 8.8E-04 | 5.1E-08 | 0.0E+00 | 8.9E-04 | 2.0E-03 | 2.02 | 2 | 4.3 | 4.3E-03 | 33.2% |
| NICKEL | | 5.56E+00 | 0.00E+00 | NSTDV | 5.15E+00 | 8.8E-04 | 1.3E-07 | 0.0E+00 | 4.9E-03 | 5.1E-03 | 2.00 | 2 | 4.3 | 2.2E-02 | 66.9% |
| SELENIUM | | 5.26E+00 | 1.67E+00 | NSTDV | 2.10E+00 | 8.8E-04 | 5.2E-08 | 0.0E+00 | 4.7E-03 | 2.5E-03 | 2.00 | 2 | 4.3 | 2.0E-02 | 152.2% |
| PHOSPHORUS | | 1.13E+03 | 0.00E+00 | ** BIAS ** | 1.63E+03 | 8.8E-04 | 4.1E-05 | 0.0E+00 | 1.0E+00 | 1.6E+00 | 2.01 | 2 | 4.3 | 4.6E+00 | 44.6% |
| VANADIUM | | 1.51E+01 | 0.00E+00 | ** BIAS ** | 2.11E+01 | 8.8E-04 | 5.3E-07 | 0.0E+00 | 1.3E-02 | 2.1E-02 | 2.01 | 2 | 4.3 | 6.1E-02 | 46.0% |
| CALCIUM | | 3.98E+02 | 0.00E+00 | NSTDV | 1.55E+02 | 8.8E-04 | 3.9E-06 | 0.0E+00 | 3.5E-01 | 1.5E-01 | 2.00 | 2 | 4.3 | 1.5E+00 | 155.7% |
| SODIUM | | 1.92E+03 | 0.00E+00 | NSTDV | 4.72E+02 | 8.8E-04 | 1.2E-05 | 0.0E+00 | 1.7E+00 | 4.7E-01 | 2.00 | 2 | 4.3 | 7.3E+00 | 245.8% |
| | | | | | | | | | | | | | | | 93.9% |

| METALS: | LOC | CONC. DELTA P DETERMINATION<br>NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | Part. Bias | THETA CALCULATIONS FOR:<br>CONC. | FLOW RT | XXXXXXX | RESULTS:<br>Sr | Br | vr | vr | t | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | OUT | 2.74E-02 | 0.00E+00 | NSTDV | 1.32E-02 | 9.0E-04 | 6.6E-10 | 0.0E+00 | 2.5E-05 | 1.7E-05 | 2.02 | 2 | 4.3 | 1.1E-04 | 63.6% |
| BARIUM | | 8.13E-01 | 0.00E+00 | NSTDV | 9.16E-02 | 9.0E-04 | 4.6E-09 | 0.0E+00 | 7.3E-04 | 1.2E-04 | 2.00 | 2 | 4.3 | 3.1E-03 | 267.7% |
| BERYLLIUM | | 6.57E-04 | 8.12E-03 | ** BIAS ** | 1.97E-03 | 9.0E-04 | 9.8E-11 | 0.0E+00 | 6.3E-07 | 7.7E-06 | 2.61 | 3 | 3.18 | 8.0E-06 | 31.6% |
| CADMIUM | | 1.97E-03 | 2.44E-02 | ** BIAS ** | 5.90E-03 | 9.0E-04 | 2.9E-10 | 0.0E+00 | 1.9E-06 | 2.3E-05 | 2.61 | 3 | 3.18 | 2.4E-05 | 31.6% |
| CHROMIUM | | 5.47E-02 | 0.00E+00 | NSTDV | 2.61E-02 | 9.0E-04 | 1.3E-09 | 0.0E+00 | 4.9E-05 | 3.3E-05 | 2.02 | 2 | 4.3 | 2.1E-04 | 64.1% |
| COBALT | | 6.57E-03 | 8.12E-02 | ** BIAS ** | 1.97E-02 | 9.0E-04 | 9.8E-10 | 0.0E+00 | 6.3E-06 | 7.7E-05 | 2.61 | 3 | 3.18 | 8.0E-05 | 31.6% |
| COPPER | | 1.72E-01 | 0.00E+00 | NSTDV | 1.17E-01 | 9.0E-04 | 5.8E-09 | 0.0E+00 | 1.5E-04 | 1.5E-04 | 2.03 | 2 | 4.3 | 6.8E-04 | 45.7% |
| LEAD | | 9.55E-03 | 0.00E+00 | ** BIAS ** | 3.47E-02 | 9.0E-04 | 1.7E-09 | 0.0E+00 | 9.5E-06 | 4.4E-05 | 2.88 | 3 | 3.18 | 5.3E-05 | 12.0% |
| MANGANESE | | 8.10E-01 | 0.00E+00 | NSTDV | 7.69E-02 | 9.0E-04 | 3.8E-09 | 0.0E+00 | 7.3E-04 | 9.8E-05 | 2.00 | 2 | 4.3 | 3.1E-03 | 317.3% |
| MERCURY | | 1.71E-01 | 6.74E-02 | NSTDV | 3.61E-02 | 9.0E-04 | 1.8E-09 | 0.0E+00 | 1.5E-04 | 7.6E-05 | 2.00 | 2 | 4.3 | 6.6E-04 | 143.4% |
| MOLYBDENUM | | 1.13E-01 | 0.00E+00 | NSTDV | 2.36E-02 | 9.0E-04 | 1.2E-09 | 0.0E+00 | 1.0E-04 | 3.0E-05 | 2.00 | 2 | 4.3 | 4.4E-04 | 144.5% |
| NICKEL | | 1.31E-02 | 0.00E+00 | ** BIAS ** | 3.94E-02 | 9.0E-04 | 2.0E-09 | 0.0E+00 | 1.3E-05 | 5.0E-05 | 2.61 | 3 | 3.18 | 6.4E-05 | 12.7% |
| SELENIUM | | 1.84E-03 | 2.27E-02 | ** BIAS ** | 5.51E-03 | 9.0E-04 | 2.7E-10 | 0.0E+00 | 1.8E-06 | 2.2E-05 | 2.61 | 3 | 3.18 | 2.2E-05 | 31.6% |
| PHOSPHORUS | | 2.80E+00 | 2.70E-01 | NSTDV | 4.02E-01 | 9.0E-04 | 2.0E-08 | 0.0E+00 | 2.5E-03 | 5.7E-04 | 2.00 | 2 | 4.3 | 1.1E-02 | 210.3% |
| VANADIUM | | 3.29E-02 | 0.00E+00 | NSTDV | 2.48E-02 | 9.0E-04 | 1.2E-09 | 0.0E+00 | 3.0E-05 | 3.1E-05 | 2.04 | 2 | 4.3 | 1.3E-04 | 41.3% |
| CALCIUM | | 6.51E+00 | 0.00E+00 | NSTDV | 2.47E+00 | 9.0E-04 | 1.2E-07 | 0.0E+00 | 5.9E-03 | 3.1E-03 | 2.01 | 2 | 4.3 | 2.5E-02 | 80.2% |
| SODIUM | | 1.61E+02 | 0.00E+00 | NSTDV | 3.16E+01 | 9.0E-04 | 1.6E-06 | 0.0E+00 | 1.4E-01 | 4.0E-02 | 2.00 | 2 | 4.3 | 6.2E-01 | 154.2% |
| | | | | | | | | | | | | | | | 99.0% |

[UNAIR2.XLW]UNMETALS.XLS
6:02 PM
11/9/93

PRELIMINARY

DO NOT CITE OR QUOTE

PRELIMINARY

# PM/ANIONS
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION
## PAGE 1 OF 3

| SPECIES | LOC | RUN #1 | RUN #2 in ppm | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | |
| CHLORIDE | IN | 0.78 | 0.84 | 0.79 | 8.03E-01 | 2.84E-02 | 7.1% | 15.7% | 17.2% | 1.1E+00 | 1.93E-01 | 2.69% | 0.0% |
| FLOURIDE | | 8.24 | 9.05 | 8.37 | 8.55E+00 | 4.34E-01 | 10.5% | 15.7% | 18.8% | 6.4E+00 | 1.21E+00 | 3.86% | 0.0% |
| PHOSPHORUS | | 0.089 | 0.117 | 0.078 | 9.46E-02 | 1.99E-02 | 52.7% | 15.7% | 55.0% | 3.5E-01 | 1.95E-01 | 15.50% | 0.0% |
| SULFATE | | 300 | 298 | 271 | 2.90E+02 | 1.63E+01 | 11.4% | 15.7% | 19.4% | 1.1E+03 | 2.12E+02 | 4.33% | 0.0% |
| | | | | | AVERAGE: | 4.20E+00 | 20.4% | 15.7% | 27.6% | 2.8E+02 | 5.35E+01 | 6.59% | |

| SPECIES | LOC | RUN #1 | RUN #2 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | |
| CHLORIDE | OUT | 0.52 | 0.53 | 0.63 | 5.61E-01 | 5.80E-02 | 26.6% | 9.8% | 28.3% | 8.0E-01 | 2.26E-01 | 7.94% | 0.0% |
| FLOURIDE | | 7.1 | 6.6 | 7.3 | 7.00E+00 | 3.69E-01 | 11.3% | 9.8% | 15.0% | 5.3E+00 | 7.97E-01 | 3.98% | 0.0% |
| PHOSPHORUS | | ND< 0.13 | ND< 0.15 | ND< 0.12 | ND< 1.31E-01 | 1.65E-02 | 31.9% | 30.2% | 43.9% | ND< 5.0E-01 | 2.19E-01 | 9.38% | 100.0% |
| SULFATE | | 417 | 302 | 296 | 3.38E+02 | 6.81E+01 | 50.0% | 9.8% | 50.9% | 1.30E+03 | 6.62E+02 | 15.50% | 0.0% |
| | | | | | AVERAGE: | 1.71E+01 | 29.9% | 14.9% | 34.5% | 3.3E+02 | 1.66E+02 | 9.20% | |

| SPECIES | LOC | RUN #1 | RUN #2 in mg/Nm^3 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARTICULATES: | | | | | | | | | | | | | |
| PM-AN | IN | 7190 | 7640 | 8075 | 7.63E+03 | 4.43E+02 | 11.7% | 15.7% | 19.5% | 6.75E+03 | 1.32E+03 | 3.89% | 0.0% |
| PM-AN | OUT | 2.86 | 0.87 | 0.63 | 1.45E+00 | 1.23E+00 | 210.1% | 9.9% | 210.3% | 1.30E+00 | 2.74E+00 | 64.73% | 0.0% |

[UNAIR2.XLW]UNPMAN.XLS
3:39 PM
1/11/94

DO NOT CITE OR QUOTE

**PM/ANIONS**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE II -- UREA INJECTION**


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS IN: | | | | | | | | | | |
| FLUE FLOW RATE, pitot | In | 245,823 | 258,366 | 255,920 | 253,370 | 6649 | 2.62% | 3839 | 7.00% | 17736 |
| Particle Collection, Inlet | | | | | | | | | 14.00% | |
| ANIONS OUT: | | | | | | | | | | |
| FLUE FLOW RATE, pitot | Out | 247,465 | 262,037 | 262,102 | 257,201 | 8432 | 3.28% | 4868 | 7.00% | 18004 |
| Particle Collection, Outlet | | | | | | | | | 7.00% | |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|---|
| PARTICULATE: | | | | | | | | | | |
| FLUE FLOW RATE, pitot | In | 245,823 | 258,366 | 255,920 | 253,370 | 6649 | 2.62% | 3839 | 7.00% | 17736 |
| Particle Collection, Inlet | | | | | | | | | 14.00% | |
| FLUE FLOW RATE, pitot | Out | 247,465 | 262,037 | 262,102 | 257,201 | 8432 | 3.28% | 4868 | 7.00% | 18004 |
| Particle Collection, Outlet | | | | | | | | | 7.00% | |

[UNAIR2.XLW]UNPMAN.XLS
3:43 PM
1/11/94

PRELIMINARY

# PM/ANIONS
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION


| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | | | |
| CHLORIDE | IN | 1.64E-02 | 0.00E+00 | ** BIAS ** | 0.11 | 1.4E+00 | 4.4E-06 | 0.0E+00 | 2.9E-02 | 1.8E-01 | 3.7 | 4 | 2.78 | 1.9E-01 | 17.2% |
| FLOURIDE | | 2.51E-01 | 0.00E+00 | ** BIAS ** | 1.20 | 7.5E-01 | 2.5E-05 | 0.0E+00 | 2.1E-01 | 1.0E+00 | 3.0 | 3 | 3.18 | 1.2E+00 | 18.8% |
| PHOSPHORUS | | 1.15E-02 | 0.00E+00 | ** BIAS ** | 0.013 | 3.7E+00 | 1.4E-06 | 0.0E+00 | 4.3E-02 | 5.5E-02 | 2.1 | 2 | 4.3 | 1.9E-01 | 55.0% |
| SULFATE | | 9.41E+00 | 0.00E+00 | ** BIAS ** | 40.5 | 3.8E+00 | 4.3E-03 | 0.0E+00 | 3.9E+01 | 1.7E+02 | 2.8 | 3 | 3.18 | 2.1E+02 | 19.4% |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | | | |
| CHLORIDE | OUT | 3.35E-02 | 0.00E+00 | ** BIAS ** | 0.04 | 1.4E+00 | 3.1E-06 | 0.0E+00 | 4.9E-02 | 7.8E-02 | 2.4 | 2 | 4.3 | 2.3E-01 | 28.3% |
| FLOURIDE | | 2.13E-01 | 0.00E+00 | ** BIAS ** | 0.49 | 7.5E-01 | 2.1E-05 | 0.0E+00 | 1.9E-01 | 5.2E-01 | 3.4 | 3 | 3.18 | 8.0E-01 | 15.0% |
| PHOSPHORUS | | 9.55E-03 | 3.81E-02 | ** BIAS ** | 0.009 | 3.7E+00 | 1.9E-06 | 0.0E+00 | 3.7E-02 | 1.5E-01 | 2.3 | 2 | 4.3 | 2.2E-01 | 43.9% |
| SULFATE | | 3.93E+01 | 0.00E+00 | NSTDV | 23.7 | 3.8E+00 | 5.1E-03 | 0.0E+00 | 1.5E+02 | 1.3E+02 | 2.1 | 2 | 4.3 | 6.6E+02 | 50.9% |

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARTICULATES: | | | | | | | | | | | | | | | |
| PM-AN | IN | 2.56E+02 | 0.00E+00 | ** BIAS ** | 1069 | 8.8E-01 | 2.7E-02 | 0.0E+00 | 2.5E+02 | 1.1E+03 | 2.8 | 3 | 3.18 | 1.3E+03 | 19.5% |
| PM-AN | OUT | 7.09E-01 | 0.00E+00 | NSTDV | 0.10 | 9.0E-01 | 5.1E-06 | 0.0E+00 | 6.4E-01 | 1.3E-01 | 2.0 | 2 | 4.3 | 2.7E+00 | 210.3% |



DO NOT CITE OR QUOTE

PRELIMINARY

# PM/ANIONS
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II – UREA INJECTION


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS IN: | | | | | | | | | | |
| FLUE FLOW RATE, pitot | In | 245,823 | 258,366 | 255,920 | 253,370 | 6649 | 2.62% | 3839 | 7.00% | 17736 |
| Particle Collection, Inlet | | | | | | | | | 14.00% | |
| ANIONS OUT: | | | | | | | | | | |
| FLUE FLOW RATE, pitot | Out | 247,465 | 262,037 | 262,102 | 257,201 | 8432 | 3.28% | 4868 | 7.00% | 18004 |
| Particle Collection, Outlet | | | | | | | | | 7.00% | |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|---|
| PARTICULATE: | | | | | | | | | | |
| FLUE FLOW RATE, pitot | In | 245,823 | 258,366 | 255,920 | 253,370 | 6649 | 2.62% | 3839 | 7.00% | 17736 |
| Particle Collection, Inlet | | | | | | | | | 14.00% | |
| FLUE FLOW RATE, pitot | Out | 247,465 | 262,037 | 262,102 | 257,201 | 8432 | 3.28% | 4868 | 7.00% | 18004 |
| Particle Collection, Outlet | | | | | | | | | 7.00% | |

[UNAIR2.XLW]UNPMAN.XLS
9:53 AM
11/10/93

DO NOT CITE OR QUOTE

PRELIMINARY

# PM/ANIONS
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II – UREA INJECTION
## PAGE 3 OF 3

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANIONS: | | | | | | | | | | | | | | | |
| CHLORIDE | IN | 6.39E-01 | 0.00E+00 | NSTDV | 0.16 | 1.4E+00 | 6.3E-06 | 0.0E+00 | 8.9E-01 | 2.5E-01 | 2.0 | 2 | 4.3 | 3.9E+00 | 242.2% |
| FLOURIDE | | 2.51E-01 | 0.00E+00 | ** BIAS ** | 1.20 | 7.5E-01 | 2.5E-05 | 0.0E+00 | 2.1E-01 | 1.0E+00 | 3.0 | 3 | 3.18 | 1.2E+00 | 18.8% |
| PHOSPHORUS | | 1.15E-02 | 0.00E+00 | ** BIAS ** | 0.013 | 3.7E+00 | 1.4E-06 | 0.0E+00 | 4.3E-02 | 5.5E-02 | 2.1 | 2 | 4.3 | 1.9E-01 | 55.0% |
| SULFATE | | 9.41E+00 | 0.00E+00 | ** BIAS ** | 40.5 | 3.8E+00 | 4.3E-03 | 0.0E+00 | 3.9E+01 | 1.7E+02 | 2.8 | 3 | 3.18 | 2.1E+02 | 19.4% |
| ANIONS: | | | | | | | | | | | | | | | |
| CHLORIDE | OUT | 2.88E-02 | 0.00E+00 | ** BIAS ** | 0.03 | 1.4E+00 | 2.6E-06 | 0.0E+00 | 4.2E-02 | 6.5E-02 | 2.4 | 2 | 4.3 | 1.9E-01 | 29.1% |
| FLOURIDE | | 2.13E-01 | 0.00E+00 | ** BIAS ** | 0.49 | 7.5E-01 | 2.1E-05 | 0.0E+00 | 1.9E-01 | 5.2E-01 | 3.4 | 3 | 3.18 | 8.0E-01 | 15.0% |
| PHOSPHORUS | | 9.55E-03 | 3.81E-02 | ** BIAS ** | 0.009 | 3.7E+00 | 1.9E-06 | 0.0E+00 | 3.7E-02 | 1.5E-01 | 2.3 | 2 | 4.3 | 2.2E-01 | 43.9% |
| SULFATE | | 3.93E+01 | 0.00E+00 | NSTDV | 23.7 | 3.8E+00 | 5.1E-03 | 0.0E+00 | 1.5E+02 | 1.3E+02 | 2.1 | 2 | 4.3 | 6.6E+02 | 50.9% |

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARTICULATES: | | | | | | | | | | | | | | | |
| PM-AN | IN | 2.56E+02 | 0.00E+00 | ** BIAS ** | 1069 | 8.8E-01 | 2.7E-02 | 0.0E+00 | 2.5E+02 | 1.1E+03 | 2.8 | 3 | 3.18 | 1.3E+03 | 19.5% |
| PM-AN | OUT | 7.09E-01 | 0.00E+00 | NSTDV | 0.10 | 9.0E-01 | 5.1E-06 | 0.0E+00 | 6.4E-01 | 1.3E-01 | 2.0 | 2 | 4.3 | 2.7E+00 | 210.3% |

[UNAIR2.XLW]UNPMAN.XLS
9:51 AM
11/10/93

DO NOT CITE OR QUOTE

PRELIMINARY

DO NOT CITE OR QUOTE

**VOC/CN**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE II -- BASELINE/UREA INJECTION**


| SPECIES | LOC | RUN #1 | RUN #2 in ppb | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOC: | | | | | | | | | | | | | |
| BENZENE | IN | 2.92 | 3.96 | 4.61 | 3.83E+00 | 8.52E-01 | 56.4% | 7.0% | 56.8% | 1.17E-02 | 6.6E-03 | 15.84% | 0.0% |
| TOLUENE | IN | 19.1 | 33.3 | 12.5 | 2.16E+01 | 1.06E+01 | 122.6% | 7.0% | 122.8% | 7.77E-02 | 9.5E-02 | 35.95% | 0.0% |
| VOC: | | | | | | | | | | | | | |
| BENZENE | OUT | 2.76 | 2.53 | 1.80 | 2.36E+00 | 5.01E-01 | 51.9% | 7.0% | 52.4% | 7.32E-03 | 3.8E-03 | 15.89% | 0.0% |
| TOLUENE | OUT | 43.8 | 54.1 | 18.7 | 3.89E+01 | 1.82E+01 | 114.5% | 7.0% | 114.8% | 1.42E-01 | 1.6E-01 | 34.59% | 0.0% |

| SPECIES | LOC | RUN #1 | RUN #2 in ppb | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYANIDE | IN | ND< 13 | ND< 10 | ND< 13 | ND< 1.22E+01 | 1.81E+00 | 36.8% | 29.9% | 47.4% | ND< 1.4E-02 | 6.5E-03 | 11.34% | 100.0% |
| CYANIDE | OUT | ND< 10 | ND< 9 | ND< 8 | ND< 8.82E+00 | 7.64E-01 | 21.5% | 29.8% | 36.7% | ND< 1.0E-02 | 3.7E-03 | 5.79% | 100.0% |

# VOC/CN
# UNCERTAINTY ANALYSIS
# SITE 115, PHASE II -- BASELINE/UREA INJECTION


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|---|
| VOC: | | | dscfm | | | | | | | |
| FLUE FLOW RATE, pitot | In | 241,930 | 254,792 | 254,792 | 250,505 | 9095 | 3.63% | 6431 | 7.00% | 17535 |
| FLUE FLOW RATE, pitot | Out | 253,419 | 253,419 | 257,029 | 254,622 | 2553 | 1.00% | 1805 | 7.00% | 17824 |
| Particle Collection, Inlet | | | | | | ** | | ** | 0.00% | 0.00 |
| Particle Collection, Outlet | | | | | | | | | 0.00% | 0.00 |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|---|
| CYANIDE: | | | dscfm | | | | | | | |
| HEAT RATE FLOW RATE | In | 265,653 | 265,653 | 265,653 | 265,653 | 0 | 0.00% | 0 | 7.00% | 18596 |
| HEAT RATE FLOW RATE | Out | 273,375 | 273,375 | 273,375 | 273,375 | 0 | 0.00% | 0 | 7.00% | 19136 |
| Particle Collection, Inlet | | | | | | | | | 0.00% | 0.00 |
| Particle Collection, Outlet | | | | | | | | | 0.00% | 0.00 |

[UNAIR2.XLW]UNVCCN.XLS
10:12 AM
11/10/93

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t: | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOC: | | | | | | | | | | | | | | | |
| BENZENE | IN | 4.92E-01 | 0.00E+00 | NSTDV | 0.00 | 3.0E-03 | 4.7E-08 | 0.0E+00 | 1.5E-03 | 8.2E-04 | 2.16 | 2 | 4.3 | 6.6E-03 | 56.8% |
| TOLUENE | IN | 6.14E+00 | 0.00E+00 | NSTDV | 0.00 | 3.6E-03 | 3.1E-07 | 0.0E+00 | 2.2E-02 | 5.4E-03 | 2.03 | 2 | 4.3 | 9.5E-02 | 122.8% |
| VOC: | | | | | | | | | | | | | | | |
| BENZENE | OUT | 2.89E-01 | 0.00E+00 | NSTDV | 0.00 | 3.0E-03 | 2.9E-08 | 0.0E+00 | 8.8E-04 | 5.1E-04 | 2.01 | 2 | 4.3 | 3.8E-03 | 52.4% |
| TOLUENE | OUT | 1.05E+01 | 0.00E+00 | NSTDV | 0.00 | 3.6E-03 | 5.6E-07 | 0.0E+00 | 3.8E-02 | 9.9E-03 | 2.00 | 2 | 4.3 | 1.6E-01 | 114.8% |

| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | PART COLL. (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t: | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYANIDE | IN | 1.05E+00 | 3.56E+00 | ** BIAS ** | 0.00 | 1.1E-03 | 5.2E-08 | 0.0E+00 | 1.2E-03 | 4.1E-03 | 2.00 | 2 | 4.3 | 6.5E-03 | 47.4% |
| CYANIDE | OUT | 4.41E-01 | 2.55E+00 | ** BIAS ** | 0.00 | 1.2E-03 | 3.7E-08 | 0.0E+00 | 5.1E-04 | 3.0E-03 | 2.00 | 2 | 4.3 | 3.7E-03 | 36.7% |

[UNAIR2.XLW]UNVCCN.XLS
10:09 AM
11/10/93

# METALS SPECIATION TESTS -- AIR
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- BASELINE



| SPECIES | LOC | RUN #1 | RUN #2 in ug/Nm^3 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury, BR | IN | | | | | | | | | | | | |
| Hg(II) | | 0.52 | 0.46 | | 4.88E-01 | 3.79E-02 | 69.8% | 7.0% | 70.1% | 3.9E-04 | 2.7E-04 | 10.99% | 0.0% |
| Hg(0) | | 0.32 | 0.53 | | 4.24E-01 | 1.44E-01 | 305.4% | 7.0% | 305.5% | 3.4E-04 | 1.0E-03 | 48.10% | 0.0% |
| Hg(tot) - Filter Plug + Probe | | 0.99 | 0.94 | | 9.65E-01 | 3.74E-02 | 34.8% | 7.0% | 35.5% | 7.6E-04 | 2.7E-04 | 5.48% | 0.0% |
| Hg (total) | | 1.8 | 1.9 | | 1.88E+00 | 6.88E-02 | 32.9% | 7.0% | 33.6% | 1.5E-03 | 5.0E-04 | 5.18% | 0.0% |

| SPECIES | LOC | RUN #1 | RUN #2 in ug/Nm^3 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury, BR | OUT | | | | | | | | | | | | |
| Hg(II) | | ND< 0.032 | 0.043 | 0.129 | 6.26E-02 | 5.89E-02 | 233.6% | 11.1% | 233.9% | 5.3E-05 | 1.2E-04 | 70.48% | 8.6% |
| Hg(0) | | ND< 0.011 | ND< 0.011 | ND< 0.011 | ND< 1.07E-02 | 0.00E+00 | 0.0% | 29.7% | 29.7% | ND< 9.2E-06 | 2.7E-06 | 0.00% | 100.0% |
| Hg(tot) - Probe | | ND< 0.005 | ND< 0.005 | ND< 0.005 | ND< 5.37E-03 | 0.00E+00 | 0.0% | 29.7% | 29.7% | ND< 4.6E-06 | 1.4E-06 | 0.00% | 100.0% |
| Hg (total) | | ND< 0.048 | 0.051 | 0.137 | 7.07E-02 | 5.89E-02 | 207.0% | 13.4% | 207.4% | 6.0E-05 | 1.3E-04 | 62.45% | 11.4% |

| SPECIES | LOC | RUN #1 | RUN #2 in ug/Nm^3 | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Chrome | IN | 120.5 | 90.1 | 69.2 | 9.33E+01 | 2.58E+01 | 69.7% | 7.0% | 70.1% | 8.0E-02 | 5.6E-02 | 19.50% | 0.0% |
| Hexavalent Chrome | | 5.74 | 2.52 | 7.25 | 5.17E+00 | 2.41E+00 | 116.6% | 7.0% | 116.8% | 4.4E-03 | 5.2E-03 | 34.17% | 0.0% |

# METALS SPECIATION TESTS -- AIR
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- BASELINE


| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mercury, BR | | | | | | | | | | |
| HEAT RATE FLOW RATE | IN | 227,175 | 227,175 | 227,175 | 227,175 | 0 | 0.00% | 0 | 7.00% | 15902 |
| Particle Collection Bias | | | | | | | | | 0.00% | |
| Mercury, BR | | | | | | | | | | |
| HEAT RATE FLOW RATE | OUT | 244,748 | 244,748 | 244,748 | 244,748 | 0 | 0.00% | 0 | 7.00% | 17132 |
| Particle Collection Bias | | | | | | | | | 0.00% | |

| PARAMETER | | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|---|
| CHROMIUM: | | | | | | | | | | |
| FLOW RATE, pitot | IN | 241,930 | 241,930 | 254,792 | 246,217 | 9095 | 3.69% | 6431 | 7.00% | 17235 |
| Particle Collection Bias | | | | | | ** | | ** | 0.00% | |

[UNAIR2.XLW]UNSPEC.XLS
10:25 AM
3/3/94

**METALS SPECIATION TESTS -- AIR**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE II -- BASELINE**
**PAGE 3 OF 3**

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | Particle Coll. Eff. Bias (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury, BR | IN | | | | | | | | | | | | | | |
| Hg(II) | | 2.68E-02 | 0.00E+00 | NSTDV | 0.00E+00 | 7.9E-04 | 1.7E-09 | 0.0E+00 | 2.1E-05 | 2.7E-05 | 1.00 | 1 | 12.7 | 2.7E-04 | 70.1% |
| Hg(0) | | 1.02E-01 | 0.00E+00 | NSTDV | 0.00E+00 | 7.9E-04 | 1.5E-09 | 0.0E+00 | 8.1E-05 | 2.4E-05 | 1.00 | 1 | 12.7 | 1.0E-03 | 305.5% |
| Hg(tot) - Filter Plug + Probe | | 2.65E-02 | 0.00E+00 | NSTDV | 0.00E+00 | 7.9E-04 | 3.4E-09 | 0.0E+00 | 2.1E-05 | 5.4E-05 | 1.00 | 1 | 12.7 | 2.7E-04 | 35.5% |
| Hg (total) | | 4.87E-02 | 0.00E+00 | NSTDV | 0.00E+00 | 7.9E-04 | 6.5E-09 | 0.0E+00 | 3.9E-05 | 1.0E-04 | 1.00 | 1 | 12.7 | 5.0E-04 | 33.6% |
| Mercury, BR | OUT | | | | | | | | | | | | | | |
| Hg(II) | | 3.40E-02 | 5.37E-03 | NSTDV | 0.00E+00 | 8.5E-04 | 2.2E-10 | 0.0E+00 | 2.9E-05 | 5.9E-06 | 2.00 | 2 | 4.3 | 1.2E-04 | 233.9% |
| Hg(0) | | 0.00E+00 | 3.10E-03 | **BIAS** | 0.00E+00 | 8.5E-04 | 3.7E-11 | 0.0E+00 | 0.0E+00 | 2.7E-06 ** | 0.00 | 0 | 4.3 | 2.7E-06 | 29.7% |
| Hg(tot) - Probe | | 0.00E+00 | 1.55E-03 | **BIAS** | 0.00E+00 | 8.5E-04 | 1.9E-11 | 0.0E+00 | 0.0E+00 | 1.4E-06 ** | 0.00 | 0 | 4.3 | 1.4E-06 | 29.7% |
| Hg (total) | | 3.40E-02 | 8.05E-03 | NSTDV | 0.00E+00 | 8.5E-04 | 2.5E-10 | 0.0E+00 | 2.9E-05 | 8.1E-06 | 2.00 | 2 | 4.3 | 1.3E-04 | 207.4% |

| SPECIES | LOC | CONC. DELTA P DETERMINATION: NORM. STD DEV (Spc') | ND BIAS (Bpc1) | > OF NSTD OR BIAS | PART COLL (Bpc2) | THETA CALCULATIONS FOR: CONC. (THETAc) | FLOW RT (THETAhr) | XXXXXX (THETAff) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Chrome | IN | 1.49E+01 | 0.00E+00 | NSTDV | 0.00E+00 | 8.6E-04 | 3.3E-07 | 0.0E+00 | 1.3E-02 | 5.6E-03 | 2.11 | 2 | 4.3 | 5.6E-02 | 70.1% |
| Hexavalent Chrome | | 1.39E+00 | 0.00E+00 | NSTDV | 0.00E+00 | 8.6E-04 | 1.8E-08 | 0.0E+00 | 1.2E-03 | 3.1E-04 | 2.04 | 2 | 4.3 | 5.2E-03 | 116.8% |

