Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference maybe from a previous version of the section and no longer cited. The primary source should always be checked.

AP42 Section:	1.1
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WESTON Project No. 10016-011

TOXICS ASSESSMENT REPORT

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER - UNIT 2
COHASSET, MINNESOTA

Volume I - Main Report
December 1993

DRAFT

DOE Project:

COMPREHENSIVE ASSESSMENT OF TOXIC EMISSIONS
FROM COAL-FIRED POWER PLANTS

Prepared for:

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speciation, hexavalent chromium measurements, volatile organic compounds methods comparison, evaluation of the effects of soot blowing on metals emissions, determination of toxics on particle surfaces, and trace element partitioning and enrichment. Further assessments are planned during Project Phase II in 1994.

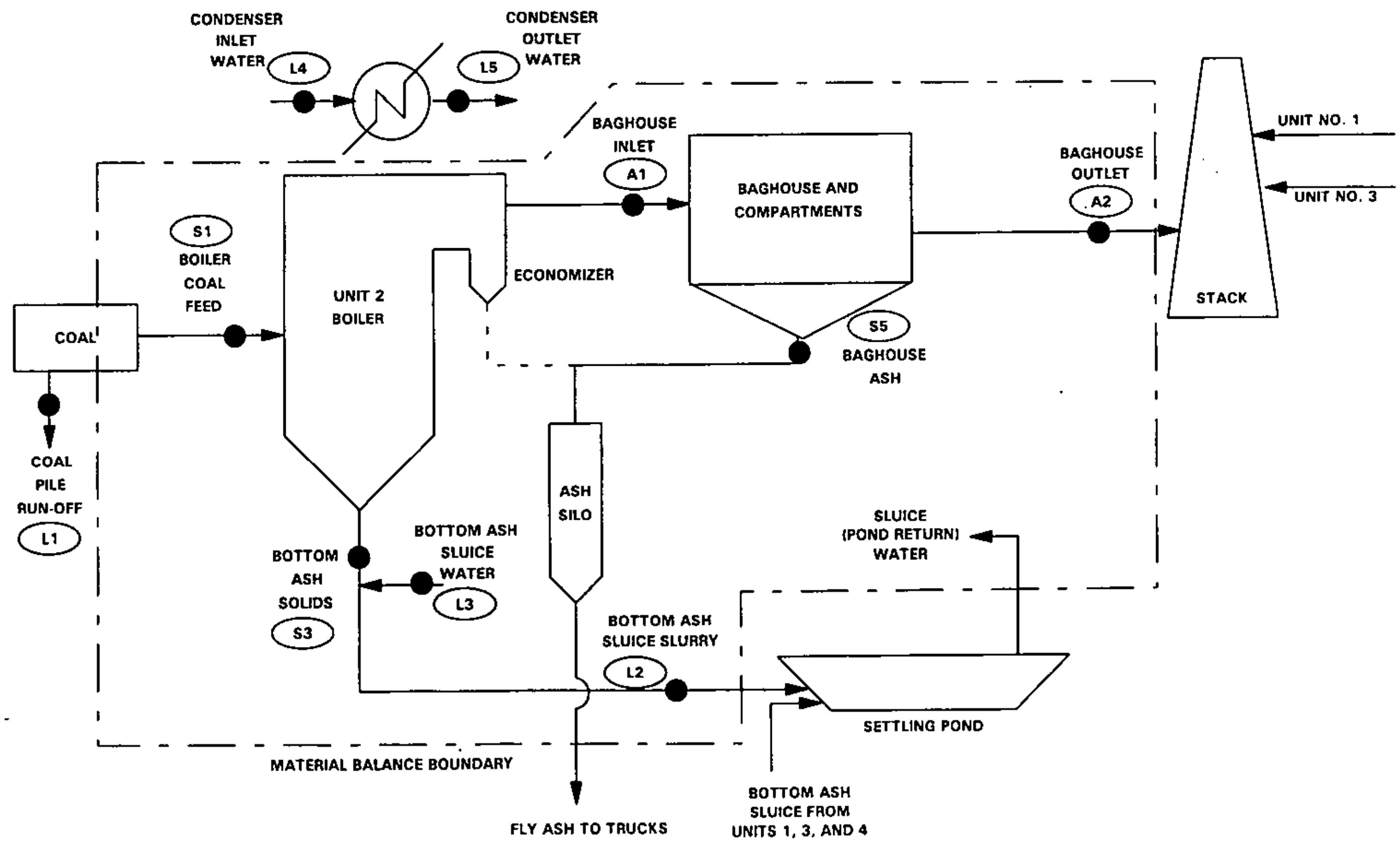
The results of this Phase I power plant toxics investigation, in conjunction with the information obtained from the seven other similar assignments, will be used to assemble an acceptable and needed database for EPA regulatory decision-making, risk assessment, and emission factor update.

