AP42 Section:	1.1
Reference:	44
Title:	Assessment of Toxic Emissions From a Coal Fired Power Plant Utilizing an ESP. Final Report- Revision 1. Energy and Environmental Research Corporation, Irvine, California. December 23, 1993.

29

ASSESSMENT OF TOXIC EMISSIONS FROM A COAL FIRED POWER PLANT UTILIZING AN ESP

P 5-16
PQL's = practical quantitation limits

DOE Contract No. DE-AC22-93PC93252

Draft Final Report - Revision 1

Cardinal

prepared for
U.S. Department of Energy
Pittsburgh Energy Technology Center
Wallace Road
Pittsburgh, PA 15236-0940

prepared by
Energy and Environmental Research Corporation
18 Mason
Irvine, California 92718

December 23, 1993

"U.S./DOE Patent Clearance is not required prior to the publication of the report"

1.0 EXECUTIVE SUMMARY

This report summarizes results of a project to characterize air toxics emissions from a utility boiler burning high sulfur bituminous coal. The project is part of a cooperative industry-government program sponsored by the U.S. Department of Energy (DOE) in cooperation with the U.S. Environmental Protection Agency (EPA), the Electric Power Research Institute (EPRI), and the Utility Air Regulatory Group. The program investigated emissions from a range of electric utilities burning lignite, bituminous, and sub-bituminous coals in a wide variety of power plant designs. Tests were conducted on designs ranging from older units without NO_X or SO_2 controls to units with advanced control technologies being demonstrated under the DOE's Clean Coal Technology Program.

This project was conducted at Cardinal Plant Unit # 1 of the Ohio Power Company, an operating company of American Electric Power Service Corporation, located in Brilliant, Ohio. The field campaign was conducted from June 23 to July 1, 1993.