[UNAIR2.XLW]UNSPEC.XLS
10:27 AM
3/3/94

PRELIMINARY

**METALS/AN - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE II – UREA INJECTION**
**PAGE 1 OF 3**

| SPECIES | LOC | | RUN #1 | | RUN #2 in mg/Kg | | RUN #3 | | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS (C&T): | | | | | | | | | | | | | | | | | | |
| ARSENIC | COAL | ND< | 3 | ND< | 3 | ND< | 3 | ND< | 3.0E+00 | 0.00E+00 | 8.9% | 29.3% | 30.6% | ND< | 2.79E-01 | 8.5E-02 | 0.00% | 100.0% |
| BARIUM(1) | | | 27 | | 15 | | 38 | | 2.7E+01 | 1.15E+01 | 107.9% | 5.0% | 108.0% | | 2.47E+00 | 2.7E+00 | 29.25% | 0.0% |
| BERYLLIUM | | | 0.30 | | 0.58 | | 0.77 | | 5.5E-01 | 2.36E-01 | 107.2% | 5.0% | 107.3% | | 5.11E-02 | 5.5E-02 | 30.30% | 0.0% |
| CADMIUM | | ND< | 0.05 | ND< | 0.06 | | 0.06 | @ ND< | 6.0E-02 | 5.77E-03 | 18.9% | 22.3% | 29.2% | ND< | 5.58E-03 | 1.6E-03 | 5.56% | 100.0% |
| CHROMIUM | | | 1.2 | | 2.1 | | 1.0 | | 1.4E+00 | 5.86E-01 | 101.9% | 5.0% | 102.1% | | 1.33E-01 | 1.4E-01 | 31.01% | 0.0% |
| COBALT | | | 1.1 | | 1.4 | | 1.4 | | 1.3E+00 | 1.73E-01 | 34.3% | 5.0% | 34.6% | | 1.21E-01 | 4.2E-02 | 10.26% | 0.0% |
| COPPER | | | 3.8 | | 4.0 | | 3.3 | | 3.7E+00 | 3.61E-01 | 19.1% | 5.0% | 19.7% | | 3.44E-01 | 6.8E-02 | 7.21% | 0.0% |
| LEAD | | | 1.7 | | 2.3 | | 2.7 | | 2.2E+00 | 5.03E-01 | 56.7% | 5.0% | 56.9% | | 2.08E-01 | 1.2E-01 | 15.92% | 0.0% |
| MANGANESE | | | 4.2 | | 6.7 | | 4.8 | | 5.2E+00 | 1.31E+00 | 62.6% | 5.0% | 62.8% | | 4.86E-01 | 3.1E-01 | 18.68% | 0.0% |
| MERCURY | | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 | ND< | 1.0E-01 | 0.00E+00 | 8.9% | 29.3% | 30.6% | ND< | 9.29E-03 | 2.8E-03 | 0.00% | 100.0% |
| MOLYBDENUM | | | 0.4 | | 0.4 | | 0.7 | | 5.0E-01 | 1.73E-01 | 86.5% | 5.0% | 86.7% | | 4.65E-02 | 4.0E-02 | 26.67% | 0.0% |
| NICKEL | | | 1.0 | | 1.0 | | 1.0 | | 1.0E+00 | 0.00E+00 | 8.9% | 5.0% | 10.2% | | 9.29E-02 | 9.4E-03 | 0.00% | 0.0% |
| SELENIUM | | ND< | 3 | ND< | 3 | ND< | 3 | ND< | 3.0E+00 | 0.00E+00 | 8.9% | 29.3% | 30.6% | ND< | 2.79E-01 | 8.5E-02 | 0.00% | 100.0% |
| PHOSPHORUS | | | 320 | | 310 | | 320 | | 3.2E+02 | 5.77E+00 | 7.4% | 5.0% | 8.9% | | 2.94E+01 | 2.6E+00 | 1.40% | 0.0% |
| VANADIUM | | | 3.5 | | 5.3 | | 4.2 | | 4.3E+00 | 9.07E-01 | 52.8% | 5.0% | 53.0% | | 4.03E-01 | 2.1E-01 | 14.87% | 0.0% |
| CALCIUM | | | 1870 | | 2770 | | 1770 | | 2.1E+03 | 5.51E+02 | 64.6% | 5.0% | 64.8% | | 1.99E+02 | 1.3E+02 | 19.76% | 0.0% |
| SODIUM | | | 270 | | 400 | | 680 | | 4.5E+02 | 2.10E+02 | 116.0% | 5.0% | 116.1% | | 4.18E+01 | 4.9E+01 | 34.07% | 0.0% |
| | | | | | | | | | | AVERAGES: | 51.2% | 10.3% | 56.0% | | 1.6E+01 | 1.1E+01 | 14.41% | |
| ANIONS (C&T): | COAL | | | | | | | | | | | | | | | | | |
| Chlorine, as Cl- (2) | | | 236 | | 239 | | 238 | | 2.4E+02 | 1.64E+00 | 9.0% | 5.0% | 10.3% | | 2.21E+01 | 2.3E+00 | 0.51% | 0.0% |
| Fluorine, as F- | | | 79 | | 89 | | 85 | | 8.4E+01 | 5.03E+00 | 12.8% | 5.0% | 13.7% | | 7.85E+00 | 1.1E+00 | 4.22% | 0.0% |
| Phosphorus, as PO4 3- | | | 981 | | 951 | | 981 | | 9.7E+02 | 1.77E+01 | 7.3% | 5.0% | 8.9% | | 9.03E+01 | 8.0E+00 | 1.40% | 0.0% |
| Sulfur, as SO4 2- | | | 13,184 | | 12,884 | | | | 1.3E+04 | 2.12E+02 | 10.1% | 5.0% | 11.3% | | 1.21E+03 | 1.4E+02 | 2.30% | 0.0% |
| | | | | | | | | | | AVERAGES: | 9.8% | 5.0% | 11.0% | | 3.3E+02 | 3.7E+01 | 2.11% | |

[UNPROC2.XLW]UNCOAL.XLS
6:52 PM
11/9/93

DO NOT CITE OR QUOTE

**METALS/AN - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE II – UREA INJECTION**


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| FUEL METALS: | | | | | | | | | |
| HHV, Btu/lb (as rec'd) | 11,468 | 11,468 | 11,382 | 11,425 | 60.8 | 0.53% | 43.00 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 88,972 | 96,098 | 93,683 | 92,918 | 3624 | 3.90% | 2092.39 | 0.00% | 0.00 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.88 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.91E+06 | 1.06E+07 | 1.01E+07 | 1.02E+07 | 3.63E+05 | 3.56% | 2.09E+05 | 5.00% | 5.09E+05 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| HHV, Btu/lb (as rec'd) | 11,468 | 11,468 | 11,382 | 11,425 | 60.8 | 0.53% | 35.11 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 88,972 | 96,098 | 93,683 | 92,918 | 3624 | 3.90% | 2092.39 | 0.00% | 0.00 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.88 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.91E+06 | 1.06E+07 | 1.01E+07 | 1.02E+07 | 3.63E+05 | 3.56% | 2.09E+05 | -5.00% | -5.09E+05 |

[UNPROC2.XLW]UNCOAL.XLS
6:54 PM
11/9/93

PRELIMINARY

**METALS/AN - COAL**
**UNCERTAINTY ANALYSIS**
**SITE 115, PHASE II – UREA INJECTION**
**PAGE 3 OF 3**

| SPECIES | LOC | CONC. DELTA P DETERMINATION | | | THETA CALCULATIONS FOR: | | | RESULTS: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | CONC. (THETAc) | HEAT RT (THETAhr) | XXXXXX (THETAhhv) | Sr | Br | vr | vr | t- | Ur | % Ur |
| METALS (C&T): | | | | | | | | | | | | | | |
| ARSENIC | COAL | 0.00E+00 | 8.66E-01 | ** BIAS ** | 9.3E-02 | 2.7E-08 | 0.0E+00 | 5.7E-03 | 8.2E-02 | 2.00 | 2 | 4.3 | 8.5E-02 | 30.6% |
| BARIUM(1) | | 6.64E+00 | 0.00E+00 | NSTDV | 9.3E-02 | 2.4E-07 | 0.0E+00 | 6.2E-01 | 1.2E-01 | 2.03 | 2 | 4.3 | 2.7E+00 | 108.0% |
| BERYLLIUM | | 1.37E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 5.0E-09 | 0.0E+00 | 1.3E-02 | 2.6E-03 | 2.03 | 2 | 4.3 | 5.5E-02 | 107.3% |
| CADMIUM | | 3.33E-03 | 1.30E-02 | ** BIAS ** | 9.3E-02 | 5.5E-10 | 0.0E+00 | 3.3E-04 | 1.2E-03 | 2.54 | 3 | 3.18 | 1.6E-03 | 29.2% |
| CHROMIUM | | 3.38E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 1.3E-08 | 0.0E+00 | 3.2E-02 | 6.7E-03 | 2.03 | 2 | 4.3 | 1.4E-01 | 102.1% |
| COBALT | | 1.00E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 1.2E-08 | 0.0E+00 | 9.6E-03 | 6.0E-03 | 2.28 | 2 | 4.3 | 4.2E-02 | 34.6% |
| COPPER | | 2.08E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 3.4E-08 | 0.0E+00 | 2.1E-02 | 1.7E-02 | 2.53 | 3 | 3.18 | 6.8E-02 | 19.7% |
| LEAD | | 2.91E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 2.0E-08 | 0.0E+00 | 2.7E-02 | 1.0E-02 | 2.10 | 2 | 4.3 | 1.2E-01 | 56.9% |
| MANGANESE | | 7.54E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 4.8E-08 | 0.0E+00 | 7.1E-02 | 2.4E-02 | 2.08 | 2 | 4.3 | 3.1E-01 | 62.8% |
| MERCURY | | 0.00E+00 | 2.89E-02 | ** BIAS ** | 9.3E-02 | 9.1E-10 | 0.0E+00 | 1.9E-04 | 2.7E-03 | 2.00 | 2 | 4.3 | 2.8E-03 | 30.6% |
| MOLYBDENUM | | 1.00E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 4.6E-09 | 0.0E+00 | 9.3E-03 | 2.3E-03 | 2.04 | 2 | 4.3 | 4.0E-02 | 86.7% |
| NICKEL | | 0.00E+00 | 0.00E+00 | ** BIAS ** | 9.3E-02 | 9.1E-09 | 0.0E+00 | 1.9E-03 | 4.6E-03 | 2.00 | 2 | 4.3 | 9.4E-03 | 10.2% |
| SELENIUM | | 0.00E+00 | 8.66E-01 | ** BIAS ** | 9.3E-02 | 2.7E-08 | 0.0E+00 | 5.7E-03 | 8.2E-02 | 2.00 | 2 | 4.3 | 8.5E-02 | 30.6% |
| PHOSPHORUS | | 3.33E+00 | 0.00E+00 | NSTDV | 9.3E-02 | 2.9E-06 | 0.0E+00 | 6.8E-01 | 1.5E+00 | 2.98 | 3 | 3.18 | 2.6E+00 | 8.9% |
| VANADIUM | | 5.24E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 4.0E-08 | 0.0E+00 | 4.9E-02 | 2.0E-02 | 2.12 | 2 | 4.3 | 2.1E-01 | 53.0% |
| CALCIUM | | 3.18E+02 | 0.00E+00 | NSTDV | 9.3E-02 | 2.0E-05 | 0.0E+00 | 3.0E+01 | 9.9E+00 | 2.08 | 2 | 4.3 | 1.3E+02 | 64.8% |
| SODIUM | | 1.21E+02 | 0.00E+00 | NSTDV | 9.3E-02 | 4.1E-06 | 0.0E+00 | 1.1E+01 | 2.1E+00 | 2.02 | 2 | 4.3 | 4.9E+01 | 116.1% |
| | | | | | | | | | | | | | | **56.0%** |

| ANIONS (C&T): | COAL | CONC. DELTA P DETERMINATION | | | THETA CALCULATIONS FOR: | | | RESULTS: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | CONC. | HEAT RT | XXXXX | Sr | Br | vr | vr | t- | Ur | % Ur |
| Chlorine, as Cl- (2) | | 9.50E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 2.2E-06 | 0.0E+00 | 4.6E-01 | 1.1E+00 | 2.15 | 2 | 4.3 | 2.3E+00 | 10.3% |
| Fluorine, as F- | | 2.91E+00 | 0.00E+00 | NSTDV | 9.3E-02 | 7.7E-07 | 0.0E+00 | 3.1E-01 | 3.9E-01 | 3.26 | 3 | 3.18 | 1.1E+00 | 13.7% |
| Phosphorus, as PO4 3- | | 1.02E+01 | 0.00E+00 | NSTDV | 9.3E-02 | 8.9E-06 | 0.0E+00 | 2.1E+00 | 4.5E+00 | 2.98 | 3 | 3.18 | 8.0E+00 | 8.9% |
| Sulfur, as SO4 2- | | 1.50E+02 | 0.00E+00 | NSTDV | 9.3E-02 | 1.2E-04 | 0.0E+00 | 2.9E+01 | 6.1E+01 | 1.57 | 2 | 4.3 | 1.4E+02 | 11.3% |
| | | | | | | | | | | | | | | **11.0%** |

[UNPROC2.XLW]UNCOAL.XLS
6:51 PM
11/9/93

DO NOT CITE OR QUOTE

PRELIMINARY

# METALS/AN - BOTTOM ASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION
PAGE 1 OF 3

| SPECIES | LOC | | RUN #1 | | RUN #2 In mg/Kg | | RUN #3 | | AVERAGE (r) | SAMPLE STD. DEV. (Spf) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | | ABSOL. VALUE In lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | | | | | | |
| ARSENIC | BOT | | 8.8 | | 3.8 | | 9.7 | | 7.5E+00 | 3.22E+00 | 86.0% | 16.8% | 87.6% | | 1.41E-02 | 1.2E-02 | 32.89% | 0.0% |
| BARIUM | ASH | | 879 | | 999 | | 1,499 | | 1.1E+03 | 3.29E+02 | 63.1% | 16.8% | 65.3% | | 2.12E+00 | 1.4E+00 | 22.11% | 0.0% |
| BERYLLIUM | | | 1.4 | | 1.6 | | 1.8 | | 1.6E+00 | 2.00E-01 | 35.2% | 16.8% | 39.0% | | 3.02E-03 | 1.2E-03 | 8.33% | 0.0% |
| CADMIUM | | ND< | 0.5 | ND< | 0.5 | ND< | 0.5 | ND< | 5.0E-01 | 0.00E+00 | 44.8% | 33.4% | 55.9% | ND< | 9.43E-04 | 5.3E-04 | 0.00% | 100.0% |
| CHROMIUM | | | 9 | | 10 | | 10 | | 9.6E+00 | 5.72E-01 | 34.9% | 16.8% | 38.7% | | 1.82E-02 | 7.0E-03 | 4.57% | 0.0% |
| COBALT | | | 5 | | 6 | | 7 | | 6.0E+00 | 1.00E+00 | 39.4% | 16.8% | 42.8% | | 1.13E-02 | 4.8E-03 | 11.11% | 0.0% |
| COPPER | | | 14 | | 15 | | 19 | | 1.6E+01 | 2.65E+00 | 39.2% | 16.8% | 42.7% | | 3.02E-02 | 1.3E-02 | 12.50% | 0.0% |
| LEAD | | | 17 | | 2.7 | | 12 | | 1.1E+01 | 7.26E+00 | 176.4% | 16.8% | 177.2% | | 1.99E-02 | 3.5E-02 | 49.63% | 0.0% |
| MANGANESE | | | 38 | | 55 | | 64 | | 5.2E+01 | 1.32E+01 | 49.7% | 16.8% | 52.5% | | 9.87E-02 | 5.2E-02 | 18.26% | 0.0% |
| MERCURY | | ND< | 0.1 | ND< | 0.1 | ND< | 0.1 | ND< | 1.0E-01 | 0.00E+00 | 44.8% | 33.4% | 55.9% | ND< | 1.89E-04 | 1.1E-04 | 0.00% | 100.0% |
| MOLYBDENUM | | ND< | 1.0 | ND< | 1.0 | ND< | 1.0 | ND< | 1.0E+00 | 0.00E+00 | 44.8% | 33.4% | 55.9% | ND< | 1.89E-03 | 1.1E-03 | 0.00% | 100.0% |
| NICKEL | | | 5 | | 6 | | 7 | | 6.0E+00 | 1.00E+00 | 39.4% | 16.8% | 42.8% | | 1.13E-02 | 4.8E-03 | 11.11% | 0.0% |
| SELENIUM | | ND< | 10 | ND< | 43 | ND< | 12 | ND< | 2.2E+01 | 1.85E+01 | 216.8% | 39.0% | 220.3% | ND< | 4.09E-02 | 9.0E-02 | 65.64% | 100.0% |
| PHOSPHORUS | | | 1,699 | | 1,899 | | 2,499 | | 2.0E+03 | 4.16E+02 | 43.8% | 16.8% | 46.9% | | 3.83E+00 | 1.8E+00 | 15.31% | 0.0% |
| VANADIUM | | | 21 | | 24 | | 27 | | 2.4E+01 | 3.00E+00 | 35.2% | 16.8% | 39.0% | | 4.51E-02 | 1.8E-02 | 8.37% | 0.0% |
| CALCIUM | | | 14,534 | | 13,534 | | 25,528 | | 1.8E+04 | 6.66E+03 | 76.0% | 16.8% | 77.9% | | 3.37E+01 | 2.6E+01 | 28.59% | 0.0% |
| SODIUM | | | 3,021 | | 2,721 | | 3,813 | | 3.2E+03 | 5.64E+02 | 40.5% | 16.8% | 43.9% | | 6.01E+00 | 2.6E+00 | 13.14% | 0.0% |
| | | | | | | | | | | AVERAGES: | 65.3% | 21.0% | 69.7% | | 2.7E+00 | 1.9E+00 | 17.74% | |
| ANIONS: | BOT ASH | | | | | | | | | | | | | | | | | |
| Chlorine, as Cl- | | | 90 | | 18 | | 70 | | 5.9E+01 | 3.70E+01 | 161.9% | 16.8% | 162.8% | | 1.12E-01 | 1.8E-01 | 46.46% | 0.0% |
| Fluorine, as F- | | ND< | 3 | ND< | 3 | ND< | 3 | ND< | 3.0E+00 | 0.00E+00 | 44.8% | 33.4% | 55.9% | ND< | 5.66E-03 | 3.2E-03 | 0.00% | 100.0% |
| Phosphorus, as PO4 3- | | ND< | 20 | ND< | 20 | ND< | 20 | ND< | 2.0E+01 | 0.00E+00 | 44.8% | 33.4% | 55.9% | ND< | 3.77E-02 | 2.1E-02 | 0.00% | 100.0% |
| Sulfur, as SO4 2- | | | 251 | | 932 | | 1241 | | 8.1E+02 | 5.06E+02 | 162.0% | 16.8% | 162.9% | | 1.52E+00 | 2.5E+00 | 45.96% | 0.0% |
| | | | | | | | | | | AVERAGES: | 103.4% | 25.1% | 109.4% | | 4.2E-01 | 6.7E-01 | 23.11% | |

[UNPROC2.XLW]UNBOTASH.XLS
4:37 PM
1/11/94

DO NOT CITE OR QUOTE

# METALS/AN - BOTTOM ASH
## *UNCERTAINTY ANALYSIS*
## SITE 115, PHASE II -- UREA INJECTION


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| BOTTOM ASH METALS: | | | | | | | | | |
| Norm. Ash Flow, lba/lbf | 0.0259 | 0.0235 | 0.0181 | 0.0225 | 0.0040 | 17.69% | 0.0023 | 16.00% | 0.0036 |
| HHV, Btu/lb (dry) | 12,692 | 12,692 | 12,584 | 12,638 | 76.37 | 0.60% | 44.09 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr (dry) | 80,435 | 86,877 | 84,694 | 84,002 | 3276 | 3.90% | 1892 | 0.00% | 0.00 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.88 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.91E+06 | 1.06E+07 | 1.01E+07 | 1.02E+07 | 3.65E+05 | 3.58% | 2.11E+05 | 5.00% | 5.09E+05 |
| Ash Flow Rate, lb/hr | 2,083 | 2,041 | 1,536 | 1,886 | 304.42 | 16.14% | 175.76 | 0.00% | 0.00 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |
| 7 | 2.37 |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV | %STDEV | N STDEV | % BIAS | BIAS |
|---|---|---|---|---|---|---|---|---|---|
| BOTTOM ASH ANIONS: | | | | | | | | | |
| Norm. Ash Flow, lba/lbf | 0.0259 | 0.0235 | 0.0181 | 0.0225 | 0.0040 | 17.69% | 0.0023 | 16.00% | 0.0036 |
| HHV, Btu/lb (dry) | 12,692 | 12,692 | 12,584 | 12,638 | 76.37 | 0.60% | 44.09 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr (dry) | 80,435 | 86,877 | 84,694 | 84,002 | 3276 | 3.90% | 1892 | 0.00% | 0.00 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.88 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.91E+06 | 1.06E+07 | 1.01E+07 | 1.02E+07 | 3.65E+05 | 3.58% | 2.11E+05 | 5.00% | 5.09E+05 |
| Ash Flow Rate, lb/hr | 2,083 | 2,041 | 1,536 | 1,886 | 304.42 | 16.14% | 175.76 | 0.00% | 0.00 |

[UNPROC2.XLW]UNBOTASH.XLS
4:39 PM
1/11/94

# METALS/AN - BOTTOM ASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION


| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | HEAT RATE (THETAhr) | ASH RATE (THETAhhv) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | | |
| ARSENIC | BOT | 1.86E+00 | 0.00E+00 | NSTDV | 1.9E-03 | 1.4E-09 | 6.3E-01 | 3.8E-03 | 2.4E-03 | 2.68 | 3 | 3.18 | 1.2E-02 | 87.6% |
| BARIUM | ASH | 1.90E+02 | 0.00E+00 | NSTDV | 1.9E-03 | 2.1E-07 | 9.5E+01 | 4.2E-01 | 3.6E-01 | 3.37 | 3 | 3.18 | 1.4E+00 | 65.3% |
| BERYLLIUM | | 1.15E-01 | 0.00E+00 | NSTDV | 1.9E-03 | 3.0E-10 | 1.3E-01 | 3.8E-04 | 5.1E-04 | 3.79 | 4 | 2.78 | 1.2E-03 | 39.0% |
| CADMIUM | | 0.00E+00 | 1.44E-01 | ** BIAS ** | 1.9E-03 | 9.3E-11 | 4.2E-02 | 9.8E-05 | 3.1E-04 | 2.16 | 2 | 4.3 | 5.3E-04 | 55.9% |
| CHROMIUM | | 3.30E-01 | 0.00E+00 | NSTDV | 1.9E-03 | 1.8E-09 | 8.1E-01 | 2.0E-03 | 3.0E-03 | 2.62 | 3 | 3.18 | 7.0E-03 | 38.7% |
| COBALT | | 5.77E-01 | 0.00E+00 | NSTDV | 1.9E-03 | 1.1E-09 | 5.0E-01 | 1.6E-03 | 1.9E-03 | 4.16 | 4 | 2.78 | 4.8E-03 | 42.8% |
| COPPER | | 1.53E+00 | 0.00E+00 | NSTDV | 1.9E-03 | 3.0E-09 | 1.3E+00 | 4.3E-03 | 5.1E-03 | 4.15 | 4 | 2.78 | 1.3E-02 | 42.7% |
| LEAD | | 4.19E+00 | 0.00E+00 | NSTDV | 1.9E-03 | 2.0E-09 | 8.9E-01 | 8.2E-03 | 3.3E-03 | 2.28 | 2 | 4.3 | 3.5E-02 | 177.2% |
| MANGANESE | | 7.62E+00 | 0.00E+00 | NSTDV | 1.9E-03 | 9.7E-09 | 4.4E+00 | 1.8E-02 | 1.7E-02 | 3.68 | 4 | 2.78 | 5.2E-02 | 52.5% |
| MERCURY | | 0.00E+00 | 2.89E-02 | ** BIAS ** | 1.9E-03 | 1.9E-11 | 8.4E-03 | 2.0E-05 | 6.3E-05 | 2.16 | 2 | 4.3 | 1.1E-04 | 55.9% |
| MOLYBDENUM | | 0.00E+00 | 2.89E-01 | ** BIAS ** | 1.9E-03 | 1.9E-10 | 8.4E-02 | 2.0E-04 | 6.3E-04 | 2.16 | 2 | 4.3 | 1.1E-03 | 55.9% |
| NICKEL | | 5.77E-01 | 0.00E+00 | NSTDV | 1.9E-03 | 1.1E-09 | 5.0E-01 | 1.6E-03 | 1.9E-03 | 4.16 | 4 | 2.78 | 4.8E-03 | 42.8% |
| SELENIUM | | 1.07E+01 | 7.62E+00 | NSTDV | 1.9E-03 | 4.0E-09 | 1.8E+00 | 2.1E-02 | 1.6E-02 | 2.18 | 2 | 4.3 | 9.0E-02 | 220.3% |
| PHOSPHORUS | | 2.40E+02 | 0.00E+00 | NSTDV | 1.9E-03 | 3.8E-07 | 1.7E+02 | 6.0E-01 | 6.4E-01 | 4.05 | 4 | 2.78 | 1.8E+00 | 46.9% |
| VANADIUM | | 1.73E+00 | 0.00E+00 | NSTDV | 1.9E-03 | 4.4E-09 | 2.0E+00 | 5.7E-03 | 7.6E-03 | 3.80 | 4 | 2.78 | 1.8E-02 | 39.0% |
| CALCIUM | | 3.84E+03 | 0.00E+00 | NSTDV | 1.9E-03 | 3.3E-06 | 1.5E+03 | 8.1E+00 | 5.6E+00 | 2.90 | 3 | 3.18 | 2.6E+01 | 77.9% |
| SODIUM | | 3.26E+02 | 0.00E+00 | NSTDV | 1.9E-03 | 5.9E-07 | 2.7E+02 | 8.8E-01 | 1.0E+00 | 4.16 | 4 | 2.78 | 2.6E+00 | 43.9% |
| | | | | | | | | | | | | | | 69.7% |

| ANIONS: | BOT ASH | CONC. DELTA P DETERMINATION NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. | HEAT RT | ASH FLOW | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorine, as Cl- | | 2.14E+01 | 0.00E+00 | NSTDV | 1.9E-03 | 1.1E-08 | 5.0E+00 | 4.2E-02 | 1.9E-02 | 2.33 | 2 | 4.3 | 1.8E-01 | 162.8% |
| Fluorine, as F- | | 0.00E+00 | 8.66E-01 | *ND BIAS* | 1.9E-03 | 5.6E-10 | 2.5E-01 | 5.9E-04 | 1.9E-03 | 2.16 | 2 | 4.3 | 3.2E-03 | 55.9% |
| Phosphorus, as PO4 3- | | 0.00E+00 | 5.77E+00 | *ND BIAS* | 1.9E-03 | 3.7E-09 | 1.7E+00 | 3.9E-03 | 1.3E-02 | 2.16 | 2 | 4.3 | 2.1E-02 | 55.9% |
| Sulfur, as SO4 2- | | 2.92E+02 | 0.00E+00 | NSTDV | 1.9E-03 | 1.5E-07 | 6.8E+01 | 5.7E-01 | 2.6E-01 | 2.33 | 2 | 4.3 | 2.5E+00 | 162.9% |
| | | | | | | | | | | | | | | 109.4% |

[UNPROC2.XLW]UNBOTASH.XLS
4:38 PM
1/11/94

PRELIMINARY

# METALS/AN - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION
PAGE 1 OF 3

| SPECIES | LOC | RUN #1 | RUN #2 In mg/Kg | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE In lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | |
| ARSENIC | FLY | 11 | 11 | 3.7 | 8.6E+00 | 4.21E+00 | 123.3% | 16.0% | 124.4% | 5.78E-02 | 7.2E-02 | 37.87% | 0.0% |
| BARIUM | ASH | 1200 | 880 | 690 | 9.2E+02 | 2.58E+02 | 71.3% | 16.0% | 73.1% | 6.23E+00 | 4.6E+00 | 19.98% | 0.0% |
| BERYLLIUM | | 2.4 | 2.8 | 2.4 | 2.5E+00 | 2.31E-01 | 18.1% | 16.0% | 24.1% | 1.71E-02 | 4.1E-03 | 7.02% | 0.0% |
| CADMIUM | | ND< 1 | ND< 1 | ND< 1 | ND< 1.0E+00 | 0.00E+00 | 16.5% | 33.0% | 36.9% | ND< 6.75E-03 | 2.5E-03 | 0.00% | 100.0% |
| CHROMIUM | | 15 | 16 | 12 | 1.4E+01 | 2.08E+00 | 29.3% | 16.0% | 33.4% | 9.68E-02 | 3.2E-02 | 10.85% | 0.0% |
| COBALT | | 13 | 12 | 12 | 1.2E+01 | 5.77E-01 | 13.0% | 16.0% | 20.6% | 8.33E-02 | 1.7E-02 | 3.60% | 0.0% |
| COPPER | | 40 | 38 | 36 | 3.8E+01 | 2.00E+00 | 13.6% | 16.0% | 21.0% | 2.57E-01 | 5.4E-02 | 3.51% | 0.0% |
| LEAD | | 31 | 34 | 24 | 3.0E+01 | 5.13E+00 | 34.0% | 16.0% | 37.6% | 2.00E-01 | 7.5E-02 | 12.73% | 0.0% |
| MANGANESE | | 61 | 68 | 62 | 6.4E+01 | 3.79E+00 | 14.3% | 16.0% | 21.4% | 4.30E-01 | 9.2E-02 | 4.54% | 0.0% |
| MERCURY | | 0.3 | 0.2 | 0.1 | 2.0E-01 | 1.00E-01 | 125.3% | 16.0% | 126.3% | 1.35E-03 | 1.7E-03 | 33.33% | 0.0% |
| MOLYBDENUM | | 3 | 3 | 5 | 3.7E+00 | 1.15E+00 | 80.0% | 16.0% | 81.5% | 2.48E-02 | 2.0E-02 | 24.24% | 0.0% |
| NICKEL | | 15 | 10 | 13 | 1.3E+01 | 2.52E+00 | 52.0% | 16.0% | 54.4% | 8.55E-02 | 4.7E-02 | 14.04% | 0.0% |
| SELENIUM | | ND< 8.8 | ND< 1.3 | 4.3 @ | ND< 8.8E+00 | 3.77E+00 | 107.8% | 23.2% | 110.3% | ND< 5.94E-02 | 6.6E-02 | 45.45% | 100.0% |
| PHOSPHORUS | | 4,200 | 4,400 | 4,000 | 4.2E+03 | 2.00E+02 | 13.1% | 16.0% | 20.7% | 2.84E+01 | 5.9E+00 | 3.17% | 0.0% |
| VANADIUM | | 66 | 54 | 54 | 5.8E+01 | 6.93E+00 | 25.1% | 16.0% | 29.8% | 3.92E-01 | 1.2E-01 | 9.20% | 0.0% |
| CALCIUM | | 30,000 | 31,000 | 30,000 | 3.0E+04 | 5.77E+02 | 17.1% | 16.0% | 23.5% | 2.05E+02 | 4.8E+01 | 1.47% | 0.0% |
| SODIUM | | 4,100 | 5,600 | 4,700 | 4.8E+03 | 7.55E+02 | 31.4% | 16.0% | 35.2% | 3.24E+01 | 1.1E+01 | 11.11% | 0.0% |
| | | | | | | AVERAGES: | 46.2% | 17.4% | 51.4% | 1.6E+01 | 4.1E+00 | 14.24% | |
| ANIONS: | FLY ASH | | | | | | | | | | | | |
| Chlorine, as Cl- | | ND< 50 | ND< 50 | ND< 50 | ND< 5.0E+01 | 0.00E+00 | 16.5% | 33.0% | 36.9% | ND< 3.38E-01 | 1.2E-01 | 0.00% | 100.0% |
| Fluorine, as F- | | 23 | 40 | 34 | 3.2E+01 | 8.62E+00 | 68.3% | 16.0% | 70.1% | 2.18E-01 | 1.5E-01 | 19.24% | 0.0% |
| Phosphorus, as PO4 3- | | ND< 200 | ND< 200 | ND< 200 | ND< 2.0E+02 | 0.00E+00 | 16.5% | 33.0% | 36.9% | ND< 1.35E+00 | 5.0E-01 | 0.00% | 100.0% |
| Sulfur, as SO4 2- | | 1500 | 1500 | 1500 | 1.5E+03 | 0.00E+00 | 16.5% | 16.0% | 23.0% | 1.01E+01 | 2.3E+00 | 0.00% | 0.0% |
| | | | | | | AVERAGES: | 29.4% | 24.5% | 41.7% | 3.0E+00 | 7.8E-01 | 4.81% | |

[UNPROC2.XLW]UNFLYASH.XLS
4:41 PM
1/11/94

DO NOT CITE OR QUOTE

# METALS/AN - FLYASH
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION


| SPECIES | LOC | CONC. DELTA P DETERMINATION NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. (THETAc) | Fly Ash Rt (THETAhr) | xxxxxx (THETAhhv) | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS: | | | | | | | | | | | | | | |
| ARSENIC | FLY | 2.43E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 8.9E-04 | 0.0E+00 | 1.7E-02 | 9.3E-03 | 2.07 | 2 | 4.3 | 7.2E-02 | 124.4% |
| BARIUM | ASH | 1.49E+02 | 0.00E+00 | NSTDV | 6.8E-03 | 9.6E-02 | 0.0E+00 | 1.0E+00 | 1.0E+00 | 2.23 | 2 | 4.3 | 4.6E+00 | 73.1% |
| BERYLLIUM | | 1.33E-01 | 0.00E+00 | NSTDV | 6.8E-03 | 2.6E-04 | 0.0E+00 | 1.1E-03 | 2.7E-03 | 3.65 | 4 | 2.78 | 4.1E-03 | 24.1% |
| CADMIUM | | 0.00E+00 | 2.89E-01 | ** BIAS ** | 6.8E-03 | 1.0E-04 | 0.0E+00 | 2.6E-04 | 2.2E-03 | 2.00 | 2 | 4.3 | 2.5E-03 | 36.9% |
| CHROMIUM | | 1.20E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 1.5E-03 | 0.0E+00 | 8.9E-03 | 1.5E-02 | 2.80 | 3 | 3.18 | 3.2E-02 | 33.4% |
| COBALT | | 3.33E-01 | 0.00E+00 | NSTDV | 6.8E-03 | 1.3E-03 | 0.0E+00 | 3.9E-03 | 1.3E-02 | 3.60 | 4 | 2.78 | 1.7E-02 | 20.6% |
| COPPER | | 1.15E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 4.0E-03 | 0.0E+00 | 1.3E-02 | 4.1E-02 | 3.80 | 4 | 2.78 | 5.4E-02 | 21.0% |
| LEAD | | 2.96E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 3.1E-03 | 0.0E+00 | 2.1E-02 | 3.2E-02 | 2.58 | 3 | 3.18 | 7.5E-02 | 37.6% |
| MANGANESE | | 2.19E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 6.6E-03 | 0.0E+00 | 2.2E-02 | 6.9E-02 | 3.95 | 4 | 2.78 | 9.2E-02 | 21.4% |
| MERCURY | | 5.77E-02 | 0.00E+00 | NSTDV | 6.8E-03 | 2.1E-05 | 0.0E+00 | 3.9E-04 | 2.2E-04 | 2.07 | 2 | 4.3 | 1.7E-03 | 126.3% |
| MOLYBDENUM | | 6.67E-01 | 0.00E+00 | NSTDV | 6.8E-03 | 3.8E-04 | 0.0E+00 | 4.6E-03 | 4.0E-03 | 2.18 | 2 | 4.3 | 2.0E-02 | 81.5% |
| NICKEL | | 1.45E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 1.3E-03 | 0.0E+00 | 1.0E-02 | 1.4E-02 | 2.44 | 2 | 4.3 | 4.7E-02 | 54.4% |
| SELENIUM | | 2.18E+00 | 1.48E+00 | NSTDV | 6.8E-03 | 9.2E-04 | 0.0E+00 | 1.5E-02 | 1.4E-02 | 2.10 | 2 | 4.3 | 6.6E-02 | 110.3% |
| PHOSPHORUS | | 1.15E+02 | 0.00E+00 | NSTDV | 6.8E-03 | 4.4E-01 | 0.0E+00 | 1.3E+00 | 4.5E+00 | 3.63 | 4 | 2.78 | 5.9E+00 | 20.7% |
| VANADIUM | | 4.00E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 6.1E-03 | 0.0E+00 | 3.1E-02 | 6.3E-02 | 3.13 | 3 | 3.18 | 1.2E-01 | 29.8% |
| CALCIUM | | 3.33E+02 | 0.00E+00 | NSTDV | 6.8E-03 | 3.2E+00 | 0.0E+00 | 8.2E+00 | 3.3E+01 | 2.33 | 2 | 4.3 | 4.8E+01 | 23.5% |
| SODIUM | | 4.36E+02 | 0.00E+00 | NSTDV | 6.8E-03 | 5.0E-01 | 0.0E+00 | 3.2E+00 | 5.2E+00 | 2.69 | 3 | 3.18 | 1.1E+01 | 35.2% |
| | | | | | | | | | | | | | | 51.4% |

| ANIONS: | FLY ASH | CONC. DELTA P DETERMINATION NORM. STD DEV | ND BIAS | > OF NSTD OR BIAS | THETA CALCULATIONS FOR: CONC. | Fly Ash Rt | xxxxxx | RESULTS: Sr | Br | vr | vr | t- | Ur | % Ur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorine, as Cl- | | 0.00E+00 | 1.44E+01 | ** BIAS ** | 6.8E-03 | 5.2E-03 | 0.0E+00 | 1.3E-02 | 1.1E-01 | 2.00 | 2 | 4.3 | 1.2E-01 | 36.9% |
| Fluorine, as F- | | 4.98E+00 | 0.00E+00 | NSTDV | 6.8E-03 | 3.4E-03 | 0.0E+00 | 3.5E-02 | 3.5E-02 | 2.25 | 2 | 4.3 | 1.5E-01 | 70.1% |
| Phosphorus, as PO4 3- | | 0.00E+00 | 5.77E+01 | ** BIAS ** | 6.8E-03 | 2.1E-02 | 0.0E+00 | 5.2E-02 | 4.5E-01 | 2.00 | 2 | 4.3 | 5.0E-01 | 36.9% |
| Sulfur, as SO4 2- | | 0.00E+00 | 0.00E+00 | ** BIAS ** | 6.8E-03 | 1.6E-01 | 0.0E+00 | 3.9E-01 | 1.6E+00 | 2.00 | 2 | 4.3 | 2.3E+00 | 23.0% |
| | | | | | | | | | | | | | | 41.7% |

[UNPROC2.XLW]UNFLYASH.XLS
4:42 PM
1/11/94

PRELIMINARY

DO NOT CITE OR QUOTE

PRELIMINARY

METALS/AN - FLYASH
UNCERTAINTY ANALYSIS
SITE 115, PHASE II -- UREA INJECTION


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| FLY ASH METALS: | | | | | | | | | |
| FLY ASH RATE,lb/MWhr | 59.86 | 66.23 | 68.04 | 64.71 | 4.29 | 6.64% | 2.48 | 16.00% | 10.35 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.882 | 0.00% | 0.00 |
| Ash Flow Rate, lb/hr | 6166 | 6888 | 7212 | 6755 | 535.5 | 7.93% | 309.2 | 0.00% | 0.00 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 5 | 2.57 |

| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spl) | %STDEV (Spl,%) | N STDEV (Spl') | % BIAS (Bpl,%) | BIAS (Bpl) |
|---|---|---|---|---|---|---|---|---|---|
| FLY ASH ANIONS: | | | | | | | | | |
| FLY ASH RATE,lb/MWhr | 59.86 | 66.23 | 68.04 | 64.71 | 4.29 | 6.64% | 2.48 | 16.00% | 10.35 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.88 | 0.00% | 0.00 |
| Ash Flow Rate, lb/hr | 6166 | 6888 | 7212 | 6755 | 535.5 | 7.93% | 309.2 | 0.00% | 0.00 |

DO NOT CITE OR QUOTE

[UNPROC2.XLW]UNFLYASH.XLS
4:43 PM
1/11/94

INAA - COAL
UNCERTAINTY ANALYSIS
SITE 115, PHASE II -- UREA INJECTION
PAGE 1 OF 3

| SPECIES | LOC | RUN #1 | RUN #2 in mg/Kg | RUN #3 | AVERAGE (r) | SAMPLE STD. DEV. (Spl) | % SAMPLE RND ERR (Sr,%) | SAMPLE % BIAS (Br,%) | % UNCERT. (Ur,%) | ABSOL. VALUE in lb/hr | ABSOL. UNCERT. (Ur) | % RPDM | % CONTRIB OF ND, TO AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS (INAA): | | | | | | | | | | | | | |
| ARSENIC | COAL | 0.75 | 0.47 | 0.70 | 6.38E-01 | 1.48E-01 | 58.1% | 5.0% | 58.3% | 5.93E-02 | 3.5E-02 | 17.58% | 0.0% |
| BARIUM | | 350 | 335 | 333 | 3.39E+02 | 9.29E+00 | 7.2% | 5.0% | 8.8% | 3.15E+01 | 2.8E+00 | 2.10% | 0.0% |
| CADMIUM | | 0.12 | 0.10 | 0.13 | 1.15E-01 | 1.50E-02 | 33.6% | 5.0% | 34.0% | 1.07E-02 | 3.6E-03 | 8.70% | 0.0% |
| CHROMIUM | | 3.4 | 2.4 | 2.5 | 2.73E+00 | 5.35E-01 | 49.4% | 5.0% | 49.6% | 2.54E-01 | 1.3E-01 | 15.04% | 0.0% |
| COBALT | | 0.97 | 1.00 | 0.79 | 9.18E-01 | 1.16E-01 | 32.7% | 5.0% | 33.1% | 8.53E-02 | 2.8E-02 | 9.68% | 0.0% |
| MERCURY (1) | | 0.011 | 0.027 | | 1.91E-02 | 1.11E-02 | 523.8% | 5.0% | 523.9% | 1.78E-03 | 9.3E-03 | 82.35% | 0.0% |
| MOLYBDENUM | | 1.6 | 1.4 | 1.5 | 1.48E+00 | 7.64E-02 | 10.0% | 5.0% | 11.2% | 1.38E-01 | 1.5E-02 | 3.75% | 0.0% |
| SELENIUM | | 1.1 | 0.91 | 2.4 | 1.45E+00 | 7.85E-01 | 134.7% | 5.0% | 134.8% | 1.35E-01 | 1.8E-01 | 41.38% | 0.0% |
| CHLORIDE | | 16 | 17 | 16 | 1.62E+01 | 7.64E-01 | 9.5% | 5.0% | 10.7% | 1.50E+00 | 1.6E-01 | 3.44% | 0.0% |
| | | | | | | AVERAGES: | 95.5% | 5.0% | 96.0% | 3.7E+00 | 3.7E-01 | 28.4% | |

Note: (1) Results not reported for one Hg replicate.

[UNPROC2.XLW]UNINAA
7:11 PM
11/9/93

# INAA - COAL
## UNCERTAINTY ANALYSIS
## SITE 115, PHASE II -- UREA INJECTION


| PARAMETER | RUN #1 | RUN #2 | RUN #3 | AVERAGE | STD DEV (Spi) | %STDEV (Spi,%) | N STDEV (Spi') | % BIAS (Bpi,%) | BIAS (Bpi) |
|---|---|---|---|---|---|---|---|---|---|
| METALS FUEL NAA: | | | | | | | | | |
| HHV, Btu/lb | 11,468 | 11,468 | 11,382 | 11,425 | 60.81 | 0.53% | 35.11 | 0.00% | 0.00 |
| FUEL FLOW, lb/hr | 88,972 | 96,098 | 93,683 | 92,918 | 3624.12 | 3.90% | 2092.39 | 0.00% | 0.00 |
| LOAD, MW | 103 | 104 | 106 | 104 | 1.53 | 1.46% | 0.88 | 0.00% | 0.00 |
| HEAT RATE, Btu/MWhr | 9.91E+06 | 1.06E+07 | 1.01E+07 | 1.02E+07 | 3.63E+05 | 3.56% | 2.09E+05 | -5.00% | -5.09E+05 |

| DEGREES FREEDOM | T-VALUE |
|---|---|
| 1 | 12.71 |
| 2 | 4.30 |
| 3 | 3.18 |
| 4 | 2.78 |
| 5 | 2.57 |
| 6 | 2.45 |
| 7 | 2.37 |
| 8 | 2.31 |

[UNPROC2.XLW]UNINAA
7:14 PM
11/9/93

INAA - COAL
UNCERTAINTY ANALYSIS
SITE 115, PHASE II – UREA INJECTION
PAGE 3 OF 3

| SPECIES | LOC | CONC. DELTA P DETERMINATION | | | THETA CALCULATIONS FOR: | | | RESULTS: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NORM. STD DEV (Spc') | ND BIAS (Bpc) | > OF NSTD OR BIAS | CONC. (THETAc) | HEAT RT (THETAhr) | xxxxxx (THETAhhv) | Sr | Br | vr | vr | t | Ur | % Ur |
| METALS (INAA): | | | | | | | | | | | | | | |
| ARSENIC | COAL | 8.52E-02 | 0.00E+00 | NSTDV | 9.3E-02 | 5.8E-09 | 0.0E+00 | 8.0E-03 | 3.0E-03 | 2.10 | 2 | 4.3 | 3.5E-02 | 58.3% |
| BARIUM | | 5.36E+00 | 0.00E+00 | NSTDV | 9.3E-02 | 3.1E-06 | 0.0E+00 | 8.2E-01 | 1.6E+00 | 3.75 | 4 | 2.78 | 2.8E+00 | 8.8% |
| CADMIUM | | 8.66E-03 | 0.00E+00 | NSTDV | 9.3E-02 | 1.1E-09 | 0.0E+00 | 8.3E-04 | 5.3E-04 | 2.30 | 2 | 4.3 | 3.6E-03 | 34.0% |
| CHROMIUM | | 3.09E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 2.5E-08 | 0.0E+00 | 2.9E-02 | 1.3E-02 | 2.13 | 2 | 4.3 | 1.3E-01 | 49.6% |
| COBALT | | 6.72E-02 | 0.00E+00 | NSTDV | 9.3E-02 | 8.4E-09 | 0.0E+00 | 6.5E-03 | 4.3E-03 | 2.31 | 2 | 4.3 | 2.8E-02 | 33.1% |
| MERCURY (1) | | 7.88E-03 | 0.00E+00 | NSTDV | 9.3E-02 | 1.7E-10 | 0.0E+00 | 7.3E-04 | 8.9E-05 | 1.00 | 1 | 12.7 | 9.3E-03 | 523.9% |
| MOLYBDENUM | | 4.41E-02 | 0.00E+00 | NSTDV | 9.3E-02 | 1.4E-08 | 0.0E+00 | 5.0E-03 | 6.9E-03 | 3.56 | 4 | 2.78 | 1.5E-02 | 11.2% |
| SELENIUM | | 4.53E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 1.3E-08 | 0.0E+00 | 4.2E-02 | 6.7E-03 | 2.02 | 2 | 4.3 | 1.8E-01 | 134.8% |
| CHLORIDE | | 4.41E-01 | 0.00E+00 | NSTDV | 9.3E-02 | 1.5E-07 | 0.0E+00 | 5.1E-02 | 7.5E-02 | 3.72 | 4 | 2.78 | 1.6E-01 | 10.7% |
| | | | | | | | | | | | | | | 96.0% |

[UNPROC2.XLW]UNINAA
7:12 PM
11/9/93

PRELIMINARY

DO NOT CITE OR QUOTE

**MASS BALANCE UNCERTAINTY CALCULATIONS**
**FOR**
**SITE 115 - BASELINE**

| Element | Coal (A) | | | Bot. Ash (C) | | | Fly Ash (D) | | | FFDC Outlet Gas (B) | | | Total Out (E) | | (B+C+D)/A = F | Del(F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average lb/10^12 Btu | Std. Dev. | Del(A) | Average lb/10^12 Btu | Std. Dev. | Del(C) | Average lb/10^12 Btu | Std. Dev. | Del(D) | Average lb/10^12 Btu | Std. Dev. | Del(B) | B+C+D lb/10^12 Btu | Del(E) | | |
| Arsenic (2) | 43.0 | 7.02 | 4.06 | 3.10 | 0.24 | 0.14 | 22.70 | 0.00 | 0.00 | 0.8 | 0.56 | 0.32 | 26.6 | 0.35 | 62% | 6% |
| Barium (2) | 37,566 | 8,342 | 4,816 | 1,915 | 189 | 109 | 9,790 | 895 | 517 | 1.1 | 0.6 | 0.37 | 11,706 | 528 | 31% | 4% |
| Beryllium | 20.0 | 1.4 | 0.79 | 2.16 | 0.29 | 0.17 | 9.79 | 0.89 | 0.52 | ND< 0.02 | 0.00 | 0.00 | 12.0 | 0.54 | 60% | 4% |
| Cadmium | ND< 4.5 | 0.0 | 0.00 | ND< 0.59 | 0.00 | 0.00 | ND< 1.5 | 0.00 | 0.00 | 0.12 | 0.1 | 0.05 | – | – | – | – |
| Chromium | 97.4 | 22.6 | 13.0 | 5.9 | 0.4 | 0.25 | 45.5 | 4.6 | 2.65 | 0.7 | 0.2 | 0.11 | 52.1 | 2.7 | 53% | 8% |
| Cobalt | 83.6 | 10.3 | 6.0 | 4.9 | 0.6 | 0.37 | 29.0 | 3.8 | 2.20 | ND< 0.2 | 0.00 | 0.00 | 34.0 | 2.23 | 41% | 4% |
| Copper | 241 | 5.17 | 2.99 | 20.0 | 3.3 | 1.91 | 140 | 29.3 | 16.9 | 1.1 | 0.27 | 0.15 | 161 | 17.0 | 67% | 7% |
| Lead | 185 | 40.4 | 23.3 | 21.2 | 0.00 | 0.00 | 144 | 23.9 | 13.8 | 0.4 | 0.0 | 0.02 | 165 | 13.8 | 89% | 13% |
| Manganese | 379 | 129 | 74.7 | 82.5 | 10.7 | 6.20 | 410 | 15.8 | 9.12 | 1.0 | 0.48 | 0.27 | 493 | 11.0 | 130% | 26% |
| Mercury (2) | 1.9 | 0.61 | 0.35 | 0.30 | 0.32 | 0.18 | 0.90 | 0.60 | 0.34 | ND< 0.35 | 0.00 | 0.00 | 1.55 | 0.39 | 81% | 25% |
| Molybdenum | 9.0 | 7.8 | 4.5 | ND< 1.62 | 0.00 | 0.00 | 22.0 | 1.5 | 0.87 | 0.2 | 0.01 | 0.004 | 23.8 | 0.87 | 265% | 133% |
| Nickel | 53 | 18.7 | 10.8 | ND< 3.70 | 0.00 | 0.00 | 23.3 | 10.3 | 5.9 | 1.5 | 7.8 | 4.50 | 28.5 | 7.43 | 53% | 18% |
| Selenium (2) | 73.0 | 8.72 | 5.03 | ND< 5.9 | 0.00 | 0.00 | 23.8 | 1.2 | 0.69 | 0.4 | 0.18 | 0.11 | 30.0 | 0.70 | 41% | 3% |
| Phosphorus | 36,745 | 7,813 | 4,511 | 4,103 | 414 | 239 | 20,179 | 2,979 | 1,720 | 6.7 | 0.4 | 0.3 | 24,289 | 1,736 | 66% | 9% |
| Vanadium | 266 | 42.4 | 24.5 | 25.2 | 3.36 | 1.94 | 156 | 33 | 19.0 | 0.24 | 0.09 | 0.05 | 181.23 | 19.1 | 68% | 10% |
| | | | | | | | | | | | | | | | | |
| Chlorine, as Cl- (2) | 2,002 | 315 | 182 | 108.0 | 12.2 | 7.05 | 68.3 | 16.1 | 9.3 | 626 | 257 | 149 | 803 | 149 | 40% | 8% |
| Fluorine, as F- | 7,558 | 451 | 260 | ND< 70.96 | 0.00 | 0.00 | 144 | 51.6 | 29.8 | 4,292 | 2,352 | 1,358 | 4,507 | 1358 | 60% | 18% |
| Phosphorus, as PO4 3- | 112,679 | 23,959 | 13,833 | ND< 473 | 0.00 | 0.00 | ND< 121 | 0.00 | 0.00 | ND< 1,897 | 0.00 | 0.00 | ND< 2,492 | 0.00 | – | – |
| Sulfur, as SO4 2- | 1,181,532 | 80,559 | 46,511 | 985 | 674 | 389 | 5,883 | 830 | 479 | 982,928 | 33,775 | 19,500 | 989,797 | 19,510 | 84% | 4% |
| | | | | | | | | | | | | | | **AVERAGE** | 76% | 18% |

Notes:
(1) ND not divided by two for mass balance calculations
(2) Fuel from INAA

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PRELIMINARY

**MASS BALANCE UNCERTAINTY CALCULATIONS**
**FOR**
**SITE 115 - BASELINE RADIONUCLIDES**

| Radionuclide | Coal (A) | | | Bot. Ash (C) | | | Fly Ash (D) | | | FFDC Outlet Gas (B) | | | Total Out (E) | | (B+C+D)/A = F | Del(F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average uCi/10^12 Btu | Std. Dev. | Del(A) | Average uCi/10^12 Btu | Std. Dev. | Del(C) | Average uCi/10^12 Btu | Std. Dev. | Del(D) | Average uCi/10^12 Btu | Std. Dev. | Del(B) | B+C+D uCi/10^12 Btu | Del(E) | | |
| Uranium-233 & -234 | 4,817.6 | 909.30 | 524.99 | 2285.81 | 167.08 | 96.46 | 6259.47 | 0.00 | 0.00 | ND< 20.0 | 0.00 | 0.00 | 8565.3 | 96.46 | 178% | 19% |
| Uranium-235 | 361 | 313 | 181 | 105 | 2 | 1 | 317 | 206 | 119 | ND< 20.0 | 0.0 | 0.00 | 442 | 119 | 122% | 69% |
| Uranium-238 | 3,372.3 | 1367.9 | 789.78 | 2289.14 | 154.11 | 88.98 | 6531.66 | 544.16 | 314.17 | ND< 20.03 | 0.00 | 0.00 | 8840.8 | 326.53 | 262% | 62% |
| Radium-226 | 10,117.0 | 1302.8 | 752.15 | 2866.11 | 0.00 | 0.00 | 7618.6 | 0.00 | 0.00 | 39.26 | 1.1 | 0.63 | 10524.0 | 0.63 | 104% | 8% |
| Radium-228 | 8,551.3 | 3619.2 | 2089.6 | 2052.2 | 132.0 | 76.23 | 4805.3 | 531.9 | 307.11 | 294.7 | 37.8 | 21.81 | 7152.2 | 317.2 | 84% | 21% |
| Lead-210 (1) | 17,885.4 | 8,617.0 | 4,975.0 | 770.2 | 156.1 | 90.11 | 2903.6 | 685.6 | 395.81 | ND< 260.4 | 0.00 | 0.00 | 3934.2 | 405.94 | 22% | 7% |
| Polonium-210 | 4,215 | 2759.64 | 1593.28 | 386.8 | 225.6 | 130.25 | 3987 | 801.6 | 462.8 | ND< 19.6 | 0.00 | 0.00 | 4394 | 480.8 | 104% | 41% |
| Thorium-228 | 3,493 | 752.1 | 434.3 | 3258.8 | 0.00 | 0.00 | 6804 | 813.4 | 469.6 | ND< 119.1 | 0.0 | 0.00 | 10182 | 469.6 | 292% | 39% |
| Thorium-230 | 7,106 | 3,357 | 1,938.3 | 3153.3 | 254.1 | 146.70 | 6799 | 1618.6 | 934.47 | ND< 60.1 | 0.00 | 0.00 | 10012 | 945.9 | 141% | 41% |
| Thorium-232 | 3,733.7 | 2054.56 | 1186.20 | 3399.10 | 251.71 | 145.32 | 7077.63 | 510.24 | 294.59 | ND< 20.03 | 0.00 | 0.00 | 10496.76 | 328.48 | 281% | 90% |

Notes:
(1) ND not divided by two for mass balance calculations

**AVERAGE** 159% 40%

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# BAGHOUSE UNCERTAINTY CALCULATIONS
# FOR
# SITE 115 - BASELINE

| Element | Baghouse Inlet Gas (A) | | | | Baghouse Outlet Gas (B) | | | IN - OUT | Baghouse efficiency | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average lb/10^12 Btu | Std. Dev. | Del(A) | | Average lb/10^12 Btu | Std. Dev. | Del(B) | C=A-B lb/10^12 Btu | Del(C) lb/10^12 Btu | D=C/A % | Del(D) |
| Arsenic | 23.1 | 7.06 | 4.08 | | 0.75 | 0.56 | 0.32 | 22.3 | 4.09 | 96.7% | 25% |
| Barium | 234 | 195 | 112.62 | | 1.12 | 0.6 | 0.37 | 232 | 113 | 99.5% | 68% |
| Beryllium | 9.01 | 3.32 | 1.92 | ND< | 0.02 | 0.00 | 0.00 | 8.99 | 1.9 | > 99.8% | 30% |
| Cadmium | 2.28 | 0.49 | 0.28 | | 0.12 | 0.08 | 0.05 | 2.16 | 0.3 | 94.8% | 17% |
| Chromium | 50.0 | 19.4 | 11.2 | | 0.7 | 0.2 | 0.11 | 49.4 | 11.2 | 98.7% | 31% |
| Cobalt | 29.9 | 11.7 | 6.76 | ND< | 0.2 | 0.00 | 0.00 | 29.7 | 6.8 | > 99.3% | 32% |
| Copper | 169 | 20.4 | 11.8 | | 1.10 | 0.27 | 0.15 | 168 | 11.8 | 99.4% | 10% |
| Lead | 63.8 | 44.6 | 25.7 | | 0.44 | 0.0 | 0.02 | 63.4 | 25.7 | 99.3% | 57% |
| Manganese | 195 | 69.3 | 40.0 | | 1.0 | 0.48 | 0.27 | 194 | 40.0 | 99.5% | 29% |
| Mercury | 1.33 | 0.48 | 0.28 | ND< | 0.35 | 0.00 | 0.00 | 0.98 | 0.28 | > 73.9% | 26% |
| Molybdenum | 10.7 | 4.20 | 2.42 | | 0.2 | 0.01 | 0.00 | 10.6 | 2.42 | 98.4% | 32% |
| Nickel | 30.2 | 13.3 | 7.7 | | 1.5 | 7.8 | 4.5 | 29 | 8.9 | 95.1% | 38% |
| Selenium | 22.39 | 4.16 | 2.40 | | 0.36 | 0.18 | 0.11 | 22.02 | 2.40 | 98.4% | 15% |
| Phosphorus | 14,311 | 464 | 268 | | 6.7 | 0.4 | 0.3 | 14,304 | 268 | 99.95% | 3% |
| Vanadium | 135 | 50 | 29 | | 0.24 | 0.09 | 0.05 | 135 | 29.0 | 99.8% | 30% |
| Chloride | 795 | 46 | 27 | | 626 | 257 | 149 | 168 | 151 | 21.2% | 19% |
| Fluoride | 4,778 | 695 | 401 | | 4,292 | 2,352 | 1,358 | 486 | 1,416 | 10.2% | 30% |
| Phosphate | 1,282 | 767 | 443 | ND< | 1,897 | 0.00 | 0.00 | -- | -- | -- | -- |
| Sulfate | 1,056,505 | 92,428 | 53,363 | | 982,928 | 33,775 | 19,500 | 73,576 | 56,815 | 7.0% | 5% |
| | lb/10^6 Btu | | | | lb/10^6 Btu | | | lb/10^6 Btu | lb/10^6 Btu | | |
| Particulates | 5.36 | 1.13 | 0.65 | | 0.0019 | 0.0016 | 0.00092 | 5.36 | 0.65 | 99.96% | 17.27% |

Notes:
(1) ND not divided by two for baghouse efficiency calculations

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## MASS BALANCE UNCERTAINTY CALCULATIONS
## FOR
## SITE 115 - UREA INJECTION

| Element | Coal (A) | | | Bot. Ash (C) | | | Fly Ash (D) | | | FFDC Outlet Gas (B) | | | Total Out (E) | | (B+C+D)/A = F | Del(F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average lb/10^12 Btu | Std. Dev. | Del(A) | Average lb/10^12 Btu | Std. Dev. | Del(C) | Average lb/10^12 Btu | Std. Dev. | Del(D) | Average lb/10^12 Btu | Std. Dev. | Del(B) | B+C+D lb/10^12 Btu | Del(E) | | |
| Arsenic (2) | 55.9 | 12.91 | 7.45 | 15.0 | 6.78 | 3.91 | 51.16 | 23.6 | 13.6 | 0.2 | 0.04 | 0.02 | 66.3 | 14.18 | 119% | 30% |
| Barium (2) | 29,701 | 813 | 470 | 2,206 | 290 | 168 | 5,552 | 1,188 | 686 | 1.05 | 1.12 | 0.65 | 7,759 | 706 | 26% | 2% |
| Beryllium | 48.1 | 20.7 | 11.95 | 3.19 | 0.13 | 0.08 | 15.42 | 1.69 | 0.98 | ND< 0.02 | 0.00 | 0.00 | 18.6 | 0.98 | 39% | 10% |
| Cadmium | ND< 5.3 | 0.0 | 0.00 | ND< 1.18 | 0.00 | 0.00 | ND< 6.5 | 0.00 | 0.00 | ND< 0.07 | 0.0 | 0.00 | – | – | – | – |
| Chromium | 125 | 51.3 | 29.6 | 19.4 | 2.2 | 1.28 | 86.8 | 9.8 | 5.65 | 0.30 | 0.08 | 0.04 | 106.5 | 5.8 | 85% | 21% |
| Cobalt | 113.8 | 15.2 | 8.8 | 11.9 | 0.1 | 0.07 | 74.9 | 2.6 | 1.50 | ND< 0.2 | 0.00 | 0.00 | 87.1 | 1.50 | 77% | 6% |
| Copper | 324 | 31.56 | 18.22 | 31.8 | 1.5 | 0.89 | 231 | 3.0 | 1.7 | 1.3 | 0.22 | 0.13 | 264 | 2.0 | 81% | 5% |
| Lead | 195 | 44.1 | 25.4 | 22.0 | 17.43 | 10.06 | 180 | 25.6 | 14.8 | 0.4 | 0.02 | 0.01 | 202 | 17.9 | 103% | 16% |
| Manganese | 458 | 114 | 66.0 | 102.8 | 11.3 | 6.53 | 388 | 35.5 | 20.52 | 0.9 | 1.13 | 0.65 | 491 | 21.5 | 107% | 16% |
| Mercury (2) | 1.7 | 0.97 | 0.56 | ND< 0.24 | 0.00 | 0.00 | 1.19 | 0.70 | 0.40 | 0.41 | 0.23 | 0.13 | 1.84 | 0.43 | 110% | 45% |
| Molybdenum | 43.8 | 15.2 | 8.8 | ND< 2.36 | 0.00 | 0.00 | 22.6 | 8.6 | 4.94 | 0.3 | 0.15 | 0.089 | 25.2 | 4.94 | 58% | 16% |
| Nickel | 87.5 | 0.0 | 0.0 | 11.90 | 0.11 | 0.07 | 76.8 | 13.9 | 8.0 | 0.5 | 0.01 | 0.01 | 89.2 | 8.03 | 102% | 9% |
| Selenium (2) | 126.9 | 68.7 | 39.6 | ND< 86.2 | 0.00 | 0.00 | ND< 50.1 | 0.0 | 0.0 | ND< 0.07 | 0.00 | 0.00 | 136.3 | 0.00 | 107% | 34% |
| Phosphorus | 27,717 | 505 | 292 | 4,017 | 213 | 123 | 25,537 | 1,473 | 851 | 4.6 | 3.9 | 2.3 | 29,558 | 859 | 107% | 3% |
| Vanadium | 379 | 79.4 | 45.9 | 47.6 | 1.93 | 1.11 | 351 | 23.6 | 13.6 | 0.29 | 0.05 | 0.03 | 399 | 13.7 | 105% | 13% |
| Calcium | 187,017 | 48,206 | 27,832 | 34,893 | 8,065 | 4,656 | 184,627 | 12,455 | 7,191 | 28.6 | 9.43 | 5.45 | 219,548 | 8,567 | 117% | 18% |
| Sodium | 39,387 | 18,339 | 10,588 | 6,349 | 847 | 489 | 29,293 | 5,461 | 3,153 | 367 | 232 | 134 | 36,009 | 3,193 | 91% | 26% |
| | | | | | | | | | | | | | | | | |
| Chlorine, as Cl- (2) | 1,415 | 67 | 39 | 122.0 | 88.0 | 50.8 | ND< 325 | 0.00 | 0.00 | 719 | 86.1 | 49.7 | 1,166 | 71.1 | 82% | 6% |
| Fluorine, as F- | 7,381 | 441 | 254 | ND< 7.09 | 0.00 | 0.00 | 198 | 59.4 | 34.3 | 4,805 | 290 | 168 | 5,010 | 171 | 68% | 3% |
| Phosphorus, as PO4 3- | 84,995 | 1,550 | 895 | ND< 47 | 0.00 | 0.00 | ND< 1,298 | 0.00 | 0.00 | ND< 513 | 0.00 | 0.00 | -- | -- | – | – |
| Sulfur, as SO4 2- | 1,145,178 | 15,141 | 8,742 | 1,520 | 812 | 469 | 9,130 | 600 | 346 | 1,169,039 | 217,339 | 125,481 | 1,179,689 | 125,482 | 103% | 11% |
| | | | | | | | | | | | | | | **AVERAGE** | 89% | 15% |