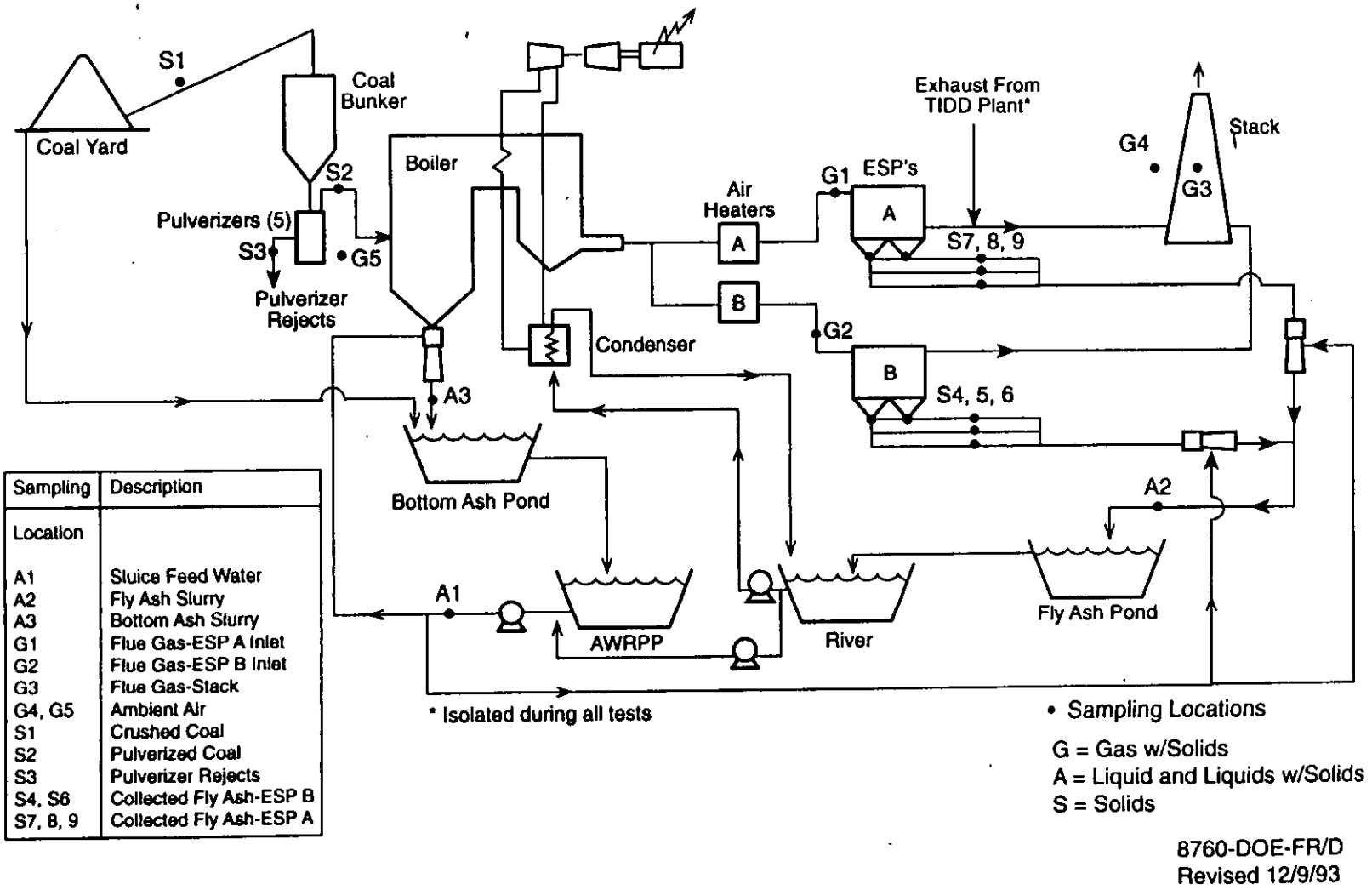
1.2 Process Summary

Cardinal Plant Unit # 1 is a 615 MWe unit. A process flow diagram of the host unit is provided in Figure 1-1. The boiler employs 5 pulverizers feeding a total of 30 burners on the front and back walls of the boiler furnace, 20 of which are in cell burner arrangements (two coal nozzles each). The unit is equipped with two electrostatic precipitators (ESPs) arranged in parallel and a wet handling system for fly ash and bottom ash. The unit burned Pittsburgh No. 8 high sulfur bituminous coal during the test program.

Prior to the test, EER, DOE, and AEPSC established criteria for plant operation to ensure that normal process variations were included and that conditions considered atypical of normal operation could be clearly identified. Table 1-1 summarizes target and actual operating conditions for the boiler and ESP during the tests. All target operating conditions were achieved during sampling. Boiler operation was very steady during the tests, based on the small degree of excess O_2 variation during each run and between runs.

1.3 Test Measurements

The matrix of emissions measurements performed on each day of testing, shown in



Sampling Location	Description
A1	Sluice Feed Water
A2	Fly Ash Slurry
A3	Bottom Ash Slurry
G1	Flue Gas-ESP A Inlet
G2	Flue Gas-ESP B Inlet
G3	Flue Gas-Stack
G4, G5	Ambient Air
S1	Crushed Coal
S2	Pulverized Coal
S3	Pulverizer Rejects
S4, S6	Collected Fly Ash-ESP B
S7, 8, 9	Collected Fly Ash-ESP A

Figure 1-1. Cardinal Unit #1 process overview and sampling locations.

TABLE 1-1. PLANT OPERATING CONDITIONS

TABLE 1-2. FLUE GAS MEASUREMENT MATRIX

	ESP B Inlet	ESP A Inlet	Stack
"O" Days	M0010/23 VOST (VOC) 0011 (Aldehyde) M26 (Acid Gases) M5 (Particulate) O2 (Teledyne)	None	M0010/23 (SVOC) VOST (VOC) 0011 (Aldehyde) M26 (Acid Gases) M5 (Particulate) CEMS (O2, CO2, CO, NOx, SO2, THC)
"M" Days	MMT (Metals) Carbon Trap (As, Hg, Se) Cyclones (Metals) Cyclones (PSD) O2 (Teledyne)	MMT (Metals) O2 (Teledyne)	MMT (Metals) Carbon Trap (As, Hg, Se) BIF 13 (Hexavalent Chromium) Cyclones (Metals) Impactors (PSD) CEMS (O2, CO2, CO, NOx, SO2)