*Notes:*
(1) ND not divided by two for mass balance calculations
(2) Fuel from INAA

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PRELIMINARY

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## BAGHOUSE UNCERTAINTY CALCULATIONS
## FOR
## SITE 115 - UREA INJECTION

| Element | Baghouse Inlet Gas (A) Average lb/10^12 Btu | Std. Dev. | Del(A) | | Baghouse Outlet Gas (B) Average lb/10^12 Btu | Std. Dev. | Del(B) | IN - OUT C=A-B lb/10^12 Btu | Baghouse efficiency Del(C) lb/10^12 Btu | D=C/A % | Del(D) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 12.8 | 6.00 | 3.46 | | 0.15 | 0.04 | 0.02 | 12.7 | 3.46 | 98.8% | 38% |
| Barium | 192 | 52 | 29.7 | | 1.05 | 1.1 | 0.65 | 191 | 30 | 99.5% | 22% |
| Beryllium | 7.46 | 1.12 | 0.65 | ND< | 0.02 | 0.0 | 0.00 | 7.44 | 0.6 | > 99.7% | 12% |
| Cadmium | 2.01 | 0.41 | 0.24 | ND< | 0.07 | 0.00 | 0.00 | 1.94 | 0.2 | > 96.5% | 16% |
| Chromium | 50.8 | 10.8 | 6.2 | | 0.3 | 0.1 | 0.04 | 50.5 | 6.2 | 99.4% | 17% |
| Cobalt | 26.3 | 5.1 | 2.95 | ND< | 0.2 | 0.00 | 0.00 | 26.1 | 2.9 | > 99.1% | 16% |
| Copper | 206 | 60.3 | 34.8 | | 1.34 | 0.22 | 0.13 | 204 | 34.8 | 99.3% | 24% |
| Lead | 45.6 | 28.1 | 16.2 | | 0.40 | 0.0 | 0.01 | 45.1 | 16.2 | 99.1% | 50% |
| Manganese | 88 | 24.5 | 14.1 | | 0.9 | 1.13 | 0.65 | 87 | 14.1 | 99.0% | 23% |
| Mercury | 1.88 | 1.32 | 0.76 | | 0.41 | 0.23 | 0.13 | 1.46 | 0.77 | 77.9% | 52% |
| Molybdenum | 11.7 | 1.30 | 0.75 | | 0.3 | 0.15 | 0.09 | 11.5 | 0.76 | 97.7% | 9% |
| Nickel | 29.4 | 7.9 | 4.6 | | 0.5 | 0.0 | 0.0 | 29 | 4.6 | 98.5% | 22% |
| Selenium | 11.91 | 7.18 | 4.15 | ND< | 0.07 | 0.00 | 0.00 | 11.8 | 4.15 | > 99.4% | 49% |
| Phosphorus | 9,296 | 1,605 | 926 | | 4.6 | 3.9 | 2.3 | 9,291 | 926 | 99.95% | 14% |
| Vanadium | 120 | 22 | 12 | | 0.29 | 0.05 | 0.03 | 120 | 12.4 | 99.8% | 15% |
| Calcium | 879 | 543 | 313 | | 28.6 | 9.43 | 5.45 | 851 | 314 | 96.8% | 50% |
| Sodium | 2,675 | 2,627 | 1,517 | | 367 | 232 | 134 | 2,308 | 1,523 | 86.3% | 75% |
| Chloride | 1,013 | 36 | 21 | | 719 | 86 | 50 | 294 | 54 | 29.0% | 5% |
| Fluoride | 5,781 | 295 | 170 | | 4,805 | 290 | 168 | 976 | 239 | 16.9% | 4% |
| Phosphate | 319 | 66 | 38 | ND< | 513 | 0.00 | 0.00 | -- | -- | -- | -- |
| Sulfate | 988,390 | 48,557 | 28,034 | | 1,169,039 | 217,339 | 125,481 | (180,649) | 128,574 | (18.3%) | (13%) |
| | lb/10^6 Btu | | | | lb/10^6 Btu | | | lb/10^6 Btu | lb/10^6 Btu | | |
| Particulates | 6.09 | 0.40 | 0.23 | | 0.0012 | 0.0010 | 0.00056 | 6.09 | 0.23 | 99.98% | 5.37% |

Notes:

(1) ND not divided by two for baghouse efficiency calculations

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## UNCERTAINTY CALCULATION FOR COAL ULTIMATE ANALYSIS SITE 115 PHASE I - BASELINE

| Species | Ultimate Analysis, % | | | Average | Uncertainty |
|---|---|---|---|---|---|
| | COAL 11/17 | COAL 11/18 | COAL 11/19 | | @ 95% C.I. |
| Moisture | 11.14 | 11.11 | 11.34 | 11.20 | 0.3 |
| C | 71.0 | 71.9 | 69.9 | 70.9 | 2.4 |
| H | 4.76 | 5.12 | 5.07 | 4.98 | 0.5 |
| O (by diff) | 11.5 | 10.7 | 13.4 | 11.8 | 3.4 |
| N | 1.81 | 1.78 | 1.78 | 1.79 | 0.04 |
| S | 0.53 | 0.49 | 0.46 | 0.49 | 0.09 |
| Ash | 10.45 | 10.00 | 9.38 | 9.94 | 1.3 |
| HHV, Btu/lb (dry) | 12,507 | 12,548 | 12,639 | 12,565 | 168 |
| HHV, Btu/lb (as rec'd) | 11,114 | 11,154 | 11,206 | 11,158 | 115 |
| F-factor, dscf/MMBtu | 9,693 | 9,902 | 9,481 | 9,692 | 523 |

Notes:
(1) C,H,O,N,S, and Ash results on a dry basis.

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**UNCERTAINTY CALCULATION FOR**
**COAL ULTIMATE ANALYSIS**
**SITE 115**
**PHASE II – BASELINE**

| Species | Ultimate Analysis, % | | | Average (1) | Uncertainty |
|---|---|---|---|---|---|
| | COAL 3/8 | COAL 3/9 | COAL 3/15 | | @ 95% C.I. |
| Moisture | 10.10 | 10.01 | 10.26 | 10.14 | 1.6 |
| C | 67.0 | 72.0 | 70.8 | 71.4 | 7.5 |
| H | 4.63 | 5.03 | 4.92 | 4.98 | 0.7 |
| O (by diff) | 11.67 | 11.36 | 12.0 | 11.7 | 3.8 |
| N | 1.57 | 1.79 | 1.80 | 1.80 | 0.1 |
| S | 0.60 | 0.52 | 0.67 | 0.60 | 1.0 |
| Ash | 14.52 | 9.30 | 9.83 | 9.57 | 3.4 |
| HHV, Btu/lb (dry) | 11,832 | 12,846 | 12,408 | 12,627 | 2,783 |
| HHV, Btu/lb (wet) | 10,637 | 11,560 | 11,135 | 11,348 | 2,701 |
| F-factor, dscf/MMBtu | 9,683 | 9,637 | 9,784 | 9,710 | 935 |

Notes:

(1) Average ultimate analysis results do not include sample "COAL 3/8," high ash value not consistent with previous fuel anaylses.

(2) C,H,O,N,S, and Ash results on a dry basis

**UNCERTAINTY CALCULATION FOR**
**COAL ULTIMATE ANALYSIS**
**SITE 115**
**PHASE II -- UREA INJECTION**

| Species | Ultimate Analysis, % | | | Average (2) | Uncertainty |
|---|---|---|---|---|---|
| | COAL 3/10 -- AM (1) | COAL 3/10 -- PM (1) | COAL 3/11 | | @ 95% C.I. |
| Moisture | 9.64 | 9.64 | 9.55 | 9.60 | 0.6 |
| C | 72.4 | 72.4 | 71.6 | 72.0 | 4.9 |
| H | 5.11 | 5.11 | 5.01 | 5.06 | 0.6 |
| O (by diff) | 10.99 | 10.99 | 11.2 | 11.1 | 1.5 |
| N | 1.87 | 1.87 | 1.80 | 1.84 | 0.4 |
| S | 0.49 | 0.49 | 0.48 | 0.49 | 0.1 |
| Ash | 9.13 | 9.13 | 9.84 | 9.49 | 4.5 |
| HHV, Btu/lb (dry) | 12,692 | 12,692 | 12,584 | 12,638 | 686 |
| HHV, Btu/lb (wet) | 11,468 | 11,468 | 11,382 | 11,425 | 548 |
| F-factor, dscf/MMBtu | 9,839 | 9,839 | 9,791 | 9,815 | 306 |

Notes:

(1) Ultimate analysis results for the morning and afternoon tests on 3/10 were from a composite of morning and afternoon fuel samples.

(2) Average ultimate analysis results calculated from the two different runs.

(3) C,H,O,N,S, and Ash results on a dry basis.

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PRELIMINARY

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# APPENDIX G
# QUALITY ASSURANCE AND QUALITY CONTROL DATA
# PHASES I AND II - BASELINE

This appendix presents detailed quality assurance and quality control (QA/QC) data for the Phase I and Phase II - Baseline FFDC inlet and outlet gas, coal, flyash and bottom ash samples. The QA/QC data includes results of duplicate samples, spiked samples and laboratory check standards (LCS). Additional QA/QC data such as instrument calibration data required by the sampling and analytical methodology is maintained by Carnot and the laboratory. QA/QC data is grouped by sample type and analysis. All data pertaining to an analysis is presented together. Analytical data and blank analyses are presented in Appendix H. QA/QC and analytical data for Phase II and urea injection samples are presented in Appendices I and J. QA/QC results for Baseline are presented in the following tables.

TABLE G-1
SUMMARY OF QUALITY CONTROL RESULTS FOR
SITE 115 PHASE I BASELINE
FFDC INLET AND OUTLET METALS ANALYSES

Duplicate Analysis Results:

| Element | Sample Value ug/train | Duplicate Value ug/train | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| 3-MTLS-IN | | | | | |
| Arsenic | 50 | NP | – | 10 | |
| Barium | 237 | 241 | 1.6 | 10 | |
| Beryllium | 36.8 | 37.6 | 2.1 | 10 | |
| Cadmium | 7.1 | 10.2 | 37 | 10 | Does not meet DQO |
| Chromium | 218 | 219 | 0.5 | 10 | |
| Cobalt | 129 | 139 | 7.8 | 10 | |
| Copper | 513 | 523 | 1.9 | 10 | |
| Lead | 98 | NP | – | 10 | |
| Manganese | 804 | 807 | 0.3 | 10 | |
| Mercury | | | | | |
| FH/HNO3 | 5.859 | 6.347 | 8.0 | 10 | Results for 1-Mtls-In |
| KMnO4 | 0.945 | 1.215 | 25 | 10 | Results for 1-Mtls-In, Does not meet DQO |
| Molybdenum | 54.6 | 52.5 | 3.8 | 10 | |
| Nickel | 129 | 141 | 8.6 | 10 | |
| Selenium | 88 | NP | – | 10 | (1) |
| Phosphorus | 51094 | 50750 | 0.7 | 10 | Results for 5-Mtls-In |
| Vanadium | 552 | 550 | 0.4 | 10 | |
| 1-MTLS-OUT | | | | | |
| Arsenic | 2.47 | 2.48 | 0.1 | 10 | Results for 5-Mtls -Out, (1) |
| Barium | 19.5 | 19.5 | 0.1 | 10 | |
| Beryllium | ND < 0.1 | ND < 0.1 | NC | 10 | |
| Cadmium | 0.96 | 1.0 | 6.2 | 10 | |
| Chromium | 4.0 | 3.6 | 11 | 10 | Does not meet DQO |
| Cobalt | ND < 1 | ND < 1 | NC | 10 | |
| Copper | 7.6 | 7.6 | 0.4 | 10 | |
| Lead | 6.6 | NP | – | 10 | |
| Manganese | 5.6 | 5.8 | 3.3 | 10 | |
| Mercury | | | | | |
| FH/HNO3 | ND < 0.5 | ND < 0.5 | NC | 10 | |
| KMnO4 | ND < 0.5 | ND < 0.5 | NC | 10 | |
| Molybdenum | 12.7 | 12.8 | 1.2 | 10 | |
| Nickel | 70.3 | 71.0 | 1.0 | 10 | |
| Selenium | 0.97 | 0.98 | 0.5 | 10 | Results for 5-Mtls -Out, (1) |
| Phosphorus | 31.36 | 30.70 | 2.1 | 10 | Results for 3-Mtls -Out |
| Vanadium | 1.9 | 2.1 | 8.6 | 10 | |

Notes:

(continued)

RPD: Relative Percent Difference

NC: Not Calculated

ND: Not Detected

NP: Not Performed

(1) Outlet arsenic and inlet and outlet selenium results are from ICP hydride analysis.

## TABLE G-1 (continued)
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I BASELINE FFDC INLET AND OUTLET METALS ANALYSES

**Spike Results:**

| Element | Predigestion Blank Spike % Recovery | 3-MTLS-IN Post-digestion Spike % Recovery | 1-MTLS-OUT Post-digestion Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic | 84 | MSA | 15 | 75-125 | Outlet result for 3-Mtls-Out, Does not meet DQO, (2) |
| Barium | 94 | 96 | 16 | 75-125 | Outlet does not meet DQO |
| Beryllium | 82 | 92 | 70 | 75-125 | 6-MTLS-OUT does not meet DQO |
| Cadmium | 90 | 99 | 59 | 75-125 | Outlet does not meet DQO |
| Chromium | 83 | 98 | 36 | 75-125 | Outlet does not meet DQO |
| Cobalt | 83 | 107 | 81 | 75-125 | |
| Copper | 94 | 96 | 80 | 75-125 | |
| Lead | NP | MSA | MSA | 75-125 | |
| Manganese | 84 | 94 | 116 | 75-125 | |
| Mercury | | | | | |
| FH/HNO3 | 88 | 115 | 103 | 75-125 | Inlet result for 1-Mtls-In |
| KMnO4 | 91 | 82 | 91 | 75-125 | Inlet result for 1-Mtls-In |
| Molybdenum | 88 | 90 | 80 | 75-125 | |
| Nickel | 83 | 107 | 76 | 75-125 | |
| Selenium | 105 | NP | NP | 75-125 | (2) |
| Phosphorus | NP | 124 | 78 | 75-125 | Inlet result for 5-Mtls-In, Outlet result for 3-Mtls-Out |
| Vanadium | 83 | 95 | 85 | 75-125 | |

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 109 | 92 | NP | 90-110 | (1) |
| Barium | 104 | 104 | 100 | 90-110 | |
| Beryllium | 102 | 98 | 95 | 90-110 | |
| Cadmium | 101 | 104 | 99 | 90-110 | |
| Chromium | 107 | 108 | 99 | 90-110 | |
| Cobalt | 105 | 103 | 98 | 90-110 | |
| Copper | 104 | 103 | 99 | 90-110 | |
| Lead | NP | MSA | MSA | 90-110 | |
| Manganese | 105 | 107 | 100 | 90-110 | |
| Mercury | | | | | |
| FH/HNO3 | 103 | 96 | 100 | 80-120 | |
| KMnO4 | 98 | 92 | NP | 80-120 | |
| Molybdenum | 96 | 98 | 93 | 90-110 | |
| Nickel | 105 | 101 | 98 | 90-110 | |
| Selenium | 108 | 104 | 224 | 90-110 | Final CCV does not meet DQO, (1) |
| Phosphorus | 99 | 107 | 108 | 90-110 | |
| Vanadium | 102 | 106 | 100 | 90-110 | |

Notes:

(continued)

MSA: Method of Standard Additions used because of poor spike recoveries

NP: Not Performed

(1) Outlet arsenic and inlet and outlet selenium results are from ICP hydride analysis

(2) Predigestion spikes were performed during arsenic and selenium ICP hydride analysis. Recoveries were 65% for arsenic and 44% for selenium.

**TABLE G-1 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE I BASELINE**
**FFDC INLET AND OUTLET METALS ANALYSES**

<u>Correlation Coefficients for MSA Data:</u>

| Sample ID | Arsenic r^2 | Lead r^2 | Data Quality Objective for MSA | Comments |
|---|---|---|---|---|
| LAB BLANK | 0.9999 | 0.9999 | 0.995 | |
| 1-MTLS-IN | 0.9947 | 0.9989 | 0.995 | Arsenic value does not meet DQO |
| 3-MTLS-IN | 0.9961 | 1.0000 | 0.995 | |
| 5-MTLS-IN | 0.9998 | 0.999 | 0.995 | |
| FB-MTLS-IN | 0.998 | 0.998 | 0.995 | |
| 1-MTLS-OUT | 0.9975 | 0.9988 | 0.995 | |
| 3-MTLS-OUT | 0.9902 | 0.9975 | 0.995 | Arsenic value does not meet DQO |
| 5-MTLS-OUT | 0.9988 | 0.9997 | 0.995 | |
| FB-MTLS-OUT | 0.9999 | 0.9993 | 0.995 | |
| RB-MTLS | 0.9978 | 0.9999 | 0.995 | |

Notes:
MSA: Method of Standard Additions; used because of poor spike recoveries

TABLE G-2
SUMMARY OF QUALITY CONTROL RESULTS
FOR SITE 115 PHASE I BASELINE
FFDC INLET AND OUTLET PAH ANALYSES

Duplicate Blank Matrix Spike Results:

| Component | Blank Matrix Spike #1 ug | Blank Matrix Spike #2 ug | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Naphthalene | NM | NM | -- | 50 | |
| Acenaphthylene | 0.20 | 0.19 | 5.1 | 50 | |
| Acenaphthene | 0.19 | 0.20 | 5.1 | 50 | |
| Fluorene | 0.20 | 0.18 | 11 | 50 | |
| Phenanthrene | 0.30 | 0.30 | 0.0 | 50 | |
| Anthracene | 0.20 | 0.20 | 0.0 | 50 | |
| Fluoranthene | 0.20 | 0.19 | 5.1 | 50 | |
| Pyrene | 0.20 | 0.20 | 0.0 | 50 | |
| Benz(a)anthracene | 0.20 | 0.20 | 0.0 | 50 | |
| Chrysene | 0.20 | 0.21 | 4.9 | 50 | |
| Benzo(b)fluoranthene | 0.18 | 0.18 | 0.0 | 50 | |
| Benzo(k)fluoranthene | 0.22 | 0.21 | 4.7 | 50 | |
| Benzo(a)pyrene | 0.18 | 0.18 | 0.0 | 50 | |
| Indeno(1,2,3-cd)pyrene | 0.20 | 0.19 | 5.1 | 50 | |
| Dibenzo(a,h)anthracene | 0.17 | 0.19 | 11 | 50 | |
| Benzo(g,h,i)perylene | 0.18 | 0.19 | 5.4 | 50 | |
| 2-Methylnaphthalene | NS | NS | -- | -- | |
| 7,12-Dimethylbenz(a)anthracene | NS | NS | -- | -- | |
| 3-Methylcholanthrene | NS | NS | -- | -- | |

Blank Matrix Spike Recoveries:

| Component | Blank Matrix Spike #1 % Recovery | Blank Matrix Spike #2 % Recovery | Average % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Naphthalene | NA | NA | -- | 50-150 | |
| Acenaphthylene | 100 | 95 | 97.5 | 50-150 | |
| Acenaphthene | 95 | 100 | 98 | 50-150 | |
| Fluorene | 100 | 90 | 95 | 50-150 | |
| Phenanthrene | 150 | 150 | 150 | 50-150 | |
| Anthracene | 100 | 100 | 100 | 50-150 | |
| Fluoranthene | 100 | 95 | 97.5 | 50-150 | |
| Pyrene | 100 | 100 | 100 | 50-150 | |
| Benz(a)anthracene | 100 | 105 | 103 | 50-150 | |
| Chrysene | 100 | 105 | 102.5 | 50-150 | |
| Benzo(b)fluoranthene | 90 | 90 | 90 | 50-150 | |
| Benzo(k)fluoranthene | 110 | 105 | 107.5 | 50-150 | |
| Benzo(a)pyrene | 90 | 90 | 90 | 50-150 | |
| Indeno(1,2,3-cd)pyrene | 100 | 95 | 98 | 50-150 | |
| Dibenzo(a,h)anthracene | 85 | 95 | 90 | 50-150 | |
| Benzo(g,h,i)perylene | 90 | 95 | 92.5 | 50-150 | |
| 2-Methylnaphthalene | NS | NS | NS | -- | |
| 7,12-Dimethylbenz(a)anthracene | NS | NS | NS | -- | |
| 3-Methylcholanthrene | NS | NS | NS | -- | |

RPD: Relative Percent Difference
NM: Not Meaningful; spike level used was too low
NS: Not Spiked

(continued)

**TABLE G-2 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS**
**FOR SITE 115 PHASE I BASELINE**
**FFDC INLET AND OUTLET PAH ANALYSIS**

| PAH Recovery Results | Method Blank | Average Blank Matrix Spike | Sample ID: FB-PAH-IN | 2-PAH-IN | 4-PAH-IN | 6-PAH-IN | FB-PAH-OUT | 2-PAH-OUT | 4-PAH-OUT | 3-PAH-OUT | Data Quality Objective for Spikes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Internal Recoveries, % | | | | | | | | | | | |
| (added pre-extraction) | | | | | | | | | | | |
| Napthalene-2H8 | 73 | 78 | 69 | 64 | 61 | 30* | 84 | 73 | 68 | 70 | 50-150 |
| Acenapthylene-2H8 | 77 | 91 | 74 | 72 | 76 | 50 | 90 | 76 | 60 | 73 | 50-150 |
| Acenapthene–2H10 | 78 | 90 | 82 | 79 | 88 | 59 | 87 | 75 | 79 | 82 | 50-150 |
| Fluorene-2H10 | 81 | 96 | 90 | 80 | 92 | 58 | 98 | 90 | 87 | 90 | 50-150 |
| Phenanthrene-2H10 | 79 | 88 | 88 | 58 | 60 | 47* | 100 | 85 | 81 | 85 | 50-150 |
| Anthracene-2H10 | 66 | 76 | 62 | 57 | 47* | 37* | 85 | 63 | 40* | 57 | 50-150 |
| Fluoranthene-2H10 | 91 | 102 | 88 | 62 | 52 | 39* | 120 | 97 | 77 | 73 | 50-150 |
| Pyrene-2H10 | 91 | 99 | 89 | 62 | 49* | 37* | 120 | 96 | 73 | 72 | 50-150 |
| Benz(a)anthracene-2H12 | 95 | 97 | 93 | 49* | 28* | 36* | 110 | 88 | 85 | 68 | 50-150 |
| Chrysene-2H12 | 92 | 89 | 84 | 49* | 28* | 34* | 110 | 82 | 84 | 61 | 50-150 |
| Benzo(b)fluoranthene-2H12 | 99 | 112 | 97 | 26* | 17* | 32* | 94 | 89 | 86 | 56 | 50-150 |
| Benzo(k)fluoranthene-2H12 | 87 | 90 | 75 | 15* | 8* | 17* | 81 | 54 | 59 | 54 | 50-150 |
| Benzo(a)pyrene-2H12 | 91 | 109 | 63 | 18* | 12* | INT | 77 | 58 | 34* | INT | 50-150 |
| Indeno(1,2,3-c,d)pyrene-2H12** | 92 | 117 | 100 | 2* | 8* | 5* | 130 | 97 | 92 | 93 | 50-150 |
| Dibenzo(a,h)anthracene-2H14** | 92 | 114 | 96 | 7* | 8* | 5* | 110 | 85 | 84 | 89 | 50-150 |
| Benzo(g,h,i)perylene-2H12** | 91 | 110 | 100 | 4* | 7* | 7* | 130 | 94 | 91 | 87 | 50-150 |
| Surrogate Recoveries, % | | | | | | | | | | | |
| (field spikes) | | | | | | | | | | | |
| Benzo(e)pyrene-2H12 | NS | NS | 92 | 37* | 26* | 23* | 92 | 86 | 86 | INT | 50-150 |
| Terphenyl-2H14 | NS | NS | 84 | 78 | 78 | 63 | 107 | 82 | 94 | 64 | 50-150 |

NS: Not Spiked
INT: Interference
* Results do not meet DQO
** Inlet sample results for these compounds are not recovery corrected.

## TABLE G-3
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I AND II BASELINE FFDC INLET AND OUTLET BENZENE AND TOLUENE ANALYSIS

**PHASE I**

Sample Duplicate Results:

| Component | Sample ID | Run # 1 ppb | Run #2 ppb | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|---|
| Benzene | 3A-VOC-IN | 0.47 | 0.46 | 2.2 | 20 | |
| | 3A-VOC-OUT | 1.22 | 1.46 | 18 | 20 | |
| Toluene | 3A-VOC-IN | 1.48 | 1.37 | 7.7 | 20 | |
| | 3A-VOC-OUT | 29.4 | 32.0 | 8.5 | 20 | |

Matrix Spike Results:

| Component | Sample ID | Expected Value ppb | Measured Value ppb | % Recovery | Data Quality Objective for spikes | Comments |
|---|---|---|---|---|---|---|
| Benzene | 3A-VOC-OUT | 48.9 | 42.4 | 87 | 70-130 | |
| Toluene | 3A-VOC-OUT | 75.7 | 72.6 | 96 | 70-130 | |

**PHASE II**

Sample Duplicate Results:

| Component | Sample ID | Run # 1 ppb | Run #2 ppb | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|---|
| Benzene | 8B-VOC-IN | 3.23 | 2.60 | 22 | 20 | Does not meet DQO |
| | 8A-VOC-OUT | 3.08 | 2.43 | 24 | 20 | Does not meet DQO |
| Toluene | 8B-VOC-IN | 19.3 | 18.8 | 2.6 | 20 | |
| | 8A-VOC-OUT | 40.8 | 46.9 | 14 | 20 | |

Matrix Spike Results:

| Component | Sample ID | Expected Value ppb | Measured Value ppb | % Recovery | Data Quality Objective for spikes | Comments |
|---|---|---|---|---|---|---|
| Benzene | 9A-VOC-IN | 27.4 | 32.8 | 120 | 70-130 | |
| | 9A-VOC-OUT | 25.4 | 28.0 | 110 | 70-130 | |
| Toluene | 9A-VOC-OUT | 52.5 | 48.0 | 91 | 70-130 | |
| | 9A-VOC-OUT | 39.3 | 36.6 | 93 | 70-130 | |

Notes:
RPD=Relative Percent Difference

## TABLE G-4
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I BASELINE FFDC INLET AND OUTLET FORMALDEHYDE ANALYSIS

**Sample Duplicate Results:**

| Sample ID | Sample ug/sample | Duplicate ug/sample | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| FB-A-IN | 3.04 | 2.67 | 13 | 10 | Does not meet DQO |
| 4C-FORM-IN #1 | 0.41 | 0.40 | 2.5 | 10 | |
| FB-C-OUT | 0.56 | 0.56 | 0.0 | 10 | |

**Spike Results:**

| Spike ID | Expected Value ug | Measured Value ug | % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Matrix spikes: | | | | | |
| 4A-FORM-IN #1 | 13.43 | 13.63 | 101 | 80-120 | |
| 4A-FORM-OUT #1 | 13.43 | 14.59 | 108 | 80-120 | |
| Field Spikes: | | | | | |
| Inlet | 5.0 | 10.83 | 217 | 60-140 | Does not meet DQO |
| Outlet | 5.0 | 5.34 | 107 | 60-140 | |
| Trip Spike | 5.0 | 6.98 | 140 | 60-140 | |

Notes:
RPD = Relative Percent Difference

**TABLE G-5**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE I BASELINE**
**FFDC INLET AND OUTLET PARTICULATE ANALYSES**

| Quality Control | Measured Value or Range | Data Quality Objective | Comments |
|---|---|---|---|
| Acetone Blank, mg/ml | 0.0000 | < =0.008 | |
| Balance Calibration Check, mg | | | |
| Total weight > 20 g | -0.1 to +0.2 | +/- 0.3 | |
| Total weight < 20 g | -0.1 to +0.1 | +/- 0.1 | |

Note: NBS traceable weights used for balance calibration check

## TABLE G-6
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I BASELINE FFDC INLET AND OUTLET ANIONS ANALYSIS

**Sample Duplicate Results:**

| Anion | Sample value mg/sample | Duplicate value mg/sample | RPD | Data Quality Objectives for Duplicates | Comments |
|---|---|---|---|---|---|
| Filter | | | | | |
| Chloride | ND < 0.03 | ND < 0.03 | NC | 15 | |
| Fluoride | 0.07 | 0.08 | 18 | 15 | Does not meet DQO |
| Phosphate | 0.18 | 0.19 | 0.2 | 15 | |
| Sulfate | 1.19 | 1.20 | 0.8 | 15 | |
| Front Half | | | | | |
| Chloride | ND < 0.03 | ND < 0.03 | NC | 15 | |
| Fluoride | ND < 0.02 | ND < 0.02 | NC | 15 | |
| Phosphate | ND < 0.1 | ND < 0.1 | NC | 15 | |
| Sulfate | 0.064 | 0.067 | 4.6 | 15 | |

**Spike Results:**

| Anion | Matrix Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|
| Filter | | | |
| Chloride | 72 | 80-120 | Does not meet DQO |
| Fluoride | 97 | 80-120 | |
| Phosphate | 93 | 80-120 | |
| Sulfate | 107 | 80-120 | |
| Front Half | | | |
| Chloride | 82 | 80-120 | |
| Fluoride | 118 | 80-120 | |
| Phosphate | 112 | 80-120 | |
| Sulfate | 88 | 80-120 | |

Note:
RPD= Relative Percent Difference
ND=Not Detected
NC=Not Calculated

(continued)

## TABLE G-6 (continued)
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I BASELINE FFDC INLET AND OUTLET ANIONS ANALYSIS

**Laboratory Check Standard Results:**

| Anion | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Calibration 1/19 | | | | | |
| Chloride | 100 | 99.2 | 102 | 95-105 | |
| Fluoride | 102 | 103 | 103 | 95-105 | |
| Phosphate | 103 | 105 | 107 | 95-105 | CCV#2 does not meet DQO |
| Sulfate | 101 | 104 | 106 | 95-105 | CCV#2 does not meet DQO |
| Calibration 1/20 | | | | | |
| Chloride | 97.3 | 99.3 | 104 | 95-105 | |
| Fluoride | 98.0 | 103 | 100 | 95-105 | |
| Phosphate | 100 | 103 | 105 | 95-105 | |
| Sulfate | 101 | 103 | 103 | 95-105 | |
| Calibration 1/22 | | | | | |
| Chloride | 96.0 | 97.6 | 97.5 | 95-105 | |
| Fluoride | 106.0 | 101 | 99.3 | 95-105 | ICV does not meet DQO |
| Phosphate | 101 | 102 | 103 | 95-105 | |
| Sulfate | 99.4 | 101 | 101 | 95-105 | |
| Calibration 1/27 | | | | | |
| Chloride | 92.8 | 92.1 | NP | 95-105 | ICV does not meet DQO |
| Fluoride | 97.1 | 103 | NP | 95-105 | |
| Phosphate | 97.2 | 96.7 | NP | 95-105 | |
| Sulfate | 98.1 | 98.2 | NP | 95-105 | |

NP=Not Performed

## TABLE G-7
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I BASELINE FFDC OUTLET RADIONUCLIDES ANALYSES

**Replicate Laboratory Control Sample Results(1):**

| Radionuclide | Current LCS value pCi/L | Mean LCS value pCi/L | RPD | Data Quality Objective for Duplicates |
|---|---|---|---|---|
| Uranium-234 | 3.15 | 2.9 | 8 | 20 |
| Uranium-235 | NP | -- | -- | 20 |
| Uranium-238 | 3.3 | 2.2 | 40* | 20 |
| Radium-226 | 3190 | 3110 | 2.5 | 20 |
| Radium-228(LCS#1) | 1758 | 2200 | 22* | 20 |
| Radium-228(LCS#2) | 1962 | 2200 | 11 | 20 |
| Lead-210(LCS#1) | 3130 | 3600 | 14 | 20 |
| Lead-210(LCS#2) | 3220 | 3600 | 11 | 20 |
| Polonium-210 (LCS #1) | 3.21 | 3.7 | 14 | 20 |
| Polonium-210 (LCS #2) | 3.27 | 3.7 | 12 | 20 |
| Thorium-228 | NP | -- | -- | 20 |
| Thorium-230 | 6.05 | 6.5 | 7.2 | 20 |
| Thorium-232 | NP | -- | -- | 20 |

**Laboratory Control Sample Recoveries:**

| Radionuclide | Expected Value pCi/L | Measured Value pCi/L | % Recovery | Data Quality Objective for LCS |
|---|---|---|---|---|
| Uranium-234 | 2.86 | 3.15 | 110 | 80-120 |
| Uranium-235 | -- | NP | -- | 80-120 |
| Uranium-238 | 2.86 | 3.3 | 115 | 80-120 |
| Radium-226 | 2973 | 3190 | 107 | 80-120 |
| Radium-228(LCS#1) | 2100 | 1758 | 84 | 80-120 |
| Radium-228(LCS#2) | 2100 | 1962 | 93 | 80-120 |
| Lead-210(LCS#1) | 3470 | 3130 | 90 | 80-120 |
| Lead-210(LCS#2) | 3470 | 3220 | 93 | 80-120 |
| Polonium-210 (LCS #1) | 3.8 | 3.21 | 84 | 80-120 |
| Polonium-210 (LCS #2) | 3.8 | 3.27 | 86 | 80-120 |
| Thorium-228 | -- | NP | -- | 80-120 |
| Thorium-230 | 6.89 | 6.05 | 88 | 80-120 |
| Thorium-232 | -- | NP | -- | 80-120 |

**Internal Spike Recoveries:**

| Sample ID | Uranium-232 | Radium-226 | Radium-228 | Lead-210 | Po-209 | Thorium-229 | Data Quality Objective for Spikes |
|---|---|---|---|---|---|---|---|
| | % Recovery | | | | | | |
| Laboratory Method Blank(#1,2) | 59 | 97,96 | NA | 63 | 34*,30* | NA | 50-150 |
| Laboratory Control Sample(#1,2) | 68 | 98 | NA | 38*,69 | 34*,62 | NA | 50-150 |
| Reagent Blank | 64 | 90 | 115 | 90 | 24* | 48* | 50-150 |
| 1-PM/AN-OUT | 64 | 89 | 104 | 73 | 24* | 48* | 50-150 |
| 3-PM/AN-OUT | 63 | 88 | 112 | 73 | 24* | 56 | 50-150 |
| 5-PM/AN-OUT | 54 | 91 | 104 | 50 | 14* | 50 | 50-150 |

Note: Sample results are corrected for internal spike recoveries

(1) Replicate LCS results are based on comparison of current LCS values to mean LCS values for previous 30 runs.