Traversing Isokinetic Trains	Single Point Isokinetic Trains	Nonisokinetic Trains
Method 0010 (SW-846)/23 SVOCs PCDD/PCDF (1) POM/PAH Velocity, H2O Method 29 Trace metals Total Particulate emissions Velocity, H2O BIF 11 Hexavalent Chromium Method 5 Total particulate emissions Radionuclides Velocity, H2O Bulk fly ash analyses: Carbon Chloride, fluoride Sulfates, phosphates Macro Elements Impinger analysis: TOC Sulfates, phosphates	Method 0011 (SW-846) Formaldehyde Ketones Aldehydes Series Cyclones Fractionated fly ash for metals PSD - ESP Inlet Impactors PSD - Stack	VOST (SW-846) VOCs Carbon Trap Volatile Metals (As, Hg, Se) Method 26 HCl and Cl HF NH HCN Continuous Emissions Monitoring O2 CO2 CO NOx SO2 Total Hydrocarbons Method 18 1,3 Butadiene

8760-DOE-FR/D
Revised 12/9/93

Table 1-2, included three days of testing primarily for organics followed by three days of testing primarily for trace metals and anions. All measurements were made in triplicate. To the extent possible, measurements of similar species were performed simultaneously at all locations. The inlet to one ESP and the stack were sampled for all substances and characteristics; the inlet to the other ESP was sampled for trace metals and total particulate matter only. Also, separate measurements of trace metals (in triplicate) and semivolatile organics (single run) were made at the stack during sootblowing. Table 1-3 summarizes the sampling and analytical methods employed. All measurements were made in accordance with the requirements of an EPA Category II Quality Assurance Project Plan. External quality assurance audits of the measurements were conducted in the field and in the laboratory by Research Triangle Institute on behalf of EPA.

1.4 Test Results

Table 1-4 summarizes the individual or classes of hazardous air pollutants (HAPs) included in Title III of the 1990 Clean Air Act Amendments (CAAA) which were detected in the flue gas of the Cardinal Plant. 47 of the 189 CAAA HAPs were detected at the stack. Of these, 31 were detected with a high degree of confidence because the measurements satisfied all of the project quality assurance criteria.

1.4.1 Mass Balance

Mass balances were used to provide an overall indication of measurement data quality. Table 1-5 presents total mass and ash mass flow rates. The results indicate generally very good closure for each test run. Measured bottom ash flow rates varied significantly from run to run. Calculated retention of mineral matter in the coal as bottom ash ranged from about 2 to 16 percent and averaged 9 percent for all tests based on bottom ash slurry flow measurements. This seems reasonable considering that furnace ash deposit formation and removal probably is very irregular, having time constants possibly on the order of days, and that only two of the four bottom ash sluice events were sampled during each test day. Bottom ash retention calculated by difference between fly ash and coal measurements averaged 11 percent, which is in excellent agreement with that calculated from the average bottom ash slurry flow rate measurements.

The collected fly ash flow rates measured on metals test days are suspect. The data do not compare well with previous measurements on organics days and do not agree with calculated flow rates based on flue gas fly ash measurements. Collected fly ash flow rate was determined by

measuring fly ash slurry flow rate and determining the percent solids in the slurry by filtration. Liquid and slurry samples were filtered on-site for preservation purposes. The cause of the discrepancy is most likely a procedural error in how the fly ash slurry samples were filtered in the field, since different personnel performed fly ash slurry sample recovery on metals and organics days. Therefore collected fly ash flow rate for metals days was calculated by difference based on flue gas measurements instead of measured fly ash slurry flow rate. The overall impact on the quality of the test results is minor since air emissions data are not affected.

Mass balance closure on individual trace metals was generally within ±50 percent of the total input level, where all metals were measured at levels significantly above the detection limits. Apparent closure of metals which were measured at concentrations below the detection limits was generally within ±100 percent, however some exceeded ±200 percent of the input. Overall, mass balances for carbon, sulfur, and selected major elements were considered excellent.

1.4.3 Emission Factors

Emission factors for all pollutants in gas, solid, and liquid streams were developed based on the test results. Emission factors for air emissions, i.e., final stack emissions, were the primary focus of this project. The emission factors reported in this section of the report have been corrected for blank results (see Section 6). Table 1-6 summarizes the average concentration and emission factors in the flue gas for the sixteen trace metals considered in this program. Also shown for comparison are levels of these metals in the coal, bottom ash, and collected fly ash expressed in emission factor units. The table includes detection limits where concentrations were not detected. In general, the level of emissions was very low. The levels of almost all of the trace metals except cadmium and nickel were approximately one to two orders of magnitude lower than data reported by EPRI [1]. Cadmium emissions were in good agreement with the EPRI data set, while nickel emissions were about half the level reported there. Mercury emissions were at the extreme low end of the range reported by EPA [2], who indicated emissions ranging from 0.4 to 308 lb/10^{12} Btu for bituminous coal fired units. Measurements to measure total and hexavalent chromium showed that hexavalent chromium is a very small fraction of total chromium emissions, despite the fact that hexavalent chromium emissions were biased high due to analytical interferences.