* Indicates results do not meet DQO

RPD: Relative Percent Difference

NP: Not Performed

NA: Not Available

## TABLE G-8
## SUMMARY OF QUALITY CONTROL RESULTS FOR
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET CYANIDE ANALYSIS

**Sample Duplicate Results:**

| Sample ID | Sample mg/L | Duplicate mg/L | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| 6C-IN-CN | 0.012 | 0.014 | 15 | 20 | |

**Spike Results:**

| Spike ID | Expected Value mg/L | Measured Value mg/L | % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| 6C-IN-CN | 0.25 | 0.234 | 94 | 75-125 | |

Notes:
RPD=Relative Percent Difference

**TABLE G-9**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II BASELINE**
**FFDC INLET TOTAL AND HEXAVALENT CHROMIUM ANALYSES**

**Duplicate Analysis Results:**

| Analyte | Sample ID | Sample Value ug/ml | Duplicate Value ug/ml | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|---|
| Chromium (VI) | 8B-CR-IN NaOH | 0.00324 | 0.00336 | 3.6 | 15 | |
| Total chromium | SRM WP481 | 0.0550 | 0.0567 | 3.0 | 10 | |

**Matrix Spike Analysis Results:**

| Analyte | Sample ID | Expected value ug/ml | Measured value ug/ml | % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|---|
| Chromium (VI) | 8B-CR-IN | 0.00200 | 0.00183 | 91.5 | 80-120 | |
| Total Chromium | SRM WP481 #1 | 0.0522 | 0.0550 | 105 | 75-125 | |
| | SRM WP481 #2 | 0.0522 | 0.0567 | 109 | 75-125 | |

**Laboratory Check Standard Results:**

| Analyte | Sample ID | Expected value ug/ml | Measured value ug/ml | % Recovery | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|---|
| Chromium (VI) | QC #1 | 0.00200 | 0.00191 | 95.5 | 95-105 | |
| | QC #2 | 0.00200 | 0.00182 | 91.0 | 95-105 | Does not meet DQO |
| Total Chromium | QC #1 | 0.0200 | 0.0209 | 105 | 90-110 | |

Notes:
RPD: Relative Percent Difference

## TABLE G-10
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II BASELINE MERCURY SPECIATION EVALUATION ANALYSES

**Replicate Analyses**

| Sample ID | Species | Replicate #1 ng/trap | Replicate #2 ng/trap | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|---|
| 14A-HG-IN | Hg(II) | 9.2 | 8.8 | 4.4 | 10 | |
| | Hg(0) | 12.3 | 11.3 | 8.5 | 10 | |
| 14A-HG-OUT | Hg(0) | 0.8 | 1.0 | 22 | 10 | Does not meet DQO |
| Coal (ng/sample) | Total Hg | 4.6 | 4.3 | 6.7 | 10 | |
| Flyash (ng/sample) | Total Hg | 105.2 | 107.4 | 2.1 | 10 | |

**Laboratory Check Standard Results**

| Sample ID | Reference (total Hg) ng/g | Measured (total Hg) ng/g | % Recovery | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| NBS 1630 (coal) | 127 | 93 | 73 | 90-110 | Does not meet DQO |
| NBS 1633 (ash) | 160 | 161 | 101 | 90-110 | |

Notes:
RPD: Relative Percent Difference

## TABLE G-11
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I COAL METALS ICP-AES,GFAAS AND CVAAS ANALYSES

**Spike Results:**

| Element | Predigestion Blank Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|
| Arsenic | 11 | 5 | 75-125 | Neither meet DQO |
| Barium | NP | 210 | 75-125 | Does not meet DQO |
| Beryllium | NP | 83 | 75-125 | |
| Cadmium | 29 | 88 | 75-125 | Blank spike does not meet DQO |
| Chromium | NP | 87 | 75-125 | |
| Cobalt | NP | 88 | 75-125 | |
| Copper | NP | 97 | 75-125 | |
| Lead | NP | 79 | 75-125 | |
| Manganese | NP | 85 | 75-125 | |
| Mercury | 106 | 98 | 75-125 | |
| Molybdenum | NP | 112 | 75-125 | |
| Nickel | NP | 87 | 75-125 | |
| Selenium | NP | 0 | 75-125 | Does not meet DQO |
| Phosphorus | 96 | 94 | 75-125 | |
| Vanadium | NP | 89 | 75-125 | |

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 99 | 106 | NP | 90-110 | |
| Barium | 102 | 99 | 98 | 90-110 | |
| Beryllium | 97 | 95 | 94 | 90-110 | |
| Cadmium | 98 | 96 | 88 | 90-110 | |
| Chromium | 104 | 101 | 100 | 90-110 | |
| Cobalt | 101 | 97 | 96 | 90-110 | |
| Copper | 102 | 101 | 99 | 90-110 | |
| Lead | 100 | 100 | NP | 90-110 | |
| Manganese | 104 | 100 | 99 | 90-110 | |
| Mercury | 103 | 99 | 103 | 80-120 | |
| Molybdenum | 104 | 101 | 99 | 90-110 | |
| Nickel | 103 | 98 | 94 | 90-110 | |
| Selenium | 97 | 104 | NP | 90-110 | |
| Phosphorus | 101 | 109 | NP | 90-110 | |
| Vanadium | 103 | 101 | 99 | 90-110 | |

NP: Not Performed

## TABLE G-12
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I COAL METALS AND CHLORINE INAA ANALYSIS

**Laboratory Check Standard Results**

NIST SRM 1571:

| Element | Reference Value ug/g | Measured Value ug/g | Recovery % | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic | 10 | 11 | 110 | 90-110 | |
| Barium | 44 | 48 | 109 | 90-110 | |
| Cadmium | -- | NP | -- | 90-110 | |
| Chlorine | NA | NA | -- | 90-110 | |
| Chromium | 2.6 | 2.9 | 112 | 90-110 | Does not meet DQO |
| Cobalt | -- | NP | -- | 90-110 | |
| Manganese | 91 | 93 | 102 | 90-110 | |
| Mercury (1) | 107 | 101 | 94 | 90-110 | |
| Selenium | -- | NP | -- | 90-110 | |

Note:
NP: Not Performed
NA: Not Available
(1) Mercury check standard results are for SRM 8408

## TABLE G-13
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE I COAL ULTIMATE AND ANION PRECURSOR ANALYSES

**Duplicate Analysis Results:**

| Component, % | Sample | Duplicate | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Moisture | 0.96 | 1.03 | 7.0 | 10 | |
| Carbon | 70.48 | 69.84 | 0.9 | 10 | |
| Hydrogen | 4.80 | 4.74 | 1.3 | 10 | |
| Nitrogen | 1.58 | 1.54 | 2.6 | 10 | |
| Sulfur | 0.50 | 0.50 | 0.0 | 10 | |
| Ash | 15.95 | 16.73 | 4.8 | 10 | |
| Dry Btu | 12539 | 12565 | 0.2 | 10 | |
| Chlorine | 0.06 | 0.06 | 0 | 10 | |
| Fluorine, ug/g | 54 | 50 | 7.7 | 10 | |

**Laboratory Check Standard Analysis:**

| Component | Reference LCS Value | Measured LCS Value | % Recovery | Data Quality objective for LCS | Comments |
|---|---|---|---|---|---|
| Moisture | NA | NA | -- | 90-110 | |
| Carbon | NA | NA | -- | 90-110 | |
| Hydrogen | NA | NA | -- | 90-110 | |
| Nitrogen | NA | NA | -- | 90-110 | |
| Sulfur | NA | NA | -- | 90-110 | |
| Ash | 8.76 | 8.7 | 99 | 90-110 | |
| HHV, cal | 2394.27 | 2393.99 | 100 | 90-110 | |
| Chlorine | -- | NA | -- | 90-110 | |
| Fluorine | 79 | 80 | 101 | 90-110 | |

RPD: Relative Percent Difference
NP: Not Performed
NA: Not Available

**TABLE G-14**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE I**
**COAL AND ASH RADIONUCLIDES ANALYSES**

**Duplicate Analyses:**

Bottom Ash 11/19

| Radionuclide | Sample Value pCi/g | Duplicate Value pCi/g | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Uranium-234 | 2.4 | 2.1 | 13 | 20 | |
| Uranium-235 | 0.1 | 0.1 | 0.0 | 20 | |
| Uranium-238 | 2.1 | 2.3 | 9.1 | 20 | |
| Radium-226 | 2.9 | 2.7 | 7 | 20 | |
| Radium-228 | 2.450 | 2.400 | 2.1 | 20 | |
| Lead-210 | 0.6 | 0.7 | 15 | 20 | |
| Polonium-210 | 0.4 | 0.3 | 29 | 20 | Does not meet DQO |
| Thorium-228 | 3.2 | 2.9 | 10 | 20 | |
| Thorium-230 | 3.0 | 2.6 | 14 | 20 | |
| Thorium-232 | 3.0 | 2.5 | 18 | 20 | |

**Duplicate Laboratory Control Sample Results(1):**

Solid

| Radionuclide | Current LCS Value pCi/g | Mean LCS Value pCi/g | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Uranium-234 | 8.7 | 7.7 | 12 | 20 | |
| Uranium-235 | NP | – | – | 20 | |
| Uranium-238 | 8.2 | 7.9 | 3.7 | 20 | |
| Radium-226 | 42.1 | 40 | 5.1 | 20 | |
| Radium-228 | NP | – | – | 20 | |
| Lead-210 | NP | – | – | 20 | |
| Polonium-210 (LCS #1) | 236 | NA | – | 20 | |
| (LCS #2) | 259 | NA | – | 20 | |
| Thorium-228 | NP | – | – | 20 | |
| Thorium-230 | NP | – | – | 20 | |
| Thorium-232 | 37 | 34 | 8 | 20 | |

Liquid

| Radionuclide | Sample Value pCi/L | Duplicate Value pCi/L | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Uranium-234 | 3150 | 2900 | 8 | 20 | |
| Uranium-235 | NP | – | – | 20 | |
| Uranium-238 | 3300 | 2200 | 40 | 20 | Does not meet DQO |
| Radium-226 (LCS #1) | 3190 | 3110 | 2.5 | 20 | |
| (LCS #2) | 3040 | 3110 | 2.3 | 20 | |
| Radium-228 (LCS #1) | 1758 | 2200 | 22 | 20 | Does not meet DQO |
| (LCS #2) | 1962 | 2200 | 11 | 20 | |
| (LCS #3) | 2480 | 2200 | 12 | 20 | |
| (LCS #4) | 2281 | 2200 | 3.6 | 20 | |
| Lead-210 (LCS #1) | 3130 | 3600 | 14 | 20 | |
| (LCS #2) | 3220 | 3600 | 11 | 20 | |
| Polonium-210 (LCS #1) | 320 | 280 | 13 | 20 | |
| (LCS #2) | 330 | 280 | 16 | 20 | |
| Thorium-228 | NP | – | – | 20 | |
| Thorium-230 | 7390 | 6500 | 13 | 20 | |
| Thorium-232 | NP | – | – | 20 | |

Note:
(1) Replicate LCS results are based on comparison of current LCS values to mean LCS value for previous 30 runs.
RPD: Relative Percent Difference
NP: Not Performed

(continued)

**TABLE G-14 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE I**
**COAL AND ASH RADIONUCLIDES ANALYSES**

Internal Spike Recoveries:

| Sample ID | Uranium-232 | Radium-226 | Radium-228 | Lead-210 | Po-209 | Thorium-229 | Data Quality Objective for Spikes |
|---|---|---|---|---|---|---|---|
| | | | % Recovery | | | | |
| Laboratory Method Blank (Solid,Liquid)** | NP, 59 | NP, 95 | NP, 109 | NP, 53 | 41*, 32* | 45*, 59 | 50-150 |
| Laboratory Control Sample (Solid,Liquid)** | NP, 68 | NP, 97 | NP, 112 | NP, 54 | 23*, 48* | 63, 24* | 50-150 |
| Coal 11/17 | 46* | 96 | 129 | 71 | 20* | 50 | 50-150 |
| Coal 11/18 | 40* | 100 | 124 | 64 | 12* | 54 | 50-150 |
| Coal 11/19 | 46* | 94 | 103 | 71 | 13* | 54 | 50-150 |
| Flyash 11/17 | 68 | 92 | 118 | 19* | 14* | 48* | 50-150 |
| Flyash 11/18 | 70 | 99 | 145 | 50 | 6.2* | 59 | 50-150 |
| Flyash 11/19 | 63 | 98 | 160* | 64 | 7.4* | 59 | 50-150 |
| Bottom ash 11/17 | 71 | 99 | 133 | 67 | 31* | 52 | 50-150 |
| Bottom ash 11/18 | 57 | 97 | 124 | 49* | 18* | 50 | 50-150 |
| Bottom ash 11/19 | 61 | 97 | 136 | 60 | 13* | 55 | 50-150 |
| Sluice Water Blank 11/17 | 82 | 89 | 85 | 18* | 26* | 38* | 50-150 |
| Sluice Water Blank 11/18 | 93 | 88 | 96 | 27* | 17* | 33* | 50-150 |
| Sluice Water Blank 11/19 | 81 | 91 | 100 | 28* | 16* | 34* | 50-150 |

Laboratory Control Sample Recoveries (2):

| Component | Solid LCS % Recovery | Liquid LCS % Recovery | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|
| Uranium-234 | 106 | 110 | 80-120 | |
| Uranium-235 | -- | -- | 80-120 | |
| Uranium-238 | 100 | 115 | 80-120 | |
| Radium-226 | 111 | 105 | 80-120 | |
| Radium-228 | -- | 99 | 80-120 | |
| Lead-210 | -- | 92 | 80-120 | |
| Polonium-210 | 98 | 86 | 80-120 | |
| Thorium-228 | -- | -- | 80-120 | |
| Thorium-230 | -- | 107 | 80-120 | |
| Thorium-232 | 106 | -- | 80-120 | |

Notes:
NP: Not Performed
(2) When more than one LCS was performed, result is the average recovery.

## TABLE G-15
## SUMMARY OF QUALITY CONTROL RESULTS FOR
## SITE 115 PHASE I
## FLYASH AND BOTTOM ASH (SOLID) METALS ANALYSIS (1)

**Spike Results:**

| Element | Predigestion Blank Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|
| Arsenic | NP | 81 | 75-125 | |
| Barium | 102 | NP | 75-125 | |
| Beryllium | 112 | NP | 75-125 | |
| Cadmium | 113 | NP | 75-125 | |
| Chromium | 104 | NP | 75-125 | |
| Cobalt | 100 | NP | 75-125 | |
| Copper | 107 | NP | 75-125 | |
| Lead | NP | 77 | 75-125 | |
| Manganese | 103 | NP | 75-125 | |
| Mercury | 106 | NP | 75-125 | |
| Molybdenum | 100 | NP | 75-125 | |
| Nickel | 98 | NP | 75-125 | |
| Selenium | 104 | 61 | 75-125 | Sample spike does not meet DQO |
| Phosphorus | 96 | NP | 75-125 | |
| Vanadium | 101 | NP | 75-125 | |

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 100 | 107 | NP | 90-110 | |
| Barium | 101 | 105 | 104 | 90-110 | |
| Beryllium | 96 | 100 | 100 | 90-110 | |
| Cadmium | 101 | 96 | 96 | 90-110 | |
| Chromium | 103 | 105 | 105 | 90-110 | |
| Cobalt | 101 | 103 | 104 | 90-110 | |
| Copper | 101 | 105 | 104 | 90-110 | |
| Lead | 100 | 100 | NP | 90-110 | |
| Manganese | 103 | 106 | 107 | 90-110 | |
| Mercury | 103 | 90 | 95 | 80-120 | |
| Molybdenum | 98 | 101 | 102 | 90-110 | |
| Nickel | 99 | 101 | 103 | 90-110 | |
| Selenium | 107 | 108 | 108 | 90-110 | |
| Phosphorus | 101 | 105 | 103 | 90-110 | |
| Vanadium | 102 | 106 | 107 | 90-110 | |

NP: Not Performed

(1) Bottom ash samples consisted of solid and liquid fractions. Quality assurance results for the liquid fraction analysis are presented in Tab

TABLE G-16
SUMMARY OF QUALITY CONTROL RESULTS FOR
SITE 115 PHASE I
BOTTOM ASH (LIQUID) AND SLUICE WATER BLANK METALS ANALYSES (1)

**Spike Results:**

| Element | Predigestion Blank Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|
| Arsenic | 100 | 90 | 75-125 | |
| Barium | 101 | NP | 75-125 | |
| Beryllium | 101 | NP | 75-125 | |
| Cadmium | 112 | NP | 75-125 | |
| Chromium | 103 | NP | 75-125 | |
| Cobalt | 105 | NP | 75-125 | |
| Copper | 100 | NP | 75-125 | |
| Lead | 115 | NP | 75-125 | |
| Manganese | NP | NP | 75-125 | |
| Mercury | 97 | NP | 75-125 | |
| Molybdenum | 101 | NP | 75-125 | |
| Nickel | 101 | NP | 75-125 | |
| Selenium | 108 | 62 | 75-125 | Sample spike does not meet DQO |
| Phosphorus | 113 | NP | 75-125 | |
| Vanadium | 101 | NP | 75-125 | |

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 109 | 99 | 93 | 90-110 | |
| Barium | 101 | 105 | 104 | 90-110 | |
| Beryllium | 96 | 100 | 100 | 90-110 | |
| Cadmium | 101 | 96 | 96 | 90-110 | |
| Chromium | 103 | 105 | 105 | 90-110 | |
| Cobalt | 101 | 103 | 104 | 90-110 | |
| Copper | 101 | 105 | 104 | 90-110 | |
| Lead | 100 | 100 | NP | 90-110 | |
| Manganese | 103 | 106 | 107 | 90-110 | |
| Mercury | 102 | 98 | 95 | 80-120 | |
| Molybdenum | 98 | 101 | 102 | 90-110 | |
| Nickel | 99 | 101 | 103 | 90-110 | |
| Selenium | 103 | 106 | 97 | 90-110 | |
| Phosphorus | 100 | 104 | 101 | 90-110 | |
| Vanadium | 102 | 106 | 107 | 90-110 | |

Notes:
NP: Not Performed
(1) Bottom ash samples consisted of solid and liquid fractions. Quality assurance results for the solid fraction are presented in Table G-13.

## TABLE G-17
## SUMMARY OF QUALITY CONTROL RESULTS FOR
## SITE 115 PHASE I
## FLYASH AND BOTTOM ASH ANIONS ANALYSIS

**Sample Duplicate Results:**

| Anion | Sample value mg/kg | Duplicate value mg/kg | RPD | Data Quality Objectives for Duplicates | Comments |
|---|---|---|---|---|---|
| FLYASH 11/19 | | | | | |
| Chloride | 13.05 | 13.53 | 3.6 | 15 | |
| Fluoride | 34.06 | 34.26 | 0.6 | 15 | |
| Phosphate | ND < 20 | ND < 20 | NC | 15 | |
| Sulfate | 836.8 | 847.90 | 1.3 | 15 | |

**Spike Results:**

| Anion | Matrix Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|
| FLYASH 11/19 | | | |
| Chloride | 133 | 80-120 | Does not meet DQO |
| Fluoride | 126 | 80-120 | Does not meet DQO |
| Phosphate | 64 | 80-120 | Does not meet DQO |
| Sulfate | 132 | 80-120 | Does not meet DQO |

**Laboratory Check Standard Results:**

| Anion | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Calibration 1/22 | | | | | |
| Chloride | 97.6 | 97.5 | 96.1 | 95-105 | |
| Fluoride | 101 | 99.3 | 99.4 | 95-105 | |
| Phosphate | 102 | 102 | 102 | 95-105 | |
| Sulfate | 101 | 101 | 100 | 95-105 | |
| Calibration 1/25 | | | | | |
| Fluoride | 95.8 | 95.8 | NP | 95-105 | |
| Phosphate | 98.5 | 97.8 | NP | 95-105 | |
| Sulfate | 98.4 | 98.3 | NP | 95-105 | |

Note:
RPD= Relative Percent Difference
NC: Not Calculated
NP: Not Performed
ND=Not Detected

# APPENDIX H
# ANALYTICAL AND BLANK CORRECTION DATA
# PHASES I AND II - BASELINE

This Appendix contains summary tables of the laboratory analysis results for the Phase I and Phase II Baseline FFDC inlet and outlet gas, coal, flyash and bottom ash samples. These tables include the analytical results obtained for field blanks, reagent blanks and laboratory preparation blanks. Field blanks are a sampling train that is set-up and recovered at the test site using the same procedure as an actual sample. In general, field blanks are not used to correct the result but do indicate the level of the analyte present in the sample train introduced by the recovery procedures. Reagent blanks are collected in the field and consist of reagents and filters used for each sample train. Laboratory preparation blanks consist only of the chemicals needed to decompose and analyze the samples. All blanks are carried through the entire analytical procedure. Corrections to the data for reagent or preparation blanks are noted. The blank correction contribution is the percentage of an analyte that was subtracted from the original value. For a series of tests the blank correction contribution is calculated as

$$\frac{\sum_{i=1}^{n_i} \left( \frac{Amount\ of\ blank\ correction}{Original\ sample\ value} \ x\ 100 \right)}{n}$$

For example, the Phase I FFDC inlet mercury result for the $FH/HNO_3$ fraction was corrected for the $FH/HNO_3$ reagent blank of 0.4 $\mu$g. Raw data for the test series were 6, 4 and 3.5 mg/train. The blank correction contribution is calculated as

$$\frac{\left(\frac{0.4}{6}\ x\ 100\right) + \left(\frac{0.4}{4}\ x\ 100\right) + \left(\frac{0.4}{3.5}\ x\ 100\right)}{3}$$

or

$$\frac{(6.7\% + 10\% + 11.4\%)}{3}$$

or

$$9\%$$

Blank corrections in no case bring the sample value below the reporting limit.

Tables in this Appendix include:

H-1 Trace Metals Analytical Results Summary

H-2 PAH Analytical Results Summary

H-3 Benzene and Toluene Analytical Results Summary

H-4 Formaldehyde Analytical Results Summary

H-5 Particulate Analytical Results Summary

## TABLE H-1
## TRACE METALS ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET

| Element | Laboratory Prep Blank ug | Reagent Blank ug | Field Blank | 1-MTLS-IN | 3-MTLS-IN | 5-MTLS-IN | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|---|---|
| | | | ug/train | | | | |
| Arsenic | ND < 0.3 | ND < 3 | 3.4 | 90 | 50 | 100 | 0 |
| Barium | 3 | 12 | 21 | 650 | 240 | 1600 | 2.5 |
| Beryllium | ND < 0.1 | ND < 0.1 | ND < 0.1 | 18 | 37 | 38 | 0 |
| Cadmium | ND < 0.3 | ND < 0.3 | 0.4 | 6.6 | 7 | 10 | 0 |
| Chromium | ND < 0.6 | 1.4 | 2.8 | 100 | 220 | 200 | 0.9 |
| Cobalt | ND < 1 | ND < 0.9 | ND < 1 | 58 | 130 | 120 | 0 |
| Copper | ND < 0.6 | 1.7 | 8.1 | 670 | 510 | 580 | 0.3 |
| Lead | 0.2 | 4.4 | 4.8 | 400 | 98 | 180 | 2.7 |
| Manganese | ND < 0.8 | 0.8 | 2.2 | 400 | 800 | 810 | 0.1 |
| Mercury - FH/HNO3 | ND < 0.4 | 0.4 | 1 | 6 | 4 | 3.5 | 9.4 |
| Mercury - KMnO4 | ND < 0.4 | ND < 0.4 | ND < 0.5 | 0.9 | ND < 0.5 | ND < 0.6 | 0 |
| Molybdenum | ND < 0.8 | 15 | 14 | 36 | 55 | 65 | 31 |
| Nickel | ND < 2 | ND < 2 | 3 | 52 | 130 | 130 | 0 |
| Selenium | ND < 0.3 | ND < 3 | ND < 0.2 | 63 | 88 | 80 | 0 |
| Phosphorus | ND < 5 | ND < 5 | ND < 5 | 48000 | 49000 | 51000 | 0 |
| Vanadium | ND < 0.6 | 0.6 | 1 | 270 | 550 | 580 | 0.1 |

Notes: Reagent blanks were used for blank correction for final results.
ND: Not Detected

(continued)

TABLE H-1 (continued)
TRACE METALS ANALYTICAL RESULTS SUMMARY
SITE 115 PHASE I BASELINE
FFDC OUTLET

| Element | Laboratory Prep Blank ug | Reagent Blank ug | Field Blank | 1-MTLS-OUT | 3-MTLS-OUT | 5-MTLS-OUT | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|---|---|
| | | | ug/train | | | | |
| Arsenic | ND < 0.3 | ND < 3 | 3.0 | 1.7 | 6.4 | 2.5 | 0 |
| Barium | 3 | 12 | 16 | 20 | 14 | 18 | 71 |
| Beryllium | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | 0 |
| Cadmium | ND < 0.3 | ND < 0.3 | ND < 0.3 | 1 | 0.5 | ND < 0.3 | 0 |
| Chromium | ND < 0.6 | 1.4 | 2.1 | 4 | 3.9 | 6 | 32 |
| Cobalt | ND < 1 | ND < 0.9 | ND < 1 | ND < 1 | ND < 1 | ND < 1 | 0 |
| Copper | ND < 0.6 | 1.7 | 5.3 | 7.6 | 7.4 | 5.6 | 25 |
| Lead | 0.2 | 4.4 | 2.2 | 6.6 | 5 | 4 | 59 |
| Manganese | ND < 0.8 | 0.8 | 1.3 | 5.6 | 7.5 | 3.3 | 16 |
| Mercury - FH/HNO3 | ND < 0.4 | 0.4 | ND < 0.9 | ND < 0.5 | ND < 1 | ND < 1 | 0 |
| Mercury - KMnO4 | ND < 0.4 | ND < 0.4 | ND < 0.5 | ND < 0.5 | ND < 0.6 | ND < 0.5 | 0 |
| Molybdenum | ND < 0.8 | 15 | 14 | 13 | 14 | 13 | 94 |
| Nickel | ND < 2 | ND < 2 | ND < 2 | 70 | 9 | 5 | 0 |
| Selenium | ND < 0.3 | ND < 3 | 0.2 | 1.5 | 2.6 | 1.0 | 0 |
| Phosphorus | ND < 5 | ND < 5 | ND < 5 | 29 | 31 | 35 | 0 |
| Vanadium | ND < 0.6 | 0.6 | 0.6 | 1.9 | 1.2 | 2.1 | 37 |

Notes: Reagent blanks were used for blank correction for final results.
ND: Not Detected

(continued)

# TABLE H-2
## PAH ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET

| Compound | Laboratory Method Blank | Sample ID | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FB-PAH-IN | 2-PAH-IN | 4-PAH-IN | 6-PAH-IN | FB-PAH-OUT | 2-PAH-OUT | 4-PAH-OUT | 6-PAH-OUT |
| | ug | ug/train | | | | | | | |
| Naphthalene | 0.98 | ND < 0.98 | 0.82 | 0.64 | 1.1 | 1.8 | 1.2 | 0.87 | 1.2 |
| Acenaphthylene | ND< 0.032 | ND < 0.032 | ND < 0.032 | ND < 0.030 | ND < 0.09 | ND < 0.089 | ND < 0.031 | ND < 0.031 | ND < 0.030 |
| Acenaphthene | ND< 0.035 | ND < 0.043 | ND < 0.038 | ND < 0.034 | ND < 0.033 | ND < 0.071 | ND < 0.039 | ND < 0.032 | ND < 0.052 |
| Fluorene | ND< 0.016 | 0.025 | 0.041 | 0.036 | 0.041 | 0.043 | 0.041 | 0.036 | ND < 0.046 |
| Phenanthrene | 0.38 | ND < 0.38 | ND < 0.38 | ND < 0.38 | ND < 0.50 | ND < 0.38 | ND < 0.38 | ND < 0.38 | ND < 0.50 |
| Anthracene | ND< 0.055 | ND < 0.020 | ND < 0.051 | ND < 0.026 | ND < 0.052 | ND < 0.041 | 0.035 | ND < 0.048 | ND < 0.023 |
| Fluoranthene | ND< 0.082 | ND < 0.080 | ND < 0.081 | ND < 0.089 | ND < 0.081 | ND < 0.081 | ND < 0.081 | ND < 0.081 | ND < 0.083 |
| Pyrene | ND< 0.082 | ND < 0.082 | ND < 0.084 | ND < 0.092 | ND < 0.083 | ND < 0.082 | ND < 0.081 | ND < 0.082 | ND < 0.083 |
| Benz(a)anthracene | ND< 0.050 | ND < 0.052 | ND < 0.050 | ND < 0.056 | ND < 0.11 | ND < 0.052 | ND < 0.051 | ND < 0.053 | ND < 0.050 |
| Chrysene | ND< 0.051 | ND < 0.051 | ND < 0.050 | ND < 0.055 | ND < 0.10 | ND < 0.052 | ND < 0.051 | ND < 0.050 | ND < 0.050 |
| Benzo(b)fluoranthene | ND< 0.021 | 0.025 | ND < 0.029 | ND < 0.065 | ND < 0.082 | ND < 0.041 | ND < 0.020 | ND < 0.028 | ND < 0.051 |
| Benzo(k)fluoranthene | ND< 0.030 | ND < 0.032 | ND < 0.057 | ND < 0.26 | ND < 0.19 | ND < 0.034 | ND < 0.037 | ND < 0.038 | ND < 0.064 |
| Benzo(a)pyrene | ND< 0.033 | ND < 0.030 | ND < 0.15 | ND < 0.21 | ND < 0.030* | ND < 0.034 | ND < 0.031 | ND < 0.090* | ND < 0.030 |
| Indeno(1,2,3-cd)pyrene | ND< 0.095 | ND < 0.089 | ND < 0.080* | ND < 0.080* | ND < 0.080* | ND < 0.093 | ND < 0.093 | ND < 0.16 | ND < 0.14 |
| Dibenzo(a,h)anthracene | ND< 0.14 | ND < 0.10 | ND < 0.10* | ND < 0.10* | ND < 0.10* | ND < 0.11 | ND < 0.11 | ND < 0.19 | ND < 0.16 |
| Benzo(g,h,i)perylene | ND< 0.10 | ND < 0.087 | ND < 0.10* | ND < 0.080* | ND < 0.080* | ND < 0.087 | ND < 0.084 | ND < 0.13 | ND < 0.12 |
| 2-Methylnaphthalene | ND< 0.019* | 0.043* | 0.11* | 0.071* | 0.042* | 0.64* | 0.18* | 0.067* | 0.078* |
| 7,12-Dimethylbenz(a)anthracene | ND< 0.020* | ND < 0.020* | ND < 0.067* | ND < 0.010* | ND < 0.13* | ND < 0.023* | ND < 0.020* | ND < 0.020* | ND < 0.010* |
| 3-Methylcholanthrene | ND< 0.039* | ND < 0.020* | ND < 0.40* | ND < 0.020* | ND < 0.40* | ND < 0.020* | ND < 0.020* | ND < 0.020* | ND < 0.020* |

Note: Naphthalene results were method blank corrected by the laboratory. Average blank correction contribution is 54% for the inlet and 48% for the outlet.
Sample results are recovery-corrected except where indicated.
ND: Not Detected
* Results are not recovery-corrected.