The data shown in Table 1-6 were taken in the absence of sootblowing. Separate measurements made during sootblowing did not reveal any consistent trend in emissions compared to measurements without sootblowing. Table 1-7 presents emission factors at the stack including

4. Based on difference between fly ash in flue gas at ESP inlets and at stack

TABLE 1-7. EMISSION FACTORS INCLUDING SOOTBLOWER OPERATION.

SUBSTANCE	EMISSION FACTOR (lb/1E12Btu)		
	Non-Sootblowing	Sootblowing	Composite*
Macro Metals			
Aluminum	235	162	217
Calcium	283	340	297
Iron	568	187	473
Magnesium	16.4	15.2	16.1
Phosphorous	141	139	141
Potassium	88.7	70.6	84.1
Silicon	ND 60.9	ND 112	73.8
Sodium	249	198	237
Titanium	16.6	11.8	15.4
Zinc	18.3	29.0	21.0
Trace Metals			
Antimony	2.36	1.42	2.12
Arsenic	3.49	1.95	3.10
Barium	0.872	0.578	0.798
Beryllium	0.070	0.038	0.062
Boron	1912	1747	1871
Cadmium	0.846	0.663	0.800
Chromium	7.51	2.14	6.17
Cobalt	0.631	0.305	0.550
Copper	1.39	1.09	1.31
Lead	3.83	3.61	3.78
Manganese	15.0	20.3	16.4
Mercury	0.448	0.779	0.531
Molybdenum	0.567	0.271	0.493
Nickel	4.72	1.79	3.99
Selenium	92.8	65.0	85.9
Silver	0.200	ND 0.350	0.238
Vanadium	1.57	1.65	1.59
Dioxins/Furans			
2378-TCDF	6.58E-07	ND 1.83E-06	9.52E-07
Total TCDD	ND MAX 5.15E-05	1.72E-06	3.91E-05
Total PeCDF	2.79E-06	ND 7.60E-05	2.11E-05
123478-HxCDD	ND 1.89E-06	6.04E-07	1.56E-06
123678-HxCDF	ND 1.25E-06	8.38E-07	1.14E-06
Total HxCDF	ND MAX 2.51E-05	3.90E-06	1.98E-05
Total-HxCDD	ND MAX 2.23E-05	6.04E-07	1.69E-05
1234678-HpCDD	2.25E-06	2.34E-06	2.27E-06
1234678-HpCDF	2.03E-06	ND 2.34E-06	2.11E-06
Total-HpCDD	ND MAX 7.61E-06	2.34E-06	6.29E-06
Total-HpCDF	2.68E-06	ND 9.75E-06	4.45E-06
OCDD	2.03E-05	1.85E-05	1.98E-05
OCDF	1.07E-05	7.80E-06	9.99E-06
SVOC			
Benzyl chloride	ND 53.9	87.0	62.2
Isophorone	23.3	ND 78.0	36.9
Dimethyl sulfate	1.83	ND 0.257	1.44
Naphthalene	1.94	ND 0.858	1.67

ND MAX - Indicates the average of detected and non-detected runs is below one-half the maximum detection limit (Full detection limit for maximum run provided).

ND - Indicates the average includes all non-detected runs (Full detection limits used in average).