**TABLE H-3**
**BENZENE AND TOLUENE**
**ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE I AND II BASELINE**
**FFDC INLET AND OUTLET**

| **PHASE I** | | Sample | Pretest Tedlar |
|---|---|---|---|
| Compound | Sample I.D. | Concentration ppb, v/v | Bag Blank ppb, v/v |
| Benzene | 2B-VOC-IN | 0.60 | 0.045 |
| | 2C-VOC-IN | ND < 0.26 | 0.045 |
| | 3A-VOC-IN | 0.46 | 0.045 |
| | 2B-VOC-OUT | 0.69 | 0.045 |
| | 2C-VOC-OUT | 0.88 | 0.045 |
| | 3A-VOC-OUT | 1.34 | 0.045 |
| Toluene | 2B-VOC-IN | 3.78 | 0.29 |
| | 2C-VOC-IN | 1.42 | 0.29 |
| | 3A-VOC-IN | 1.42 | 0.29 |
| | 2B-VOC-OUT | 43.8 | 0.29 |
| | 2C-VOC-OUT | 23.1 | 0.29 |
| | 3A-VOC-OUT | 30.7 | 0.29 |
| **PHASE II** | | | |
| Compound | Sample I.D. | ppb, v/v | ppb, v/v |
| Benzene | 8B-VOC-IN | 2.92 | 0.14 |
| | 9A-VOC-IN | 3.96 | 0.14 |
| | 9B-VOC-IN | 4.61 | 0.14 |
| | 8A-VOC-OUT | 2.76 | 0.14 |
| | 9A-VOC-OUT | 2.53 | 0.14 |
| | 9B-VOC-OUT | 1.80 | 0.14 |
| Toluene | 8B-VOC-IN | 19.1 | 12.8 |
| | 9A-VOC-IN | 33.30 | 12.8 |
| | 9B-VOC-IN | 12.50 | 12.8 |
| | 8A-VOC-OUT | 43.8 | 12.8 |
| | 9A-VOC-OUT | 54.1 | 12.8 |
| | 9B-VOC-OUT | 18.7 | 12.8 |

Note: Results are not blank corrected.
ND: Not Detected

## TABLE H-4
## FORMALDEHYDE ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET

**Pretest Reagent Blanks:**

| Run # | ug/ml |
|---|---|
| 1 | 0.014 |
| 2 | 0.011 |
| 3 | 0.011 |
| 4 | 0.011 |

**Trip Blank:**

| Sample I.D. | ug/sample |
|---|---|
| Trip Blank | 0.34 |

**Field Blanks:**

| Sample I.D. | ug/sample |
|---|---|
| FB-A-IN | 4.41 |
| FB-B-IN | 2.24 |
| FB-C-IN | 4.99 |
| FB-A-OUT | 2.93 |
| FB-B-OUT | 1.19 |
| FB-C-OUT | 1.46 |

**Samples:**

| Sample I.D. | ug/sample |
|---|---|
| 4A-FORM-IN | 1.43 |
| 4B-FORM-IN | 1.56 |
| 4C-FORM-IN | 1.86 |
| 4A-FORM-OUT | 1.46 |
| 4B-FORM-OUT | 3.17 |
| 4C-FORM-OUT | 1.45 |

Note: Results are not blank corrected.

## TABLE H-5
## PARTICULATE ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET

| | Sample ID | | | | | |
|---|---|---|---|---|---|---|
| Particulate Catch , mg | 1-PM/AN-IN | 3-PM/AN-IN | 5-PM/AN-IN | 1-PM/AN-OUT | 3-PM/AN-OUT | 5-PM/AN-OUT |
| Filter | 521.6 | 198.4 | 56.5 | 0.0 | 0.1 | 0.0 |
| Probe/nozzle wash | 19428.9 | 20098.8 | 14217.2 | 2.3 | 16.6 | 7.7 |
| Acetone blank | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 19950.5 | 20297.2 | 14273.7 | 2.3 | 16.7 | 7.7 |

## TABLE H-6
## ANIONS ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET

| Anion Distribution, mg | Sample ID: Reagent Blank (1) | 1-PM/AN-IN | 3-PM/AN-IN | 5-PM/AN-IN | Blank correction Contribution, % Average | 1-PM/AN-OUT | 3-PM/AN-OUT | 5-PM/AN-OUT | Blank correction Contribution, % Average |
|---|---|---|---|---|---|---|---|---|---|
| **Chloride:** | | | | | | | | | |
| front-half rinse | ND < 0.06 | ND< 0.13 | 0.78 | ND< 0.13 | 0.0 | ND< 0.06 | 0.10 | ND< 0.06 | 0.0 |
| filter | ND < 0.12 | 0.06 | ND< 0.06 | ND< 0.06 | 0.0 | ND< 0.12 | ND< 0.12 | ND< 0.12 | 0.0 |
| bicarbonate/carbonate fraction | ND < 0.10 | 2.0 | 1.6 | 2.0 | 0.0 | 3.2 | 2.9 | 1.1 | 0.0 |
| 3% peroxide fraction (2) | 0.56 | 0.47 | ND< 0.42 | 0.52 | NC | ND< 0.39 | 0.30 | ND< 0.44 | NC |
| **Fluoride:** | | | | | | | | | |
| front-half rinse | ND < 0.04 | 1.5 | 1.75 | 0.88 | 0.0 | ND< 0.04 | ND< 0.04 | ND< 0.04 | 0.0 |
| filter | ND < 0.08 | 0.2 | 0.16 | 0.14 | 0.0 | 0.16 | 0.16 | 0.16 | 0.0 |
| bicarbonate/carbonate fraction | ND < 0.06 | 17 | 12.8 | 14.3 | 0.0 | 28.0 | 22.6 | 7.8 | 0.0 |
| 3% peroxide fraction | ND < 0.06 | NB | NB | NB | 0.0 | NB | NB | NB | 0.0 |
| **Phosphate:** | | | | | | | | | |
| front-half rinse | ND <0.2 | ND< 0.5 | ND< 0.5 | ND< 0.5 | 0.0 | ND< 0.2 | ND< 0.2 | ND< 0.2 | 0.0 |
| filter | ND <0.4 | 0.2 | 0.4 | 0.4 | 0.0 | ND< 0.4 | ND< 0.4 | ND< 0.4 | 0.0 |
| bicarbonate/carbonate fraction | ND <0.4 | ND< 6.8 | 6.4 | 1.4 | 0.0 | ND< 8.0 | ND< 6.5 | ND< 1.8 | 0.0 |
| 3% peroxide fraction | ND <0.4 | NB | NB | NB | 0.0 | NB | NB | NB | 0.0 |
| **Sulfate:** | | | | | | | | | |
| front-half rinse | ND < 0.06 | 55 | 45 | 37.5 | 0.0 | 0.20 | 0.28 | 0.22 | 0.0 |
| filter | 0.88 | 4.2 | 3.0 | 2.4 | 29 | 1.1 | 0.84 | 0.80 | 84 |
| bicarbonate/carbonate fraction | ND <0.10 | 78.2 | 192.0 | 243.9 | 0.0 | 48 | 106.7 | 53.2 | 0.0 |
| 3% peroxide fraction | 0.46 | 3718 | 3289 | 3120 | 0.02 | 4238 | 4518 | 4734 | 0.01 |

Notes: Sulfate results for the filter and 3% peroxide fraction were reagent blank corrected for final results.

ND: Not Detected

NB: No Breakthrough from bicarbonate/carbonate fraction into peroxide fraction

(1) Reagent blank levels for the bicarbonate/carbonate and 3% peroxide fractions are based on a 200 ml reagent blank volume.

(2) Chloride results for the 3% peroxide fraction are from Carnot confirmational analysis and are reagent blank corrected..

## TABLE H-7
## RADIONUCLIDES ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC OUTLET

| Radionuclide | Reagent Blank pCi | 1-PM/AN-OUT | 3-PM/AN-OUT | 5-PM/AN-OUT |
|---|---|---|---|---|
| | | | pCi/train | |
| Uranium-233 & -234 | 0.1 | ND< 0.1 | ND< 0.1 | 0.1 |
| Uranium-235 | ND< 0.1 | ND< 0.1 | ND< 0.1 | 0.1 |
| Uranium-238 | 0.1 | ND< 0.1 | ND< 0.1 | ND< 0.1 |
| Radium-226 | 0.1 | 0.2 | 0.1 | 0.2 |
| Radium-228 | 1.5 | 1.4 | 1.7 | 1.4 |
| Lead-210 | ND< 1.0 | ND< 1.3 | ND< 1.3 | 0.4 |
| Polonium-210 | ND< 0.1 | 0.1 | ND< 0.1 | ND< 0.1 |
| Thorium-228 | ND< 0.4 | ND< 0.4 | ND< 0.6 | ND< 0.3 |
| Thorium-230 | 0.1 | ND< 0.3 | ND< 0.1 | ND< 0.3 |
| Thorium-232 | ND< 0.1 | ND< 0.1 | ND< 0.1 | ND< 0.1 |

Notes:
Results are not blank corrected.
ND: Not Detected; results reported by the laboratory as a zero or negative are considered to be

## TABLE H-8
## CYANIDE ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET

**Laboratory blank:**

| Sample I.D. | mg/L |
|---|---|
| Prep blank | ND < 0.01 |

**Reagent Blank:**

| Sample I.D. | mg/sample |
|---|---|
| Reagent blank | ND < 0.002 |

**Samples:**

| Sample I.D. | mg/sample |
|---|---|
| 6A-CN-IN | ND < 0.004 |
| 6B-CN-IN | ND < 0.004 |
| 6C-CN-IN | 0.004 |
| 6A-CN-OUT | ND < 0.002 |
| 6B-CN-OUT | 0.004 |
| 6C-CN-OUT | ND < 0.002 |

Note: Results are not blank corrected.
ND: Not Detected

## TABLE H-9
## AMMONIA ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE
## FFDC INLET AND OUTLET

| Sample I.D. | Sample Concentration gmole/L | Sample Volume ml |
|---|---|---|
| 2A-NH3-IN | 2.31E-05 | 249.0 |
| 2B-NH3-IN | 1.27E-05 | 228.4 |
| 2C-NH3-IN | 7.58E-06 | 188.8 |

Note: Results are not blank corrected.

**TABLE H-10**
**CHROMIUM SPECIATION EVALUATION**
**ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II BASELINE**
**FFDC INLET**

| Analyte | Fraction | Sample I.D. | ug/sample |
|---|---|---|---|
| Chromium (VI) | NaOH | Laboratory Blank | ND < 0.15 ng/ml |
| | | Reagent Blank | ND < 0.015 |
| | | FB-CR-IN | 3.13 |
| | | 8A-CR-IN | 7.25 |
| | | 8B-CR-IN | 3.05 |
| | | 9-CR-IN | 8.60 |
| Total Chromium | Filter/HNO3 | Laboratory Blank | ND < 0.1 |
| | | Reagent Blank | ND < 0.1 |
| | | FB-CR-IN | 46.8 |
| | | 8A-CR-IN | 145 |
| | | 8B-CR-IN | 106 |
| | | 9-CR-IN | 73.5 |

Notes:
ND: Not Detected
Results are not blank corrected.

**TABLE H-11**
**MERCURY SPECIATION EVALUATION ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II BASELINE**
**FFDC INLET AND OUTLET**

**Flue gas sample results:**

| Species | Field Blank ng/cartridge | INLET, ng/sample 14-A-Hg-IN | 14-B-Hg-IN | 14-C-Hg-IN | Blank Correction Contribution, % (Average) | OUTLET, ng/sample 14-A-Hg-OUT | 14-B-Hg-OUT | 14-C-Hg-OUT | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|---|---|---|---|
| Probe(total Hg)* | 0.2 | 0.9 | 0.9 | 0.9 | 0 | ND < 0.1 | ND < 0.1 | ND < 0.1 | 0 |
| Filter Plug(total Hg)** | NP | 33.3 | 30.6 | 2.7 | 0 | -- | -- | -- | -- |
| Hg(II) | 3.3 | 17.7 | 15.5 | 2.9 | 42 | ND < 1.5 | 2.6 | 7.4 | 66 |
| Hg(0) | 0.7 | 11.0 | 17.8 | 2.1 | 20 | ND < 0.4 | ND < 0.4 | ND < 0.4 | 72 |

**Process sample results:**

| Sample ID | Total Hg ng/vial | ng/g | Blank Correction Contribution, % |
|---|---|---|---|
| Laboratory Blank | 1.5 | -- | |
| Coal, 3/15 | 5.0 | 21 | 23 |
| Flyash, 3/15 | 106 | 216 | 4 |

Notes:
Exhaust gas probe and filter plug results are not blank corrected.
Exhaust gas speciation results are the sum of results for two collection cartridges, and are corrected for twice the average field blank cartridge level.
Coal and ash sample results are corrected for the laboratory blank level.
ND: Not Detected
NP: Not Performed
*One probe was used for all tests at the inlet and another at the outlet. The inlet probe Hg concentration was divided by three and the result was added to each te
**Glass wool plug to first soda lime cartridge at inlet location was analyzed separately because of particulate buildup. Outlet plug was not analyzed.

## TABLE H-12
## COAL ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I

| Parameter | Sample Date Fuel 11/17 | Sample Date Fuel 11/18 | Sample Date Fuel 11/19 | Laboratory Prep Blank | Blank Correction Contribution,% (Average) |
|---|---|---|---|---|---|
| **Trace Metals, ug/g: (ICP-AES, GFAAS, CVAAS)** | | | | | |
| Arsenic | ND < 0.5 | ND < 0.5 | ND < 0.5 | 0.01 | 0 |
| Barium | 2.4 | 30 | 23 | 1.8 | 6.9 |
| Beryllium | 0.21 | 0.24 | 0.23 | 0.003 | 1.3 |
| Cadmium | 0.09 | ND < 0.05 | ND < 0.05 | ND < 0.005 | 0 |
| Chromium | 0.9 | 1.4 | 1.2 | 0.08 | 7.1 |
| Cobalt | 0.8 | 1.0 | 1.0 | ND < 0.02 | 0 |
| Copper | 2.7 | 2.8 | 2.7 | 0.04 | 1.5 |
| Lead | 2.1 | 2.5 | 1.6 | ND < 0.75 | 0 |
| Manganese | 4.0 | 6.5 | 4.0 | 0.6 | 13 |
| Mercury | ND < 0.1 | 0.1 | ND < 0.1 | ND < 0.1 | 0 |
| Molybdenum | ND < 0.1 | ND < 0.1 | 0.2 | ND < 0.01 | 0 |
| Nickel | 0.5 | 0.9 | 0.6 | 0.07 | 11 |
| Selenium | ND < 0.05 | ND < 0.05 | ND < 0.05 | ND < 0.005 | 0 |
| Phosphorus | 510 | 350 | 370 | ND < 5 | 0 |
| Vanadium | 2.7 | 3.6 | 2.9 | 0.1 | 3.3 |
| **Trace Metals, ug/g: (INAA)** | | | | | |
| Arsenic | 0.58 | 0.44 | 0.49 | | |
| Barium | 372 | 533 | 392 | | |
| Cadmium | 0.14 | 0.087 | 0.12 | | |
| Chlorine | 19 | 22 | 26 | | |
| Chromium | 3.27 | 3.77 | 2.27 | | |
| Cobalt | 0.79 | 0.82 | 0.72 | | |
| Molybdenum | 0.99 | 1.27 | 1.07 | | |
| Mercury | 0.025 | 0.026 | 0.013 | | |
| Selenium | 0.70 | 0.83 | 0.85 | | |

Note: Final results were corrected for laboratory blank levels.

(continued)

ND = Not Detected

(1) Barium result for Coal 11/17 is considered to be an outlier and was not used for final results. Blank correction contribution was calculated for the remaining replicates.

## TABLE H-12 (continued)
## COAL ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I

| Parameter | Sample Date Fuel 11/17 | Fuel 11/18 | Fuel 11/19 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Ultimate,%:** | | | | |
| Carbon | 70.99 | 71.90 | 69.94 | |
| Hydrogen | 4.76 | 5.12 | 5.07 | |
| Nitrogen | 1.81 | 1.78 | 1.78 | |
| Sulfur | 0.53 | 0.49 | 0.46 | |
| Ash | 10.45 | 10.00 | 9.38 | |
| Water | 11.14 | 11.11 | 13.37 | |
| Oxygen (by difference) | 11.46 | 10.71 | 13.37 | |
| **Higher heating value, Btu/lb:** | 12,507 | 12,548 | 12,639 | |
| **Anion Precursors:** | | | | |
| Chlorine, % | 0.06 | ND < 0.01 | 0.06 | |
| Fluorine, ug/g | 79 | 89 | 85 | |
| **Radionuclides, pCi/g:** | | | | |
| Uranium-233 & -234 | 0.16 | 0.13 | 0.11 | 0.002 |
| Uranium-235 | ND < 0.01 | ND < 0.01 | 0.02 | ND |
| Uranium-238 | 0.12 | 0.05 | 0.11 | 0.02 |
| Radium-226 | 0.29 | 0.31 | 0.24 | ND |
| Radium-228 | 0.35 | 0.20 | 0.16 | 0.2, ND |
| Lead-210 | 0.37 | ND < 0.69 | 0.77 | 0.9 |
| Polonium-210 | 0.1 | ND < 0.1 | 0.2 | ND |
| Thorium-228 | 0.09 | 0.08 | 0.12 | 0.002 |
| Thorium-230 | 0.12 | 0.17 | 0.30 | 0.004 |
| Thorium-232 | 0.12 | 0.04 | 0.15 | 0.02 |

Note: Results are not blank corrected. Radionuclide prep blank results are in pCi/blank.
Prep blank detection limits were not available.
ND = Not Detected

## TABLE H-13
## FLY ASH ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I

| Parameter | Sample Date: Flyash 11/17 | Flyash 11/18 | Flyash 11/19 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Trace Metals, ug/g:** | | | | |
| Arsenic | 2.7 | 7.0 | 1.6 | ND < 1.3 |
| Barium | 1800 | 1600 | 1500 | ND < 0.5 |
| Beryllium | 1.8 | 1.6 | 1.5 | ND< 0.1 |
| Cadmium | ND < 0.25 | ND < 0.25 | 0.3 | ND < 0.25 |
| Chromium | 8.5 | 7.3 | 7.0 | ND < 0.5 |
| Cobalt | 5.6 | 4.4 | 4.5 | ND< 0.9 |
| Copper | 25 | 27 | 18 | ND < 0.5 |
| Lead | 28 | 24 | 20 | ND < 0.75 |
| Manganese | 66 | 70 | 69 | ND < 0.7 |
| Mercury | 0.25 | 0.15 | ND < 0.1 | ND < 0.1 |
| Molybdenum | 3.8 | 3.8 | 3.4 | ND < 0.7 |
| Nickel | 5.9 | 3.0 | 2.8 | ND < 1.6 |
| Selenium | 4.2 | 3.9 | 3.8 | ND < 0.25 |
| Phosphorus | 3900 | 3300 | 2900 | ND < 5 |
| Vanadium | 32 | 25 | 21 | ND < 0.5 |
| **Anions, ug/g:** | | | | |
| Chloride | 8.2 | 13 | 13 | ND < 5 |
| Fluoride | 18 | 20 | 34 | ND < 3 |
| Phosphate | ND < 20 | ND < 20 | ND < 20 | ND < 20 |
| Sulfate | 1000 | 1100 | 840 | ND < 5 |
| **Radionuclides, pCi/g:** | | | | |
| Uranium-233 & -234 | 2.6 | 2.3 | 2.0 | 0.002 |
| Uranium-235 | 0.2 | 0.1 | ND < 0.1 | ND |
| Uranium-238 | 2.6 | 2.4 | 2.2 | 0.02 |
| Radium-226 | 3.2 | 2.7 | 2.5 | ND |
| Radium-228 | 2.0 | 1.6 | 1.7 | 0.2, ND |
| Lead-210 | 0.8 | 1.1 | 1.3 | 0.9 |
| Polonium-210 | 1.4 | 1.2 | 1.8 | ND |
| Thorium-228 | 2.8 | 2.5 | 2.2 | 0.002 |
| Thorium-230 | 3.2 | 2.2 | 2.1 | 0.004 |
| Thorium-232 | 2.7 | 2.7 | 2.4 | 0.02 |
| Loss on Ignition, % | 5.77 | 6.76 | 6.31 | |

Notes: Results are not blank corrected. Radionuclide prep blank results are in pCi/blank.
Radionuclide prep blank detection limits were not available.
ND: Not Detected

**TABLE H-14**
**BOTTOM ASH ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**

| Parameter | Sample Date 11/17 | 11/18 | 11/19 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Trace Metals** | | | | |
| SOLID FRACTION, ug/g | | | | |
| Arsenic | ND < 2.5 | ND < 2.5 | ND < 2.5 | ND < 0.25 |
| Barium | 860 | 740 | 880 | ND < 0.5 |
| Beryllium | 1.0 | 0.8 | 1.0 | ND< 0.1 |
| Cadmium | ND < 0.25 | ND < 0.25 | ND < 0.25 | ND < 0.25 |
| Chromium | 2.7 | 2.4 | 3 | ND < 0.5 |
| Cobalt | 2.2 | 1.8 | 2.3 | ND< 0.9 |
| Copper | 10 | 7.6 | 8 | ND < 0.5 |
| Lead | ND < 12 | ND < 12 | ND < 12 | ND < 12 |
| Manganese | 36 | 33 | 33 | ND < 0.7 |
| Mercury | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 |
| Molybdenum | 0.7 | ND < 0.7 | ND < 0.7 | ND < 0.7 |
| Nickel | 2.2 | ND < 1.6 | ND < 1.6 | ND < 1.6 |
| Selenium | ND < 2.5 | ND < 2.5 | ND < 2.5 | ND < 0.25 |
| Phosphorus | 1900 | 1600 | 1800 | ND < 5 |
| Vanadium | 12 | 9.4 | 11 | ND < 0.5 |
| LIQUID FRACTION, ug/L | | | | |
| Arsenic | 0.05 | 0.019 | 0.12 | ND < 0.005 |
| Barium | 0.29 | 0.59 | 0.13 | ND < 0.01 |
| Beryllium | ND< 0.002 | ND< 0.002 | ND< 0.002 | ND< 0.002 |
| Cadmium | ND < 0.005 | ND < 0.005 | ND < 0.005 | ND < 0.005 |
| Chromium | 0.02 | 0.02 | 0.021 | ND < 0.01 |
| Cobalt | ND < 0.018 | ND < 0.018 | ND < 0.018 | ND < 0.018 |
| Copper | 0.04 | 0.01 | ND < 0.01 | ND < 0.01 |
| Lead | ND < 0.003 | ND < 0.003 | ND < 0.003 | ND < 0.003 |
| Manganese | 2.3 | ND < 0.015 | 0.29 | ND < 0.015 |
| Mercury | ND < 0.002 | ND < 0.002 | ND < 0.002 | ND < 0.002 |
| Molybdenum | 0.034 | 0.17 | 0.12 | ND < 0.014 |
| Nickel | ND < 0.032 | ND < 0.032 | ND < 0.032 | ND < 0.032 |
| Selenium | ND < 0.005 | 0.47 | 0.016 | ND < 0.005 |
| Phosphorus | 5.3 | 0.01 | 4.2 | ND < 0.1 |
| Vanadium | 0.09 | 0.08 | 0.13 | ND < 0.01 |

Note: Results are not blank corrected

(continued)

ND: Not Detected

**TABLE H-14 (continued)**
**BOTTOM ASH ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**

| Parameter | Sample Date 11/17 | 11/18 | 11/19 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Anions, mg/L:** | | | | |
| Chloride | 150 | 170 | 160 | ND < 0.5 |
| Fluoride | ND < 15 | ND < 15 | ND < 15 | ND < 0.3 |
| Phosphate | ND < 100 | ND < 100 | ND < 100 | ND < 2 |
| Sulfate | 1200 | 1400 | 1400 | ND < 0.5 |
| **Radionuclides, pCi/g:** | | | | |
| Uranium-233 & -234 | 2.1 | 2.4 | 2.1 | 0.002 |
| Uranium-235 | 0.1 | 0.1 | 0.1 | ND |
| Uranium-238 | 2.0 | 2.3 | 2.3 | 0.02 |
| Radium-226 | 2.2 | 3.1 | 2.9 | ND |
| Radium-228 | 1.8 | 2.0 | 2.1 | 0.2, ND |
| Lead-210 | 0.7 | 0.9 | 0.6 | 0.9 |
| Polonium-210 | 0.6 | 0.2 | 0.3 | ND |
| Thorium-228 | 3.2 | 2.9 | 3.2 | 0.002 |
| Thorium-230 | 3.2 | 2.8 | 3.0 | 0.004 |
| Thorium-232 | 3.4 | 3.3 | 3.0 | 0.02 |
| Loss on Ignition, % | 0.74 | 1.20 | 0.78 | |

Notes: Results are not blank corrected. Radionuclide prep blank results are in pCi/blank.
Detection limits were not available.
ND: Not Detected

## TABLE H-15
## SLUICE WATER BLANK ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE I BASELINE

| Parameter | Sample Date 11/17 | 11/18 | 11/19 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Trace Metals, ug/L** | | | | |
| Arsenic | 0.019 | 0.016 | 0.019 | ND < 0.005 |
| Barium | 0.08 | 0.19 | 0.08 | ND < 0.01 |
| Beryllium | ND< 0.002 | ND< 0.002 | ND< 0.002 | ND< 0.002 |
| Cadmium | ND < 0.005 | ND < 0.005 | ND < 0.005 | ND < 0.005 |
| Chromium | 0.02 | 0.02 | 0.02 | ND < 0.01 |
| Cobalt | ND < 0.018 | ND < 0.018 | ND < 0.018 | ND < 0.018 |
| Copper | ND < 0.01 | 0.01 | 0.015 | ND < 0.01 |
| Lead | ND < 0.003 | ND < 0.003 | ND < 0.003 | ND < 0.003 |
| Manganese | 0.023 | 0.026 | 0.036 | ND < 0.015 |
| Mercury | ND < 0.002 | ND < 0.002 | ND < 0.002 | ND < 0.002 |
| Molybdenum | 0.13 | 0.12 | 0.12 | ND < 0.014 |
| Nickel | ND < 0.032 | ND < 0.032 | ND < 0.032 | ND < 0.032 |
| Selenium | 0.033 | 0.03 | 0.032 | ND < 0.005 |
| Phosphorus | 1.2 | 1.6 | 1.3 | ND < 0.1 |
| Vanadium | 0.08 | 0.06 | 0.06 | ND < 0.01 |
| **Anions, mg/L:** | | | | |
| Chloride | 290 | 180 | 200 | ND < 0.5 |
| Fluoride | 5.4 | 4.8 | 5.5 | ND < 0.3 |
| Phosphate | ND < 20 | ND < 20 | ND < 20 | ND < 2 |
| Sulfate | 1100 | 940 | 1100 | ND < 0.5 |
| **Radionuclides, pCi/sample:** (sample volume = 200 ml) | | | | |
| Uranium-233 & -234 | 3.0 | 2.3 | 2.5 | 0.02 |
| Uranium-235 | ND < 0.1 | 0.1 | ND < 0.1 | 0.01 |
| Uranium-238 | 2.6 | 1.6 | 2.3 | ND |
| Radium-226 | 0.2 | 0.3 | ND < 0.1 | ND |
| Radium-228 | 1.0 | 1.5 | 1.6 | 0.2, ND |
| Lead-210 | ND < 5.1 | ND < 3.5 | ND < 3.3 | ND |
| Polonium-210 | 0.1 | 0.1 | ND < 0.1 | 0.05, 0.001 |
| Thorium-228 | ND < 0.1 | ND < 0.1 | ND < 0.1 | 0.02 |
| Thorium-230 | 0.1 | 0.2 | 0.1 | 0.004 |
| Thorium-232 | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND |

Notes: Sluice water blank results were used for blank correction of bottom ash results.
Radionuclide prep blank results are in pCi/blank and detection limits were not available.
ND: Not Detected