* Composite = 0.25*Sootblowing + 0.75*Nonsootblowing

8760-DOE-FR/D
12/23/93

TABLE 1-8. ORGANIC EMISSION FACTORS

SUBSTANCE	EMISSION FACTOR (lb/E12Btu)	CONCENTRATION (µg/dscm)
No Sootblowing		
2-Butanone (1)	48.1	53.9
Formaldehyde (1)	60.0	66.7
2378-TCDF (2)	6.6E-07	7.0E-07
Total PeCDF	2.8E-06	3.0E-06
1234678-HpCDD	2.2E-06	2.4E-06
1234678-HpCDF	2.0E-06	2.2E-06
Total-HpCDF	2.7E-06	2.9E-06
OCDD	2.0E-05	2.2E-05
OCDF	1.1E-05	1.1E-05
Isophorone	23.3	25.0
Dimethyl sulfate	1.83	1.95
Naphthalene	1.94	2.07
Acetone	42.1	44.3
Benzene	3.40	3.57
Bromomethane	15.1	15.8
Chloroform	2.92	3.11
Chloromethane (2)	6.38	6.75
Hexane (2)	6.53	6.89
Iodomethane (2)	9.64	10.1
m,p-Xylene	2.98	3.15
Methyl Hydrazine (2)	6.57	6.94
Methyl tert-butyl Ether (2)	1.36	1.44
Toluene	5.16	5.43
Trichlorofluoromethane	15	16
Additional Substances Detected During Sootblowing		
Total TCDD	1.7E-06	1.9E-06
123478-HxCDD	6.0E-07	6.6E-07
123678-HxCDF	8.4E-07	9.1E-07
Total HxCDF	3.9E-06	4.2E-06
Total-HxCDD	6.0E-07	6.6E-07
Total-HpCDD	2.3E-06	2.5E-06
Benzyl chloride	8.7E+01	9.5E+01

(1) These had blank corrections over 50%.

(2) These were near the detection limit.

8760-DOE-FR/D
12/10/93

TABLE 1-9. CORRECTED EMISSIONS FACTORS FOR OTHER SUBSTANCES AND CRITICAL TARGET ANALYTES.

SUBSTANCE	CONCENTRATION		EMISSION FACTOR	
	Units	Value	Units	Value
Macro Metals				
Aluminum	µg/dscm	256	lb/1E12Btu	235
Calcium	µg/dscm	307	lb/1E12Btu	283
Iron	µg/dscm	618	lb/1E12Btu	568
Magnesium	µg/dscm	17.8	lb/1E12Btu	16.4
Phosphorous	µg/dscm	154	lb/1E12Btu	141
Potassium	µg/dscm	96.2	lb/1E12Btu	88.7
Silicon (1,2)	µg/dscm	65.4	lb/1E12Btu	60.9
Sodium	µg/dscm	269	lb/1E12Btu	249
Titanium	µg/dscm	18.0	lb/1E12Btu	16.6
Zinc	µg/dscm	19.8	lb/1E12Btu	18.3
Acid Gas				
Ammonia	µg/dscm	44.2	lb/1E12Btu	40.7
Chlorine	µg/dscm	1,693	lb/1E12Btu	1,547
Fluorine (2)	µg/dscm	11,953	lb/1E12Btu	10,924
Hydrogen Chloride	µg/dscm	24,941	lb/1E12Btu	22,915
Hydrogen Cyanide (2)	µg/dscm	0.647	lb/1E12Btu	0.591
Hydrogen Fluoride	µg/dscm	2,034	lb/1E12Btu	1,869
Phosphate/Sulfate				
Phosphate (2)	µg/dscm	1,009	lb/1E12Btu	923
Sulfate	µg/dscm	879,000	lb/1E12Btu	800,000
Continuous Emission Monitoring				
CO	ppm (dry, a.m.)	0.710	lb/1E12Btu	753
THC	ppm (dry, a.m.)	0.598	lb/1E12Btu	365
NOx	ppm (dry, a.m.)	704	lb/1E6Btu	1.22
SOx	ppm (dry, a.m.)	1,839	lb/1E6Btu	4.41
Radionuclides				
Pb-210	pCi/dscm	178	lb/1E6Btu	72,665
Ra-226 (2)	pCi/dscm	15.5	lb/1E6Btu	6,311
Ra-228 (2)	pCi/dscm	35.8	lb/1E6Btu	14,608
Th-230 (2)	pCi/dscm	651	lb/1E6Btu	2.7E+05
U-234 (2)	pCi/dscm	2,889	lb/1E6Btu	1.2E+06
U-235	pCi/dscm	19.8	lb/1E6Btu	8,078
U-238	pCi/dscm	228	lb/1E6Btu	93,223

(1) These had blank corrections over 50%.
(2) These were near the detection limit
a.m. = as measured

8760-DOE-FR/D
12/23/93

6.0 RESULTS

This section provides results from the sampling and analysis activities. Most results are provided on a condition average basis due to the quantity of information generated. Run specific results are provided in appendices G, H, and I. To aid in the review and interpretation of the data in this section and the appendices, the following sub-sections describe the presentation format and the procedures for handling blanks and nondetected data. Section 6.1.3 should be consulted before reviewing the data tables in this section. Results for the flue gas, solid, and liquid streams are provided in Sections 6.2, 6.3, and 6.4, respectively. Process mass flow rates are summarized in Section 6.5 and ambient air sampling results are presented in Section 6.6.