**TABLE H-16**
**SUMMARY OF BLANK CORRECTIONS**
**MADE TO ANALYTICAL DATA**
**SITE 115 PHASE I AND II BASELINE**

| Sample Type | Parameter | Type of Blank Correction | Blank Correction Contribution |
|---|---|---|---|
| Exhaust Gas, Inlet | Arsenic | None | 0.0% |
| | Barium | Reagent Blank | 2.5% |
| | Beryllium | None | 0.0% |
| | Cadmium | None | 0.0% |
| | Chromium | Reagent Blank | 0.9% |
| | Cobalt | None | 0.0% |
| | Copper | Reagent Blank | 0.3% |
| | Lead | Reagent Blank | 2.7% |
| | Manganese | Reagent Blank | 0.1% |
| | Mercury | Reagent Blank | 9.4% |
| | Molybdenum | Reagent Blank | 31% |
| | Nickel | None | 0.0% |
| | Selenium | None | 0.0% |
| | Phosphorus | None | 0.0% |
| | Vanadium | Reagent Blank | 0.1% |
| Exhaust Gas, Outlet | Arsenic | None | 0.0% |
| | Barium | Reagent Blank | 71% |
| | Beryllium | None | 0.0% |
| | Cadmium | None | 0.0% |
| | Chromium | Reagent Blank | 32% |
| | Cobalt | None | 0.0% |
| | Copper | Reagent Blank | 25% |
| | Lead | Reagent Blank | 59% |
| | Manganese | Reagent Blank | 16% |
| | Mercury | None | 0.0% |
| | Molybdenum | Reagent Blank | 94% |
| | Nickel | None | 0.0% |
| | Selenium | None | 0.0% |
| | Phosphorus | None | 0.0% |
| | Vanadium | Reagent Blank | 37% |
| Exhaust Gas, Inlet | PAH - Naphthalene | Laboratory Blank | 54% |
| Exhaust Gas, Inlet | PAH - Naphthalene | Laboratory Blank | 48% |

(continued)

**TABLE H-16 (continued)**
**SUMMARY OF BLANK CORRECTIONS**
**MADE TO ANALYTICAL DATA**
**SITE 115 PHASE I AND II BASELINE**

| Sample Type | Parameter | Type of Blank Correction | Blank Correction Contribution |
|---|---|---|---|
| Exhaust Gas, Inlet | Benzene, Toluene (Phase I) | None | 0.0% |
| | Benzene, Toluene (Phase II) | None | 0.0% |
| Exhaust Gas, Outlet | Benzene, Toluene (Phase I) | None | 0.0% |
| | Benzene, Toluene (Phase II) | None | 0.0% |
| Exhaust Gas, Inlet | Formaldehyde | None | 0.0% |
| Exhaust Gas, Outlet | Formaldehyde | None | 0.0% |
| Exhaust Gas, Inlet | Particulate | None | 0.0% |
| Exhaust Gas, Outlet | Particulate | None | 0.0% |
| Exhaust Gas, Inlet | Chloride (3% peroxide) | Reagent Blank | NC |
| | Chloride (all other sample train fractions) | None | 0.0% |
| | Fluoride (all sample train fractions) | None | 0.0% |
| | Phosphate (all sample train fractions) | None | 0.0% |
| | Sulfate: front-half | None | 0.0% |
| | filter | Reagent Blank | 29% |
| | carbonate | none | 0.0% |
| | 3% peroxide | Reagent Blank | 0.02% |
| Exhaust Gas, Outlet | Chloride (3% peroxide) | Reagent Blank | NC |
| | Chloride (all other sample train fractions) | None | 0.0% |
| | Fluoride (all sample train fractions) | None | 0.0% |
| | Phosphate (all sample train fractions) | None | 0.0% |
| | Sulfate: front-half | None | 0.0% |
| | filter | Reagent Blank | 84% |
| | carbonate | None | 0.0% |
| | 3% peroxide | Reagent Blank | 0.01% |
| Exhaust Gas, Outlet | Radionuclides | None | 0.0% |
| Exhaust Gas, Inlet | Cyanide | None | 0.0% |
| Exhaust Gas, Outlet | Cyanide | None | 0.0% |
| Exhaust Gas Inlet | Ammonia | None | 0.0% |
| Exhaust Gas, Inlet | Hexavalent and Total Chromium | None | 0.0% |

NC: Not Calculated

(continued)

## TABLE H-16 (continued)
## SUMMARY OF BLANK CORRECTIONS
## MADE TO ANALYTICAL DATA
## SITE 115 PHASE I AND II BASELINE

| Sample Type | Parameter | Type of Blank Correction | Blank Correction Contribution |
|---|---|---|---|
| Exhaust Gas, Inlet | Mercury speciation evaluation | | |
| | Hg(II) | Field Blank | 39% |
| | MMHg | Field Blank | 56% |
| | Hg(0) | Field Blank | 20% |
| | Probe(total Hg) | None | 0.0% |
| Exhaust Gas, Outlet | Mercury speciation evaluation | | |
| | Hg(II) | Field Blank | 66% |
| | MMHg | Field Blank | 66% |
| | Hg(0) | Field Blank | 72% |
| | Probe(total Hg) | None | 0.0% |
| Coal (CVAFS) | Mercury speciation evaluation | Laboratory Blank | 23% |
| Flyash (CVAFS) | Mercury speciation evaluation | Laboratory Blank | 4.0% |
| Coal | Arsenic | None | 0.0% |
| (ICP-AES, GFAAS, CVAAS | Barium | Laboratory Blank | 6.9% |
| | Beryllium | Laboratory Blank | 1.3% |
| | Cadmium | None | 0.0% |
| | Chromium | Laboratory Blank | 7.1% |
| | Cobalt | None | 0.0% |
| | Copper | Laboratory Blank | 1.5% |
| | Lead | Laboratory Blank | 12% |
| | Manganese | Laboratory Blank | 13% |
| | Mercury | None | 0.0% |
| | Molybdenum | None | 0.0% |
| | Nickel | Laboratory Blank | 11% |
| | Selenium | None | 0.0% |
| | Phosphorus | None | 0.0% |
| | Vanadium | Laboratory Blank | 3.3% |
| Coal (INAA) | Trace Metals | None | 0.0% |
| Coal | Ultimate, Chlorine, Fluorine | None | 0.0% |
| Coal, Flyash, Bottom Ash | Radionuclides | None | 0.0% |
| Flyash | Trace Metals, Anions | None | 0.0% |
| Bottom Ash* | Trace Metals, Anions | None | 0.0% |
| Sluice water blanks | Trace Metals, Anions | None | 0.0% |

Notes:
NC: Not Calculated
• Bottom ash results were corrected for sluice blank levels for final results. Blank correction contribution from laboratory and reagent blanks was 0%.

# APPENDIX I

# QUALITY ASSURANCE AND QUALITY CONTROL DATA

# PHASE II - UREA INJECTION

This appendix presents detailed QA/QC data for the Phase II Urea Injection FFDC inlet and outlet gas, coal, flyash and bottom ash samples. QA/QC criteria are the same as specified for baseline tests in Appendix G. QA/QC results for Phase II urea injection are presented in the following tables.

**TABLE I-1**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**FFDC INLET AND OUTLET METALS ANALYSES**

Duplicate Analysis Results:

| Element | Sample Value ug/train | Duplicate Value ug/train | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| **11-MTLS-IN** | | | | | |
| Arsenic | 47.1 | 47.4 | 0.6 | 10 | |
| Barium | 428 | 432 | 1.0 | 10 | |
| Beryllium | 20.2 | 20.3 | 0.4 | 10 | |
| Cadmium | 5.0 | 5.2 | 3.0 | 10 | |
| Chromium | 138 | 140 | 1.9 | 10 | |
| Cobalt | 64.9 | 66.6 | 2.6 | 10 | |
| Copper | 510 | 509 | 0.2 | 10 | |
| Lead | 171 | 165 | 3.6 | 10 | |
| Manganese | 222 | 225 | 1.7 | 10 | |
| Mercury | | | | | |
| FH/HNO3 | 3.111 | 3.167 | 1.8 | 10 | Results for 12-Mtls-In |
| KMnO4 | ND < 0.6 | 0.751 | NC | 10 | Results for 12-Mtls-In |
| Molybdenum | 54.5 | 54.6 | 0.1 | 10 | |
| Nickel | 75.3 | 80.0 | 6.1 | 10 | |
| Selenium | 43.1 | 32.5 | 28* | 10 | |
| Phosphorus | 24100 | 24700 | 2.5 | 10 | |
| Vanadium | 310 | 315 | 1.7 | 10 | |
| Calcium | 1530 | 1590 | 3.8 | 10 | |
| Sodium | 9680 | 9810 | 1.3 | 10 | |
| **11-MTLS-OUT** | | | | | |
| Arsenic (1) | 2.44 | 4.57 | 61* | 10 | Results for 10-Mtls -Out |
| Barium | 8.7 | 8.7 | 0.4 | 10 | |
| Beryllium | ND < 0.1 | ND < 0.1 | NC | 10 | |
| Cadmium | ND < 0.3 | ND < 0.3 | NC | 10 | |
| Chromium | 2.7 | 2.7 | 3.3 | 10 | |
| Cobalt | ND < 1 | ND < 1 | NC | 10 | |
| Copper | 4.9 | 5.0 | 1.0 | 10 | |
| Lead | 1.8 | NP | -- | 10 | |
| Manganese | 11.2 | 11.3 | 0.8 | 10 | |
| Mercury | | | | | |
| FH/HNO3 | ND < 1 | ND < 1 | NC | 10 | Results for 12-Mtls-Out |
| KMnO4 | ND < 0.5 | ND < 0.5 | NC | 10 | Results for 12-Mtls-Out |
| Molybdenum | 14.3 | 14.5 | 1.2 | 10 | |
| Nickel | 2.7 | 3.3 | 19* | 10 | |
| Selenium (1) | ND < 0.28 | ND < 0.28 | NC | 10 | Results for 10-Mtls -Out |
| Phosphorus | 36.4 | 8.90 | 121* | 10 | |
| Vanadium | 0.96 | 1.1 | 14* | 10 | |
| Calcium | 199 | 202 | 1.7 | 10 | |
| Sodium | 6770 | 6730 | 0.5 | 10 | |

Notes:

RPD= Relative Percent Difference

ND=Not Detected NC: Not Calculated

* Indicates result does not meet DQO

(1) Outlet arsenic and selenium results are from ICP hydride analysis.

(continued)

**TABLE I-1 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**FFDC INLET AND OUTLET METALS ANALYSES**

**Spike Results:**

| Element | Predigestion Blank Spike % Recovery | 11-MTLS-IN Post-digestion spike % Recovery | 11-MTLS-OUT Post-digestion spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic (1)(2) | 56*, 89 | 59* | 92 | 75-125 | Outlet result for 10-Mtls-Out |
| Barium | 67* | 69* | 73* | 75-125 | |
| Beryllium | 63* | 71* | 73* | 75-125 | |
| Chromium | 69* | 68* | 59* | 75-125 | |
| Cobalt | 59* | 48* | 56* | 75-125 | |
| Copper | 54* | 85 | 76 | 75-125 | |
| Lead (3) | 130*, 12* | 60* | MSA | 75-125 | |
| Manganese | 61* | 60* | 59* | 75-125 | |
| Mercury | | | | | |
| FH/HN03 | 102 | 112 | 99 | 75-125 | Results for 12-Mtls-In and -Out |
| KMnO4 | 105 | 98 | 99 | 75-125 | Results for 12-Mtls-In and 12-Mtls-Out |
| Molybdenum | 138* | 54* | 63* | 75-125 | |
| Nickel | 63* | 50* | 55* | 75-125 | |
| Selenium (1)(2) | 70*, 78 | 68* | 91 | 75-125 | Outlet result for 10-Mtls-Out |
| Phosphorus | 60* | 141* | 67* | 75-125 | |
| Vanadium | 70* | 69* | 63* | 75-125 | |
| Cadmium | 57* | 59* | 56* | 75-125 | |
| Calcium | 47* | 48* | 54* | 75-125 | |
| Sodium | NM | 83 | 88 | 75-125 | |

Notes:
NM = Not Meaningful, spike level too low to accurately assess recovery
MSA: Method of Standard Additions used for analysis due to poor spike recoveries.
* Indicates result does not meet DQO
(1) Outlet arsenic and selenium results are from ICP-hydride analysis.
(2) Predigestion blank spike recoveries are for ICP and ICP hydride analysis respectively.
(3) Predigestion blank spike recoveries are for ICP and GFAAS analysis respectively

TABLE I-1 (continued)
SUMMARY OF QUALITY CONTROL RESULTS FOR
SITE 115 PHASE II UREA INJECTION
FFDC INLET AND OUTLET METALS ANALYSES

Laboratory Check Standards Results:

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| ICP-AES, CVAAS | | | | | |
| Arsenic | 100 | 98 | 109 | 90-110 | |
| Barium | 101 | 96 | 96 | 90-110 | |
| Beryllium | 94 | 90 | 90 | 90-110 | |
| Cadmium | 103 | 99 | 96 | 90-110 | |
| Chromium | 106 | 99 | 97 | 90-110 | |
| Cobalt | 101 | 95 | 94 | 90-110 | |
| Copper | 102 | 100 | 99 | 90-110 | |
| Lead | 101 | 96 | 92 | 90-110 | |
| Manganese | 105 | 98 | 97 | 90-110 | |
| Mercury | | | | | |
| FH/HNO3 | 109 | 96 | 104 | 80-120 | |
| KMnO4 | 106 | 92 | 103 | 80-120 | |
| Molybdenum | 99 | 92 | 92 | 90-110 | |
| Nickel | 102 | 95 | 98 | 90-110 | |
| Selenium | 101 | 94 | 95 | 90-110 | |
| Phosphorus | 101 | 99 | 102 | 90-110 | |
| Vanadium | 99 | 94 | 107 | 90-110 | |
| Calcium | 101 | 96 | 95 | 90-110 | |
| Sodium | 101 | 96 | 95 | 90-110 | |
| ICP-HYDRIDE | | | | | |
| Arsenic | 100 | 98 | 93 | 90-110 | |
| Selenium | 102 | 98 | 93 | 90-110 | |

Correlation Coefficients for MSA Data:

| Sample ID | Lead r^2 | Data Quality Objective for MSA | Comments |
|---|---|---|---|
| LAB BLANK | 0.9880 | 0.995 | Does not meet DQO |
| 10-MTLS-OUT | 0.9985 | 0.995 | |
| 11-MTLS-OUT | 1.0000 | 0.995 | |
| 12-MTLS-OUT | 0.9984 | 0.995 | |
| FB-MTLS-OUT | 0.9995 | 0.995 | |
| RB-MTLS | 0.9991 | 0.995 | |

Notes:
MSA: Method of Standard Additions; used because of poor spike recoveries

**TABLE I-2**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**FFDC INLET AND OUTLET PARTICULATE ANALYSES**

| Quality Control | Measured Value or Range | Data Quality Objective | Comments |
|---|---|---|---|
| Acetone Blank, mg/ml | 0.0055 | <=0.008 | |
| Balance Calibration Check, mg | | | |
| Total weight > 20 g | -0.3 to +0.0 | +/- 0.3 | |
| Total weight < 20 g | -0.1 to +0.1 | +/- 0.1 | |

Note: NBS traceable weights used for balance calibration check

TABLE I-3
SUMMARY OF QUALITY CONTROL RESULTS FOR
SITE 115 PHASE II UREA INJECTION
FFDC INLET AND OUTLET ANIONS IC ANALYSIS

esults:

| Sample value mg/l | Duplicate value mg/l | RPD | Data Quality Objectives for Duplicates | Comments |
|---|---|---|---|---|
| ND < 0.5 | ND < 0.5 | NC | 15 | |
| 7.50 | 7.51 | 0.2 | 15 | |
| 2.36 | 2.34 | 0.9 | 15 | |
| 134.73 | 132.08 | 2.0 | 15 | |
| ND < 25 | ND < 25 | NC | 15 | |
| ND < 150 | ND < 150 | NC | 15 | |
| ND < 10 | ND < 10 | NC | 15 | |
| 4,693 | 4,679 | 0.3 | 15 | |

| Matrix Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|
| 82 | 80-120 | |
| 113 | 80-120 | |
| 42 | 80-120 | Does not meet DQO |
| 72 | 80-120 | Does not meet DQO |
| 98 | 80-120 | |
| 102 | 80-120 | |
| 105 | 80-120 | |
| 95 | 80-120 | |

(continued)

nt Difference

TABLE I-3 (continued)
SUMMARY OF QUALITY CONTROL RESULTS FOR
SITE 115 PHASE II UREA INJECTION
FFDC INLET AND OUTLET ANIONS IC ANALYSIS

**andard Results:**

| Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|
| 103 | 99 | 100 | 95-105 | |
| 110 | 101 | 98 | 95-105 | |
| 95 | 95 | 95 | 95-105 | |
| 95 | 96 | 96 | 95-105 | |
| 105 | 99 | 107 | 95-105 | CCV #2does not meet D |
| 99 | 103 | 104 | 95-105 | |
| 95 | 96 | 96 | 95-105 | |
| 96 | 97 | 98 | 95-105 | |
| 110 | 99 | NP | 95-105 | ICV does not meet DQO |
| 109 | 103 | NP | 95-105 | ICV does not meet DQO |
| 95 | 96 | NP | 95-105 | |
| 96 | 96 | NP | 95-105 | |
| 100 | 99 | 106 | 95-105 | CCV #2does not meet D |
| 100 | 106 | 100 | 95-105 | CCV #1does not meet D |
| 96 | 96 | 95 | 95-105 | |
| 97 | 97 | 97 | 95-105 | |
| 102 | 96 | 96 | 95-105 | |
| 107 | 100 | 99 | 95-105 | ICV does not meet DQO |
| 95 | 95 | 95 | 95-105 | |
| 96 | 99 | 96 | 95-105 | |

**TABLE I-4**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**FFDC INLET AND OUTLET CYANIDE ANALYSIS**

**Duplicate Analysis Results:**

| Sample ID | Sample mg/L | Duplicate mg/L | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| 13C-CN-OUT spike | 0.23 | 0.24 | 4.3 | 20 | |

**Spike Results:**

| Spike ID | Expected Value mg/L | Measured Value mg/L | % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| 13C-CN-OUT | 0.25 | 0.23 | 92 | 75-125 | |

Notes:
RPD=Relative Percent Difference

## TABLE I-5
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION COAL METALS ICP-AES, GFAAS AND CVAAS ANALYSIS

**Spike Results:**

| Element | Average Predigestion Blank Spike % Recovery | Predigestion Sample Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic | 100 | 92 | 117 | 75-125 | |
| Barium | 98 | NM | 96 | 75-125 | |
| Beryllium | 100 | 81 | 84 | 75-125 | |
| Cadmium | 113 | 128 | 112 | 75-125 | Pre- spike does not meet DQO |
| Chromium | 96 | 81 | 91 | 75-125 | |
| Cobalt | 101 | 84 | 91 | 75-125 | |
| Copper | 99 | NM | 84 | 75-125 | |
| Lead | NP | 55 | 102 | 75-125 | Pre- spike does not meet DQO |
| Manganese | 97 | 117 | 85 | 75-125 | |
| Mercury | 95 | 87 | NP | 75-125 | |
| Molybdenum | 97 | 83 | 88 | 75-125 | |
| Nickel | 99 | 88 | 86 | 75-125 | |
| Selenium | 88 | 72 | 98 | 75-125 | Pre- spike does not meet DQO |
| Phosphorus | 93 | 86 | NP | 75-125 | |
| Vanadium | 99 | 90 | 89 | 75-125 | |
| Calcium | 100 | NM | 59 | 75-125 | Post- spike does not meet DQO |
| Sodium | 96 | NM | 83 | 75-125 | |

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 96 | 100 | NP | 90-110 | |
| Barium | 102 | 97 | 96 | 90-110 | |
| Beryllium | 94 | 90 | 90 | 90-110 | |
| Cadmium | 94 | 92 | 93 | 90-110 | |
| Chromium | 103 | 102 | 98 | 90-110 | |
| Cobalt | 101 | 100 | 97 | 90-110 | |
| Copper | 103 | 98 | 97 | 90-110 | |
| Lead | 105 | 101 | NP | 90-110 | |
| Manganese | 105 | 103 | 100 | 90-110 | |
| Mercury | 97 | 86 | 86 | 80-120 | |
| Molybdenum | 100 | 98 | 96 | 90-110 | |
| Nickel | 104 | 101 | 97 | 90-110 | |
| Selenium | 92 | 102 | 109 | 90-110 | |
| Phosphorus | 103 | 107 | NP | 90-110 | |
| Vanadium | 100 | 97 | 96 | 90-110 | |
| Calcium | 103 | 106 | 104 | 90-110 | |
| Sodium | 100 | 96 | 95 | 90-110 | |

Notes:
NP: Not Performed
NM: Not Meaningful, spike level too low to accurately assess recovery

## TABLE I-6
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION COAL METALS AND CHLORINE INAA ANALYSIS

**Laboratory Check Standard Results**

NIST SRM 1571:

| Element | Reference Value ug/g | Measured Value ug/g | Recovery % | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 10 | 11 | 110 | 90-110 | |
| Barium | 44 | 48 | 109 | 90-110 | |
| Cadmium | -- | NP | -- | 90-110 | |
| Chlorine | -- | NP | -- | 90-110 | |
| Chromium | 2.6 | 2.9 | 112 | 90-110 | Does not meet DQO |
| Cobalt | -- | NP | -- | 90-110 | |
| Manganese | 91 | 93 | 102 | 90-110 | |
| Mercury | 0.155 | 0.14 | 90 | 90-110 | |
| Selenium | -- | NP | -- | 90-110 | |

Notes:
Mercury check standard results are for SRM 1633A.
NP: Not Performed

## TABLE I-7
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION COAL ULTIMATE AND ANION PRECURSOR ANALYSES

**Duplicate Analysis Results:**

| Component, % | Sample | Duplicate | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Moisture | 2.75 | 2.56 | 7.2 | 10 | |
| Carbon | 72.41 | NA | -- | 10 | |
| Hydrogen | 5.11 | NA | -- | 10 | |
| Nitrogen | 1.87 | NA | -- | 10 | |
| Sulfur | 0.49 | NA | -- | 10 | |
| Ash | 11.54 | 11.52 | 0.2 | 10 | |
| Dry Btu | 12623 | 12617 | 0.0 | 10 | |
| Chlorine, ug/g | 259 | 258 | 0.4 | 10 | |
| Fluorine, ug/g | 54 | 50 | 7.7 | 10 | |

**Laboratory Check Standard Analysis:**

| Component | Reference LCS Value | Measured LCS Value | % Recovery | Data Quality objective for LCS | Comments |
|---|---|---|---|---|---|
| Moisture | NA | NA | -- | 90-110 | |
| Carbon | 42.10 | 42.22 | 100 | 90-110 | |
| Hydrogen | 5.07 | 5.04 | 99 | 90-110 | |
| Nitrogen | 1.56 | 1.53 | 98 | 90-110 | |
| Sulfur | 1.89 | 1.87 | 99 | 90-110 | |
| Ash | NA | NA | -- | 90-110 | |
| HHV, cal | 2390.09 | 2390.83 | 100 | 90-110 | |
| Chlorine | NA | NA | -- | 90-110 | |
| Fluorine | 79 | 80 | 101 | 90-110 | |

RPD: Relative Percent Difference
NP: Not Performed
NA: Not Available

## TABLE I-8
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION FLYASH METALS ANALYSES

Spike Results:

| Element | Average Predigestion Blank Spike % Recovery | Predigestion Sample Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic | NP | 76 | NP | 75-125 | |
| Barium | 108 | NM | 101 | 75-125 | |
| Beryllium | 107 | 112 | 90 | 75-125 | |
| Cadmium | 108 | 0 | 117 | 75-125 | Pre- spike does not meet DQO |
| Chromium | 103 | 111 | 98 | 75-125 | |
| Cobalt | 108 | NM | 96 | 75-125 | |
| Copper | 108 | NM | 99 | 75-125 | |
| Lead | NP | 81 | NP | 75-125 | |
| Manganese | 105 | NM | 98 | 75-125 | |
| Mercury | NP | 97 | NP | 75-125 | |
| Molybdenum | 100 | 109 | 96 | 75-125 | |
| Nickel | 104 | 132 | 98 | 75-125 | Pre- spike does not meet DQO |
| Selenium | NP | MSA | MSA | 75-125 | |
| Phosphorus | 106 | 102 | 105 | 75-125 | |
| Vanadium | 108 | NM | 98 | 75-125 | |
| Calcium | 104 | NM | 101 | 75-125 | |
| Sodium | 104 | NM | 101 | 75-125 | |

Notes:

(continued)

NP: Not Performed

NM: Not Meaningful, spike level too low to accurately assess recovery

MSA: Method of Standard Additions used due to poor spike recovery

**TABLE I-8 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**FLYASH METALS ANALYSES**

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 98 | 106 | 95 | 90-110 | |
| Barium | 101 | 103 | 103 | 90-110 | |
| Beryllium | 97 | 95 | 95 | 90-110 | |
| Cadmium | 102 | 91 | 93 | 90-110 | |
| Chromium | 104 | 104 | 105 | 90-110 | |
| Cobalt | 104 | 103 | 103 | 90-110 | |
| Copper | 103 | 102 | 103 | 90-110 | |
| Lead | 95 | 99 | 101 | 90-110 | |
| Manganese | 103 | 105 | 106 | 90-110 | |
| Mercury | 97 | 86 | 86 | 80-120 | |
| Molybdenum | 100 | 99 | 100 | 90-110 | |
| Nickel | 106 | 103 | 105 | 90-110 | |
| Phosphorus | 100 | 102 | 105 | 90-110 | |
| Vanadium | 100 | 100 | 101 | 90-110 | |
| Calcium | 103 | 102 | 102 | 90-110 | |
| Sodium | 104 | 99 | 100 | 90-110 | |

**Correlation Coefficients for MSA Data:**

| Sample ID | Selenium r^2 | Data Quality Objective for MSA | Comments |
|---|---|---|---|
| Laboratory Blank | 0.9988 | 0.995 | |
| Flyash 3/10 AM | 0.9947 | 0.995 | Does not meet DQO |
| Flyash 3/10 PM | 0.9892 | 0.995 | Does not meet DQO |
| Flyash 3/11 | 0.9944 | 0.995 | Does not meet DQO |

Notes:
MSA: Method of Standard Additions used due to poor spike recovery

**TABLE I-9**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**FLYASH ANIONS ANALYSES**

**Duplicate Analysis Results**

Flyash 3/10 AM

| Anion | Sample mg/kg | Duplicate mg/kg | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Chloride | ND < 50 | ND < 50 | NC | 15 | |
| Fluoride | 33.5 | 31.2 | 7.1 | 15 | Result for 3/11 Flyash |
| Phosphate | ND < 200 | ND < 200 | NC | 15 | |
| Sulfate | 1532 | 1576 | 2.9 | 15 | |

**Spike Analysis Results:**

| Anion | Matrix Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|
| Chloride | 127 | 80-120 | Does not meet DQO |
| Fluoride | 96 | 80-120 | Result for 3/11 Flyash |
| Phosphate | 106 | 80-120 | |
| Sulfate | 96 | 80-120 | |

**Laboratory Check Standard Results:**

| Anion | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Chloride | 99.7 | 97.8 | 99.4 | 95-105 | |
| Fluoride | 100 | 102 | 107 | 90-110 | |
| Phosphate | 95.5 | 96.7 | 95.8 | 95-105 | |
| Sulfate | 96.8 | 103 | 104 | 95-105 | |

Note:
ND: Not Detected
NC: Not Calculated
RPD: Relative Percent Difference

**TABLE 1-10**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**BOTTOM ASH METALS ANALYSES**

Spike Results:

| Element | Average Predigestion Blank Spike % Recovery | Predigestion Sample Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic | NP | 76 | NP | 75-125 | |
| Barium | 108 | NM | 120 | 75-125 | |
| Beryllium | 107 | 105 | 92 | 75-125 | |
| Cadmium | 108 | 114 | 104 | 75-125 | |
| Chromium | 103 | NM | 98 | 75-125 | |
| Cobalt | 108 | 87 | 98 | 75-125 | |
| Copper | 108 | NM | 100 | 75-125 | |
| Lead | NP | 81 | NP | 75-125 | |
| Manganese | 105 | NM | 100 | 75-125 | |
| Mercury | 106 | 98 | NP | 75-125 | |
| Molybdenum | 100 | 56 | 97 | 75-125 | Pre-spike does not meet DQO |
| Nickel | 104 | 99 | 100 | 75-125 | |
| Selenium | NP | MSA | MSA | 75-125 | |
| Phosphorus | 106 | NM | 114 | 75-125 | |
| Vanadium | 108 | 121 | 98 | 75-125 | |
| Calcium | 104 | NM | 136 | 75-125 | Post-spike does not meet DQO |
| Sodium | 104 | NM | 108 | 75-125 | |

Notes:

(continued)

NP: Not Performed
NM: Not Meaningful, spike level too low to accurately assess recovery
MSA: Method of Standard Additions used due to poor spike recovery

**TABLE I-10 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**BOTTOM ASH METALS ANALYSES**

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 98 | 106 | 95 | 90-110 | |
| Barium | 101 | 103 | 103 | 90-110 | |
| Beryllium | 97 | 95 | 95 | 90-110 | |
| Cadmium | 102 | 91 | 93 | 90-110 | |
| Chromium | 104 | 104 | 105 | 90-110 | |
| Cobalt | 104 | 103 | 103 | 90-110 | |
| Copper | 103 | 102 | 103 | 90-110 | |
| Lead | 95 | 99 | 101 | 90-110 | |
| Manganese | 103 | 105 | 106 | 90-110 | |
| Mercury | 97 | 86 | 86 | 80-120 | |
| Molybdenum | 100 | 99 | 100 | 90-110 | |
| Nickel | 106 | 103 | 105 | 90-110 | |
| Phosphorus | 100 | 102 | 105 | 90-110 | |
| Vanadium | 100 | 100 | 101 | 90-110 | |
| Calcium | 103 | 102 | 102 | 90-110 | |
| Sodium | 104 | 99 | 100 | 90-110 | |

**Correlation Coefficients for MSA Data:**

| Sample ID | Selenium $r^2$ | Data Quality Objective for MSA | Comments |
|---|---|---|---|
| Laboratory Blank | 0.9988 | 0.995 | |
| Bottom Ash 3/10 AM | 0.9772 | 0.995 | Does not meet DQO |
| Bottom Ash 3/10 PM | 0.9339 | 0.995 | Does not meet DQO |
| Bottom Ash 3/11 | 0.9956 | 0.995 | |

Notes:
MSA: Method of Standard Additions used due to poor spike recovery

## TABLE I-11
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION BOTTOM ASH ANIONS ANALYSES

**Duplicate Analysis Results**

Bottom Ash 3/10 AM

| Anion | Sample mg/kg | Duplicate mg/kg | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Chloride | 269.90 | 264.10 | 2.2 | 15 | |
| Fluoride | ND < 2.5 | ND < 2.5 | NC | 15 | Result for 3/11 Bottom Ash |
| Phosphate | ND < 20 | ND < 20 | NC | 15 | |
| Sulfate | 985 | 971 | 1.5 | 15 | |

**Spike Analysis Results:**

| Anion | Matrix Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|
| Chloride | 90 | 80-120 | |
| Fluoride | 111 | 80-120 | Result for 3/11 Bottom Ash |
| Phosphate | 92 | 80-120 | |
| Sulfate | 92 | 80-120 | |

**Laboratory Check Standard Results:**

| Anion | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Chloride | 99.7 | 104 | 102 | 95-105 | |
| Fluoride | 100 | 102 | NP | 90-110 | |
| Phosphate | 95.5 | 95.7 | 96.2 | 95-105 | |
| Sulfate | 96.8 | 103 | 104 | 95-105 | |

Notes:
ND: Not Detected
RPD: Relative Percent Difference, not calculated for not detected values
NC: Not Calculated
NP: Not Performed

## TABLE I-12
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION SLUICE WATER BLANK METALS ANALYSES

**Spike Results:**

| Element | Average Predigestion Blank Spike % Recovery | Predigestion Sample Spike % Recovery | Postdigestion Sample Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|---|---|
| Arsenic | 93 | 7* | 84 | 75-125 | Results for 3/11 sluice |
| Barium | 102 | 96 | NP | 75-125 | |
| Beryllium | 99 | 91 | NP | 75-125 | |
| Cadmium | 108 | 95 | NP | 75-125 | |
| Chromium | 102 | 92 | NP | 75-125 | |
| Cobalt | 104 | 94 | NP | 75-125 | |
| Copper | 103 | 99 | NP | 75-125 | |
| Lead | 95 | 0* | 97 | 75-125 | Results for 3/11 sluice |
| Manganese | 102 | 96 | NP | 75-125 | |
| Mercury | 102 | 89 | NP | 75-125 | Results for 3/11 sluice |
| Molybdenum | 100 | 92 | NP | 75-125 | |
| Nickel | 100 | 94 | NP | 75-125 | |
| Selenium | 91 | 7* | 76 | 75-125 | Results for 3/11 sluice |
| Phosphorus | 105 | 101 | NP | 75-125 | |
| Vanadium | 103 | 94 | NP | 75-125 | |
| Calcium | 102 | 46* | NP | 75-125 | |
| Sodium | 101 | 64* | NP | 75-125 | |

Notes:

NP: Not Performed

* Indicates result does not meet DQO

(continued)

**TABLE I-12 (continued)**
**SUMMARY OF QUALITY CONTROL RESULTS FOR**
**SITE 115 PHASE II UREA INJECTION**
**SLUICE WATER BLANK METALS ANALYSES**

**Laboratory Check Standards Results:**

| Element | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Arsenic | 94 | 100 | 96 | 90-110 | |
| Barium | 102 | 103 | NP | 90-110 | |
| Beryllium | 93 | 95 | NP | 90-110 | |
| Cadmium | 95 | 95 | NP | 90-110 | |
| Chromium | 104 | 106 | NP | 90-110 | |
| Cobalt | 102 | 104 | NP | 90-110 | |
| Copper | 103 | 104 | NP | 90-110 | |
| Lead | 93 | 96 | 98 | 90-110 | |
| Manganese | 105 | 107 | NP | 90-110 | |
| Mercury | 106 | 101 | 90 | 80-120 | |
| Molybdenum | 101 | 103 | NP | 90-110 | |
| Nickel | 104 | 106 | NP | 90-110 | |
| Phosphorus | 102 | 105 | NP | 90-110 | |
| Selenium | 100 | 95 | 92 | 90-110 | |
| Vanadium | 100 | 102 | NP | 90-110 | |
| Calcium | 102 | 103 | NP | 90-110 | |
| Sodium | 101 | 101 | NP | 90-110 | |

## TABLE I-13
## SUMMARY OF QUALITY CONTROL RESULTS FOR SITE 115 PHASE II UREA INJECTION SLUICE WATER BLANK ANIONS ANALYSES

**Duplicate Analysis Results**

Sluice 3/10 AM

| Anion | Sample mg/L | Duplicate mg/L | RPD | Data Quality Objective for Duplicates | Comments |
|---|---|---|---|---|---|
| Chloride | 218.25 | 225.10 | 3.1 | 15 | |
| Fluoride | 3.33 | 3.26 | 2.1 | 15 | Result for 3/10 PM Sluice |
| Phosphate | ND < 2 | ND < 2 | NC | 15 | |
| Sulfate | 847.95 | 874.85 | 3.1 | 15 | |

**Spike Analysis Results:**

| Anion | Matrix Spike % Recovery | Data Quality Objective for Spikes | Comments |
|---|---|---|---|
| Chloride | 79 | 80-120 | |
| Fluoride | 105 | 80-120 | Result for 3/10 PM Sluice |
| Phosphate | 55 | 80-120 | Does not meet DQO |
| Sulfate | 122 | 80-120 | Does not meet DQO |

**Laboratory Check Standard Results:**

| Anion | Initial Calibration % Recovery | Continuing Calibration % Recovery | | Data Quality Objective for LCS | Comments |
|---|---|---|---|---|---|
| Chloride | 99.7 | 104 | 102 | 95-105 | |
| Fluoride | 100 | 100 | NP | 90-110 | |
| Phosphate | 95.5 | 95.7 | 96.2 | 95-105 | |
| Sulfate | 96.8 | 103 | 104 | 95-105 | |

Notes:
ND: Not Detected
RPD: Relative Percent Difference
NC: Not Calculated
NP: Not Performed

# APPENDIX J
## ANALYTICAL AND BLANK CORRECTION DATA
## PHASE II - UREA INJECTION

This Appendix contains summary tables of the laboratory analysis results for the Phase II Urea Injection FFDC inlet and outlet gas, coal, flyash and bottom ash samples. These tables include the analytical results obtained for field blanks, reagent blanks and laboratory preparation blanks. Detailed information on blank types and calculation of blank correction contribution are presented in Appendix H with the Baseline data.

Tables in this Appendix include:

**TABLE J-1**
**TRACE METALS ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**
**FFDC INLET**

| Element | Laboratory Prep Blank ug | Reagent Blank ug | Field Blank (ug/train) | 10-MTLS-IN (ug/train) | 11-MTLS-IN (ug/train) | 12-MTLS-IN (ug/train) | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|---|---|
| Arsenic | 1.3 | 1.6 | 1.7 | 64 | 47 | 24 | 4.2 |
| Barium | 21 | 10 | 35 | 750 | 430 | 840 | 1.6 |
| Beryllium | ND < 0.1 | ND < 0.1 | ND < 0.1 | 26 | 20 | 3111 | 0 |
| Cadmium | ND < 0.3 | ND < 0.3 | ND < 0.3 | 7.1 | 5.0 | 8.7 | 0 |
| Chromium | 1.8 | 4.5 | 8.1 | 160 | 140 | 230 | 1.1 |
| Cobalt | ND < 1 | ND < 0.9 | ND < 1 | 97 | 65 | 110 | 0 |
| Copper | 6.9 | 15 | 10 | 630 | 510 | 990 | 0 |
| Lead | ND < 10 | 7.1 | 7 | 59 | 170 | 260 | 6.3 |
| Manganese | 1.7 | 1.7 | 5.1 | 280 | 220 | 420 | 0.6 |
| Mercury - FH/HNO3 | ND < 0.4 | ND < 0.2 | ND < 0.9 | 10 | 4 | 24* | 0 |
| Mercury - KMnO4 | ND < 0.005 | ND < 0.2 | ND < 0.5 | 1.8 | ND < 0.4 | ND < 0.6 | 0 |
| Molybdenum | 0.9 | 16 | 31 | 60 | 55 | 53 | 29 |
| Nickel | ND < 2 | 2 | 4 | 95 | 75 | 140 | 2.1 |
| Selenium | ND < 0.25 | ND < 10 | ND < 30 | 63 | 43 | 80 | 0 |
| Phosphorus | ND < 6 | ND < 5 | ND < 6 | 33000 | 24000 | 39000 | 0 |
| Vanadium | ND < 0.6 | ND < 0.5 | 2.2 | 420 | 310 | 510 | 0 |
| Calcium | 80 | 120 | 510 | 5300 | 1500 | 2700 | 4.9 |
| Sodium | 7000 | 6100 | 17000 | 26000 | 10000 | 10000 | 48 |

Note: Reagent blanks were subtracted from As, Ba, Pb, Mn, Mo, Ni, Ca and Na for final results. Laboratory prep blanks were subtracted from Cr for final results. Cu prep and reagent blank levels were considered anamalous and were not subtracted.
ND: Not Detected
* Mercury result for 12-Mtls-In was considered anomalous and not used. Reporting limit value was used instead.

**TABLE J-1 (continued)**
**TRACE METALS ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**
**FFDC OUTLET**

| Element | Laboratory Prep Blank ug | Reagent Blank ug | Field Blank (ug/train) | 10-MTLS-OUT (ug/train) | 11-MTLS-OUT (ug/train) | 12-MTLS-OUT (ug/train) | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|---|---|
| Arsenic | 1.3 | 1.6 | 0.95 | 2.4 | 2.3 | 2.1 | 71 |
| Barium | 21 | 10 | 55 | 20 | 8.7** | 14 | 79 |
| Beryllium | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | 0 |
| Cadmium | ND < 0.3 | ND < 0.3 | ND < 0.3 | ND < 0.3 | ND < 0.3 | ND < 0.3 | 0 |
| Chromium | 1.8 | 4.5 | 7.0 | 3.3 | 2.7 | 3.4 | 43 |
| Cobalt | ND < 1 | ND < 0.9 | ND < 1 | ND < 1 | ND < 1 | ND < 1 | 0 |
| Copper | 6.9 | 15 | 37 | 7.1 | 4.9 | 5.8 | 0 |
| Lead | ND < 10 | 7.1 | 9.2 | 1.8** | 1.8** | 9** | 7 |
| Manganese | 1.7 | 1.7 | 5.1 | 2.7 | 11 | 2.8 | 46 |
| Mercury - HNO3 | ND < 0.4 | ND < 0.2 | ND < 0.1 | ND < 2 | ND < 1 | ND < 1 | 0 |
| Mercury - KMnO4 | ND < 0.005 | ND < 0.2 | ND < 0.4 | 1.8 | 1.4 | ND < 0.5 | 0 |
| Molybdenum | 0.9 | 16 | 29 | 18 | 14** | 15** | 93 |
| Nickel | ND < 2 | 2 | 4 | 3** | 3** | 3** | 33 |
| Selenium | ND < 0.25 | ND < 10 | ND < 0.28 | ND < 0.28 | ND < 0.28 | ND < 0.28 | 0 |
| Phosphorus | ND < 6 | ND < 5 | 6 | 21 | 36 | ND < 6 | 0 |
| Vanadium | ND < 0.6 | ND < 0.5 | 0.8 | 1.3 | 1.0 | 1.5 | 0 |
| Calcium | 80 | 120 | 280 | 250 | 200 | 290 | 50 |
| Sodium | 7,000 | 6,100 | 20,000 | 7,500 | 6,800 | 8,900 | 80 |

Note: Reagent blanks were subtracted from As, Ba, Pb, Mn, Mo, Ni, Ca and Na for final results. Laboratory prep blanks were subtracted from Cr for final results. Cu prep and reagent blank levels were considered anamalous and were not subtracted.
ND: Not Detected
** Reagent blank subtraction gives result below the reporting limit. The reporting limit was used for final results.

## TABLE J-2
## PARTICULATE ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE II UREA INJECTION
## FFDC INLET AND OUTLET

| | Sample ID | | | | | |
|---|---|---|---|---|---|---|
| Particulate Catch , mg | 10-PM/AN-IN | 11-PM/AN-IN | 12-PM/AN-IN | 10-PM/AN-OU | 11-PM/AN-OU | 12-PM/AN-OUT |
| Filter | 2431.0 | 1969.0 | 3120.7 | 1.9 | 0.6 | 1.3 |
| Probe/nozzle wash | 17106.5 | 12563.1 | 19221.2 | 11.2 | 2.8 | 2.7 |
| Acetone blank | 2.9 | 1.8 | 1.9 | 1.5 | 0.7 | 1.3 |
| Total | 19534.6 | 14530.3 | 22340.0 | 11.6 | 2.7 | 2.7 |
| Blank correction contribution | 0.02% | 0.01% | 0.01% | 13% | 25% | 48% |

Note: Results are corrected for acetone blank levels.

## TABLE J-3
## ANIONS ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE II UREA INJECTION
## FFDC INLET AND OUTLET

| Anion Distribution, mg | Reagent Blank (1) | Sample ID 10-PM/AN-IN | Sample ID 11-PM/AN-IN | Sample ID 12-PM/AN-IN | Blank Correction Contribution, % (Average) | Sample ID 10-PM/AN-OUT | Sample ID 11-PM/AN-OUT | Sample ID 12-PM/AN-OUT | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|---|---|---|---|
| **Chloride:** | | | | | | | | | |
| front-half rinse | ND < 0.05 | 0.10 | 0.20 | 0.20 | 0.0% | ND< 0.05 | ND< 0.05 | ND< 0.05 | 0.0% |
| filter | ND < 0.05 | ND< 0.05 | ND< 0.05 | ND< 0.05 | 0.0% | ND< 0.10 | ND< 0.10 | ND< 0.10 | 0.0% |
| bicarbonate/carbonate fraction (2) | ND < 0.10 | 2.5 | 1.6 | 2.8 | 0.0% | 2.7 | 2.1 | 3.5 | 0.0% |
| 3% peroxide fraction (2) | 0.46 | 0.74 | 0.69 | 0.44 | NC | 0.54 | 0.48 | 0.71 | NC |
| **Fluoride:** | | | | | | | | | |
| front-half rinse | ND < 0.03 | 1.2 | 1.0 | 0.9 | 0.0% | 0.05 | ND< 0.03 | ND< 0.03 | 0.0% |
| filter | ND < 0.03 | 1.0 | 0.80 | 1.0 | 0.0% | 0.14 | 0.14 | 0.20 | 0.0% |
| bicarbonate/carbonate fraction | ND < 0.06 | 16.8 | 12.8 | 17.7 | 0.0% | 24 | 17 | 26 | 0.0% |
| 3% peroxide fraction | 4.4 | NB | NB | NB | 0.0% | NB | NB | NB | 0.0% |
| **Phosphate:** | | | | | | | | | |
| front-half rinse | ND < 0.2 | ND< 0.2 | ND< 0.2 | ND< 0.2 | 0.0% | ND< 0.2 | ND< 0.2 | ND< 0.2 | 0.0% |
| filter | ND < 0.2 | 0.2 | 0.2 | 0.2 | 0.0% | ND< 0.4 | ND< 0.4 | ND< 0.4 | 0.0% |
| bicarbonate/carbonate fraction | ND < 0.4 | ND< 1.5 | ND< 1.3 | ND< 1.2 | 0.0% | ND< 1.6 | ND< 1.4 | ND< 1.6 | 0.0% |
| 3% peroxide fraction | ND < 0.4 | NB | NB | NB | 0.0% | NB | NB | NB | 0.0% |
| **Sulfate:** | | | | | | | | | |
| front-half rinse | ND < 0.05 | 26 | 18 | 22 | 0.0% | 1.5 | 0.13 | 0.15 | 0.0% |
| filter (2) | 0.52 | 15.0 | 13.0 | 19.0 | 3.4% | 0.50 | 0.47 | 0.47 | 90% |
| bicarbonate/carbonate fraction | ND < 0.10 | 307 | 301 | 269 | 0.0% | 267 | 373 | 240 | 0.0% |
| 3% peroxide fraction (2) | 0.7 | 3144 | 2101 | 2902 | 0.05% | 6969 | 3658 | 5213 | 0.03% |

Notes: Sulfate results for the filter and 3% peroxide fraction were reagent blank corrected for final results.

NB: No Breakthrough from bicarbonate/carbonate fraction into peroxide fraction

(1) Reagent blank levels for the bicarbonate/carbonate and 3% peroxide fractions are based on a 200 ml reagent blank volume.

(2) Chloride results for the inlet bicarbonate/carbonate and inlet and outlet 3% peroxide fraction are from Carnot confirmational titration analysis and are reagent blank corrected.

## TABLE J-4
## CYANIDE ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE II UREA INJECTION
## FFDC INLET AND OUTLET

**Laboratory blank:**

| Sample I.D. | mg/L |
|---|---|
| Prep blank | ND < 0.01 |

**Reagent Blank:**

| Sample I.D. | mg/sample |
|---|---|
| Reagent blank | ND < 0.003 |

**Samples:**

| Sample I.D. | mg/sample |
|---|---|
| 13A-CN-IN | ND < 0.006 |
| 13B-CN-IN | ND < 0.004 |
| 13C-CN-IN | ND < 0.005 |
| 13A-CN-OUT | ND < 0.006 |
| 13B-CN-OUT | ND < 0.005 |
| 13C-CN-OUT | ND < 0.005 |

Note: Results are not blank corrected.

**TABLE J-5**
**AMMONIA ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**
**FFDC INLET AND OUTLET**

| Sample I.D. | Sample Concentration ug/ml | Sample Volume ml |
|---|---|---|
| 10A-1-NH3-IN | 13.8 | 125.0 |
| 10A-2-NH3-IN | 20.9 | 122.1 |
| 10A-3-NH3-IN | 20.6 | 142.7 |
| 10A-4-NH3-IN | 12.1 | 140.4 |
| 10B-NH3-IN | 11.0 | 127.8 |
| 12A-NH3-IN | 17.7 | 140.6 |
| 12B-NH3-IN | 17.0 | 124.0 |
| 13A-NH3-IN | 19.0 | 144.8 |
| 13B-NH3-IN | 18.3 | 132.0 |
| 10-NH3-OUT | 5.6 | 126.5 |
| 12A-NH3-OUT | 12.2 | 131.1 |
| 12B-NH3-OUT | 14.4 | 131.0 |
| 12C-NH3-OUT | 10.1 | 120.2 |
| 12D-NH3-OUT | 10.7 | 130.1 |
| 12E-NH3-OUT | 13.5 | 127.1 |
| 12F-NH3-OUT | 9.2 | 120.3 |

Note: Results are not blank corrected.

**TABLE J-6**
**COAL ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**

| Parameter | Sample Date | | | | | Laboratory Prep Blank | Blank Correction Contribution,% (Average) |
|---|---|---|---|---|---|---|---|
| | Fuel 3/9 | Fuel 3/15 | Fuel 3/10 AM | Fuel 3/10 PM | Fuel 3/11 | | |
| <u>Trace Metals, ug/g:</u> <u>(ICP-AES, GFAAS, CVAAS)</u> | | | | | | | |
| Arsenic | | | ND < 3 | ND < 3 | ND < 3 | ND < 3 | 0 |
| Barium | | | 27 | 15 | 38 | 0.08 | 0.4 |
| Beryllium | | | 0.30 | 0.58 | 0.77 | ND < 0.01 | 0 |
| Cadmium | | | ND < 0.05 | ND < 0.06 | 0.06 | ND < 0.03 | 0 |
| Chromium | | | 1.2 | 2.1 | 1.0 | ND < 0.05 | 0 |
| Cobalt | | | 1.1 | 1.4 | 1.4 | ND < 0.09 | 0 |
| Copper | | | 3.8 | 4.0 | 3.3 | ND < 0.05 | 0 |
| Lead | | | 1.7 | 2.3 | 2.7 | ND < 0.5 | 0 |
| Manganese | | | 4.2 | 6.7 | 4.8 | ND < 0.05 | 0 |
| Mercury | | | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | 0 |
| Molybdenum | | | 0.4 | 0.4 | 0.7 | ND < 0.07 | 0 |
| Nickel | | | 1.0 | 1.0 | 1.0 | ND < 0.2 | 0 |
| Selenium | | | ND < 3 | ND < 3 | ND < 3 | ND < 3 | 0 |
| Phosphorus | | | 320 | 310 | 320 | ND < 5 | 0 |
| Vanadium | | | 3.5 | 5.3 | 4.2 | ND < 0.05 | 0 |
| Calcium | | | 2000 | 2900 | 1900 | 130 | 5.7 |
| Sodium | | | 540 | 670 | 950 | 270 | 34 |
| <u>Trace Metals and Chlorine, ug/g:</u> <u>(INAA)</u> | | | | | | | |
| Arsenic | | | 0.75 | 0.47 | 0.70 | | |
| Barium | | | 350 | 335 | 333 | | |
| Cadmium | | | 0.12 | 0.10 | 0.13 | | |
| Chlorine | | | 16 | 17 | 16 | | |
| Chromium | | | 3.4 | 2.4 | 2.5 | | |
| Cobalt | | | 0.97 | 1.0 | 0.79 | | |
| Molybdenum | | | 1.6 | 1.4 | 1.5 | | |
| Mercury | | | 0.011 | NR | 0.027 | | |
| Selenium | | | 1.1 | 0.9 | 2.4 | | |
| <u>Ultimate,%:</u> | | | | | | | |
| Carbon | 72.00 | 70.82 | 72.41* | – | 71.64 | | |
| Hydrogen | 5.03 | 4.92 | 5.11* | – | 5.01 | | |
| Nitrogen | 1.79 | 1.80 | 1.87* | – | 1.80 | | |
| Sulfur | 0.52 | 0.67 | 0.49* | – | 0.48 | | |
| Ash | 9.30 | 9.83 | 9.13* | – | 9.84 | | |
| Water | 10.01 | 10.26 | 9.64* | – | 9.55 | | |
| Oxygen (by difference) | 11.36 | 11.96 | 10.99* | – | 11.23 | | |
| <u>Higher heating value, Btu/lb:</u> | 12,846 | 12408 | 12692* | – | 12,584 | | |
| <u>Anion Precursors, ug/g:</u> | | | | | | | |
| Chlorine | | | 259 | 262 | 261 | | |
| Fluorine** | | | 79 | 89 | 85 | | |

Note: Ultimate, HHV and anion precursor results are presented on a dry basis.
ND: Not Detected
NR: Not Reported
* Results are for 3/10 AM and PM composite
** Results are for Phase I coal analysis

## TABLE J-7
## FLY ASH ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE II UREA INJECTION

| Parameter | Sample Date: Flyash 3/10 AM | Sample Date: Flyash 3/10 PM | Sample Date: Flyash 3/11 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Trace Metals, ug/g:** | | | | |
| Arsenic | 11 | 11 | 3.7 | ND < 1.3 |
| Barium | 1200 | 880 | 690 | ND < 0.1 |
| Beryllium | 2.4 | 2.8 | 2.4 | ND< 0.02 |
| Cadmium | ND < 1 | ND < 1 | ND < 1 | ND < 0.05 |
| Chromium | 15 | 16 | 12 | ND < 0.1 |
| Cobalt | 13 | 12 | 12 | ND< 0.2 |
| Copper | 40 | 38 | 36 | ND < 0.1 |
| Lead | 31 | 34 | 24 | ND < 0.75 |
| Manganese | 61 | 68 | 62 | ND < 0.2 |
| Mercury | 0.3 | 0.2 | 0.1 | ND < 0.1 |
| Molybdenum | 3 | 3 | 5 | ND < 0.1 |
| Nickel | 15 | 10 | 13 | ND < 0.3 |
| Selenium | ND < 8.8 | 2.6 | 4.3 | ND < 1.3 |
| Phosphorus | 4200 | 4400 | 4000 | ND < 1 |
| Vanadium | 66 | 54 | 54 | ND < 0.1 |
| Calcium | 30000 | 31000 | 30000 | ND < 5 |
| Sodium | 4100 | 5600 | 4700 | ND < 100 |
| **Anions, ug/g:** | | | | |
| Chloride | ND < 50 | ND < 50 | ND < 50 | ND < 5 |
| Fluoride | 23 | 40 | 34 | ND < 3 |
| Phosphate | ND < 200 | ND < 200 | ND < 200 | ND < 20 |
| Sulfate | 1500 | 1500 | 1500 | ND < 5 |
| Loss on Ignition (1) | 9.47 | | 9.57 | |

Notes:
ND: Not Detected
(1) LOI result reported for 3/10 is the result of analysis of a 3/10 AM and PM composite.

**TABLE J-8**
**BOTTOM ASH ANALYTICAL RESULTS SUMMARY**
**SITE 115 PHASE II UREA INJECTION**

| Parameter | Sample Date 3/10 AM | Sample Date 3/10 PM | Sample Date 3/11 | Laboratory Prep Blank | Blank Correction Contribution, % (Average) |
|---|---|---|---|---|---|
| **Trace Metals, ug/g:** | | | | | |
| Arsenic | 8.9 | 3.8 | 9.8 | ND < 1.3 | 0 |
| Barium | 880 | 1000 | 1500 | 0.4 | 0.04 |
| Beryllium | 1.4 | 1.6 | 1.8 | ND< 0.02 | 0 |
| Cadmium | ND < 0.5 | ND < 0.5 | ND < 0.5 | ND < 0.05 | 0 |
| Chromium | 9 | 10 | 10 | ND < 0.1 | 0 |
| Cobalt | 5 | 6 | 7 | ND< 0.2 | 0 |
| Copper | 14 | 15 | 19 | ND < 0.1 | 0 |
| Lead | 17 | 2.7 | 12 | ND < 0.75 | 0 |
| Manganese | 38 | 55 | 64 | ND < 0.2 | 0 |
| Mercury | ND < 0.1 | ND < 0.1 | ND < 0.1 | ND < 0.1 | 0 |
| Molybdenum | ND < 1 | ND < 1 | ND < 1 | ND < 0.1 | 0 |
| Nickel | 5 | 6 | 7 | ND < 0.3 | 0 |
| Selenium | ND < 10 | ND < 43 | ND < 12 | ND < 1.3 | 0 |
| Phosphorus | 1700 | 1900 | 2500 | ND < 1 | 0 |
| Vanadium | 21 | 24 | 27 | ND < 0.1 | 0 |
| Calcium | 15000 | 14000 | 26000 | ND < 5 | 0 |
| Sodium | 3500 | 3200 | 4300 | 120 | 3.3 |
| **Anions, ug/g:** | | | | | |
| Chloride | 270 | 240 | 250 | ND < 5 | 0 |
| Fluoride | ND < 3 | ND < 3 | ND < 3 | ND < 3 | 0 |
| Phosphate | ND < 20 | ND < 20 | ND < 20 | ND < 20 | 0 |
| Sulfate | 990 | 1400 | 1600 | ND < 5 | 0 |
| Loss on Ignition, % (1) | 1.85 | | 1.66 | | |

Note: Laboratory results are not blank corrected.
ND: Not Detected
(1) The LOI result presented for 3/10 is for a 3/10 AM and PM composite sample.

## TABLE J-9
## SLUICE WATER BLANK ANALYTICAL RESULTS SUMMARY
## SITE 115 PHASE II UREA INJECTION

| Parameter | Sample Date 3/10 AM | 3/10 PM | 3/11 | Laboratory Prep Blank |
|---|---|---|---|---|
| **Trace Metals, ug/L:** | | | | |
| Arsenic | 13 | 14 | 15 | ND < 5 |
| Barium | 320 | 330 | 350 | ND < 10 |
| Beryllium | ND < 2 | ND < 2 | ND < 2 | ND < 2 |
| Cadmium | ND < 5 | ND < 5 | ND < 5 | ND < 5 |
| Chromium | 10 | 20 | 10 | ND < 10 |
| Cobalt | ND< 20 | ND< 20 | ND< 20 | ND< 20 |
| Copper | ND< 10 | ND< 10 | ND< 10 | ND< 10 |
| Lead | ND < 3 | ND < 3 | ND < 3 | ND < 3 |
| Manganese | ND< 20 | ND< 20 | ND< 20 | ND< 20 |
| Mercury | ND < 2 | ND < 2 | ND < 2 | ND < 2 |
| Molybdenum | 100 | 100 | 100 | ND < 10 |
| Nickel | ND < 30 | ND < 30 | ND < 30 | ND < 30 |
| Selenium | 24 | 21 | 25 | ND < 5 |
| Phosphorus | 700 | 600 | 600 | ND < 100 |
| Vanadium | 50 | 50 | 50 | ND < 10 |
| Calcium | 260000 | 260000 | 270000 | ND < 500 |
| Sodium | 200000 | 200000 | 210000 | ND < 500 |
| **Anions, mg/L:** | | | | |
| Chloride | 220 | 230 | 210 | ND < 0.5 |
| Fluoride | 3.3 | 3.3 | 3.4 | ND < 0.3 |
| Phosphate | ND < 2 | ND < 2 | ND < 2 | ND < 2 |
| Sulfate | 850 | 880 | 890 | ND < 0.5 |

Note: Sluice water blank results were used for blank correction of bottom ash sample results.
ND: Not Detected

**TABLE J-10**
**SUMMARY OF BLANK CORRECTIONS**
**MADE TO ANALYTICAL DATA**
**SITE 115 PHASE II UREA INJECTION**

| Sample Type | Parameter | Type of Blank Correction | Blank Correction Contribution |
|---|---|---|---|
| Exhaust Gas, Inlet | Arsenic | Reagent Blank | 4.2% |
| | Barium | Reagent Blank | 1.6% |
| | Beryllium | None | 0.0% |
| | Cadmium | None | 0.0% |
| | Chromium | Laboratory Blank | 1.1% |
| | Cobalt | None | 0.0% |
| | Copper | None | 0.0% |
| | Lead | Reagent Blank | 6.3% |
| | Manganese | Reagent Blank | 0.6% |
| | Mercury | None | 0.0% |
| | Molybdenum | Reagent Blank | 29% |
| | Nickel | Reagent Blank | 2.1% |
| | Selenium | None | 0.0% |
| | Phosphorus | None | 0.0% |
| | Vanadium | None | 0.0% |
| | Calcium | Reagent Blank | 4.9% |
| | Sodium | Reagent Blank | 48% |
| Exhaust Gas, Outlet | Arsenic | Reagent Blank | 71% |
| | Barium | Reagent Blank | 79% |
| | Beryllium | None | 0.0% |
| | Cadmium | None | 0.0% |
| | Chromium | Laboratory Blank | 43% |
| | Cobalt | None | 0.0% |
| | Copper | None | 0% |
| | Lead | Reagent Blank | 7% |
| | Manganese | Reagent Blank | 46% |
| | Mercury | None | 0.0% |
| | Molybdenum | Reagent Blank | 93% |
| | Nickel | Reagent Blank | 33% |
| | Selenium | None | 0.0% |
| | Phosphorus | None | 0.0% |
| | Vanadium | None | 0.0% |
| | Calcium | Reagent Blank | 50% |
| | Sodium | Reagent Blank | 80% |
| Exhaust Gas, Inlet | Particulate | Reagent Blank | 0.02% |
| Exhaust Gas, Outlet | Particulate | Reagent Blank | 29% |

(continued)

## TABLE J-10 (continued)
## SUMMARY OF BLANK CORRECTIONS
## MADE TO ANALYTICAL DATA
## SITE 115 PHASE II UREA INJECTION

| Sample Type | Parameter | Type of Blank Correction | Blank Correction Contribution |
|---|---|---|---|
| Exhaust Gas, Inlet | Chloride: front half | None | 0.0% |
| | filter | None | 0.0% |
| | carbonate | None | 0.0% |
| | 3% peroxide | Reagent Blank | NC |
| | Fluoride (all sample train fractions) | None | 0.0% |
| | Phosphate (all sample train fractions) | None | 0.0% |
| | Sulfate: front-half | None | 0.0% |
| | filter | Reagent Blank | 3.4% |
| | carbonate | Reagent Blank | 0.5% |
| | 3% peroxide | Reagent Blank | 0.05% |
| Exhaust Gas, Outlet | Chloride: front half | None | 0.0% |
| | filter | None | 0.0% |
| | carbonate | None | 0.0% |
| | 3% peroxide | Reagent Blank | NC |
| | Fluoride (all sample train fractions) | None | 0.0% |
| | Phosphate (all sample train fractions) | None | 0.0% |
| | Sulfate: front-half | None | 0.0% |
| | filter | Reagent Blank | 90% |
| | carbonate | None | 0.0% |
| | 3% peroxide | Reagent Blank | 0.03% |
| Exhaust Gas, Inlet | Cyanide | None | 0.0% |
| Exhaust Gas, Outlet | Cyanide | None | 0.0% |
| Exhaust Gas, Inlet | Ammonia | None | 0.0% |
| Exhaust Gas, Outlet | Ammonia | None | 0.0% |

(continued)

**TABLE J-10 (continued)**
**SUMMARY OF BLANK CORRECTIONS**
**MADE TO ANALYTICAL DATA**
**SITE 115 PHASE II UREA INJECTION**

| Sample Type | Parameter | Type of Blank Correction | Blank Correction Contribution |
|---|---|---|---|
| Coal | Arsenic | None | 0.0% |
| (ICP-AES, GFAAS, CVAAS | Barium | Laboratory Blank | 0.4% |
| | Beryllium | None | 0.0% |
| | Cadmium | None | 0.0% |
| | Chromium | None | 0.0% |
| | Cobalt | None | 0.0% |
| | Copper | None | 0.0% |
| | Lead | None | 0.0% |
| | Manganese | None | 0.0% |
| | Mercury | None | 0.0% |
| | Molybdenum | None | 0.0% |
| | Nickel | None | 0.0% |
| | Selenium | None | 0.0% |
| | Phosphorus | None | 0.0% |
| | Vanadium | None | 0.0% |
| | Calcium | Laboratory Blank | 5.7% |
| | Sodium | Laboratory Blank | 34% |
| Coal (INAA) | Trace Metals and Chlorine | None | 0.0% |
| Flyash | Trace Metals and Anions | None | 0.0% |
| Bottom Ash* | Trace Metals and Anions (except Ba) | None | 0.0% |
| | Barium | Laboratory Blank | 0.04% |
| | Sodium | Laboratory Blank | 3.3% |
| Sluice Water Blanks | Trace Metals and Anions | None | 0.0% |

* Bottom ash results were corrected for sluice water blank levels for final results. Blank correction contribution for laboratory blanks is 0%.