6.1 Data Reduction and Reporting

To ensure that results from each of the eight test sites can be reviewed and compared easily, the DOE established specific guidance for the data reduction and reporting phases of the project. The data reduction guidance includes procedures on how to average and sum data below the analytical detection limit and how to report and correct data with field, method, trip or reagent blank detections. A detailed discussion of these procedures is provided in Section 6.1.1 and 6.1.2. Section 6.1.3 describes the data reporting format used to present a majority of the information provided in Sections 6.2, 6.3, 6.4, and 6.5. Section 6.1.4 provides definition of terms that are used to describe the data and its quality.

6.1.1 Non-Detects

This section presents the procedures for averaging, summing, and reporting various combinations of detected and non-detected values. A non-detected value is one which is below the analytical detection limit.

All values detected. The arithmetic average or sum is taken, as appropriate. No special techniques are required.

All values below the detection limit. For individual test runs or species, the data are denoted as "ND" and the detection limit is provided. For cases where all three runs are below the detection limit, the average is denoted as "ND" and the average of the detection limits for the three runs is provided.

Some values are detected and some are non-detects. As an approximation, half of the detection limit for non-detect values and the actual value for detects is used to determine reported values. As an example of averaging, an average for three test runs with results of 10, 8 and ND 6 would be 7. As an example for summing (such as for mercury fractions), individual species values of 50, ND 1, and ND 2 would be summed to provide a value of 50+.5+1, or 51.5. In reporting these types of sums or averages, no sign is used. The only exception to this rule occurs when the average is less than the highest detection limit of the non-detected values. In this case, the average is reported as "ND MAX" and the maximum detection limit is provided. For example, 5, ND 4 and ND 3 would be reported as "ND MAX" 4.

This approach also is used to obtain test train totals which required analyses of separate fractions for each individual run. Specifically, the metals test train totals (total front half and back half) for each run are obtained by addition of test train fractions which were analyzed separately. Fractions from the volatile test train included separate analyses of the tenax and condensate for each sample period. Separate analyses also were conducted on the filtrate and solid components for the liquid process streams.

Detection limit ratio. These methods of treating the data may result in some loss of information in going from raw data to final values. Specifically, what is often lost is the amount of a final emissions value that is attributable to detection limits and the amount that is attributable to measured values. To quantify and present this information, all results in this report are presented along with the "Detection Limit Component Ratio," which is calculated as the ratio of the contribution of detection limit values to a final emission result. For example, a set of three values of 8, ND 3, and ND 2 should be reported as 3.5, with a detection limit ratio of 23.8% ((1+1.5)/(8+1.5+1)). The different ratios provide insight as to the extent something is "really there," and hopefully can help provide better information to those making decisions on risk and policy issues.

6.1.2 Blank Values

The treatment of blank values is critical in interpreting data, since in many cases species are detected but not at levels significantly higher than blanks. In these cases measured values may not represent emissions, but rather just limitations of the method. However, most of the test methods used in this program either do not allow subtraction of blanks or are silent on how to treat blank values.

TEST REPORT TITLE:	Assessment of Toxic Emissions From a Coal Fired Power Plan Final Report-Revision 1. Energy and Environmental Researc Irvine, California. December 23, 1993.
COAL EF DATABASE REFERENCE NO.	29
FILENAME	DOE5.WK1
FACILITY:	Brillian, Ohio, Cardinal Unit 1

PROCESS DATA

Coal type a	Bituminous
Boiler configuration b	Pulverized, Dry bottom
Coal source a	Pennysylvania
SCC	10100202
Control device 1 a	ESP
Control device 2	None
Control device 3	None
Data Quality	D (no HHV for the coal, had to use average from AP-42)
Process Parameters a	615
Test methods c	EPA, or EPA-approved, test methods
Number of test runs d	3
Coal HHV, as received (Btu/lb) e	13,000
Coal HHV, as received (Btu/ton)	26,000,000
Coal HHV, as received (MMBtu/ton)	26.0

a Page 1-1

b Page 1-1 for "pulverized", Conversation with Greg Behrens, Radian Austin, for "dry bottom".

c Page 1-4

d Page 1-5

e Appendix A of AP-42, "Typical Parameters of Various Fuels".

METALS EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Aluminum	235	2.35E-04	6.11E-03
Calcium	283	2.83E-04	7.36E-03
Iron	568	5.68E-04	1.48E-02
Magnesium	16.4	1.64E-05	4.26E-04
Phosphorous	141	1.41E-04	3.67E-03
Potassium	88.7	8.87E-05	2.31E-03
Silicon b	60.9	6.09E-05	1.58E-03
Sodium	249	2.49E-04	6.47E-03
Titanium	16.6	1.66E-05	4.32E-04

Zinc	18.3	1.83E-05	4.76E-04
Antimony	2.36	2.36E-06	6.14E-05
Arsenic	3.49	3.49E-06	9.07E-05
Barium	0.872	8.72E-07	2.27E-05
Beryllium	0.070	7.00E-08	1.82E-06
Boron	1,912	1.91E-03	4.97E-02
Cadmium	0.846	8.46E-07	2.20E-05
Chromium	7.51	7.51E-06	1.95E-04
Cobalt	0.631	6.31E-07	1.64E-05
Copper	1.39	1.39E-06	3.61E-05
Lead	3.83	3.83E-06	9.96E-05
Manganese	15.0	1.50E-05	3.90E-04
Mercury	0.448	4.48E-07	1.16E-05
Molybdenum	0.567	5.67E-07	1.47E-05
Nickel	4.72	4.72E-06	1.23E-04
Selenium	92.8	9.28E-05	2.41E-03
Silver	0.200	2.00E-07	5.20E-06
Vanadium	1.57	1.57E-06	4.08E-05

a Page 1-11

b Detection limit value used for at least one run in developing EF.

DIOXINS/FURANS EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Total TCDD b	5.15E-05	5.15E-11	1.34E-09
Total HxCDD b	2.23E-05	2.23E-11	5.80E-10
Total HpCDD b	7.61E-06	7.61E-12	1.98E-10
Total OCDD	2.03E-05	2.03E-11	5.28E-10
2,3,7,8-TCDF	6.58E-07	6.58E-13	1.71E-11
Total PeCDF	2.79E-06	2.79E-12	7.25E-11
Total HxCDF b	2.51E-05	2.51E-11	6.53E-10
Total HpCDF	2.68E-06	2.68E-12	6.97E-11
Total OCDF	1.07E-05	1.07E-11	2.78E-10

a Page 1-11

b Detection limit value used for at least one run in developing EF.

SEMIVOLATILE ORGANICS EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Benzyl Chloride b	53.9	5.39E-05	1.40E-03
Isophorone	23.3	2.33E-05	6.06E-04
Dimethyl Sulfate	1.83	1.83E-06	4.76E-05

Naphthalene	1.94	1.94E-06	5.04E-05

a Page 1-11

b Detection limit value used for at least one run in developing EF.

ORGANIC EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Formaldehyde	60.0	6.00E-05	1.56E-03
Benzene	3.40	3.40E-06	8.84E-05
Bromomethane (Methyl Bromide)	15.1	1.51E-05	3.93E-04
Chloroform	2.92	2.92E-06	7.59E-05
Chloromethane (Methyl Chloride)	6.38	6.38E-06	1.66E-04
Hexane	6.53	6.53E-06	1.70E-04
m,p-Xylene	2.98	2.98E-06	7.75E-05
Methyl Hydrazine	6.57	6.57E-06	1.71E-04
Methyl Tert Butyl Ether	1.36	1.36E-06	3.54E-05
Toluene	5.16	5.16E-06	1.34E-04

a Page 1-13

OTHER EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Ammonia	40.7	4.07E-05	1.06E-03
Chlorine	1,547	1.55E-03	4.02E-02
Hydrogen Chloride	22,915	2.29E-02	5.96E-01
Hydrogen Cyanide	0.591	5.91E-07	1.54E-05
Hydrogen Fluoride	1,869	1.87E-03	4.86E-02
CO	753	7.53E-04	1.96E-02
THC	365	3.65E-04	9.49E-03
NOX		1.22E+00	3.17E+01
SOX		4.41E+00	1.15E+02

a Page 1-14. Note that SOx and NOx units are lb/MMBtu.