Boswell Energy Center Unit 2, built in 1957, is rated at 69 MWe. This unit features a Riley Stoker front-fired boiler that processes pulverized western subbituminous coal from the Powder River Basin area. Average "as fired" coal characteristics during this assessment were 8.4% ash, 0.7% sulfur, 24.8% moisture, and 8,800 Btu/lb higher heating value. Particulate emissions are controlled by an eight compartment Joy-Western baghouse employing fiberglass bags that is rated at 99.7% efficiency. Unit 2 has no other air pollution control equipment installed.

A process flow diagram showing program sampling and testing locations is presented in Figure ES-1. All significant process solid, liquid, and gas streams entering and exiting the process boundary (plus those associated with the baghouse) were sampled on a simultaneous basis to characterize HAPs emissions, the distribution (i.e., concentration and mass rate) of criteria and non-criteria pollutants, and pollutant control efficiencies. Corresponding process and APCE operating parameters were documented during all test periods.

Triplicate sets of inorganic and organic parameter tests were conducted over a 6-day period in June 1993. The pollutants or parameters that were determined in this study are summarized in Tables 1-2 through 1-4 of Section 1 for process solid, liquid, and gas streams, respectively. The sampling, testing, and analytical methods used to determine these pollutants or parameters are identified in Tables 1-5 through 1-7 of Section 1 for process solid, liquid, and gas stream

SAMPLE NUMBER	SAMPLE IDENTIFICATION
SOLIDS*:	
S1	BOILER COAL FEED
S3	BOTTOM ASH SOLIDS
S5	BAGHOUSE ASH
LIQUIDS:	
L1	COAL PILE RUN-OFF
L2	BOTTOM ASH SLUICE SLURRY
L3	BOTTOM ASH SLUICE WATER
L4	CONDENSER INLET WATER
L5	CONDENSER OUTLET WATER
AIR STREAM:	
A1	BAGHOUSE INLET
A2	BAGHOUSE OUTLET



* SOLIDS STREAMS S2 (MILL REJECTS) AND S4 (ECONOMIZER ASH) ARE NOT GENERATED DURING NORMAL OPERATIONS.

FIGURE ES-1
PROCESS FLOW DIAGRAM AND SAMPLING/TESTING LOCATIONS
BOSWELL ENERGY CENTER UNIT NO. 2

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MANAGERS DESIGNERS/CONSULTANTS

TABLE 1-7

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER - UNIT 2 - COHASSET, MINNESOTA
GAS MATRIX POLLUTANTS/PARAMETERS AND ASSOCIATED
SAMPLING, TESTING, AND/OR ANALYTICAL METHODS

POLLUTANTS OR PARAMETERS	SAMPLING, TESTING, AND/OR ANALYTICAL METHODS[1]
Major, minor, and trace elements	Draft M29; 3010, 3020, and 7470; 6000 and 7000 series
Mercury speciation	Sorbent traps; CVAFS
Particulate, ionic species, and radionuclides	M17 (inlet) and M5 (outlet) with M26A; 9056, 350.3, and 9010; DOE Pb-01; APHA 7500-C; EPA 904.0; LANL ER200; EPA 908.1; and DOE U-02
Particle size distribution/ elements by size fraction (inlet only)	Andersen 3-stage cyclonic separator; M5 (gravimetric); 3010, 3020, and 7470; ICP-AES and ICP-MS
Volatile organics (baghouse outlet only)	0030; 5030/8240
Semivolatile organics (including PCDD/PCDF at baghouse outlet)	0010 (and M23 at outlet); 8270 (and M23 at outlet)
Formaldehyde, aldehydes, and ketones	0011
Carbon dioxide and oxygen (baghouse inlet)	M3/M3A (integrated bag collection; instrumental analysis)
Carbon dioxide, oxygen, carbon monoxide, nitrogen oxides, sulfur dioxide, and total hydrocarbons (baghouse outlet)	M3A, M10, M7E, M6C, and M25A (CEM methods)

1 Flue gas stream moisture content, velocity, and volumetric flow rate were also measured in conjunction with each pollutant/parameter determination by M1, M2, and M4. Indicated methods are from 40 CFR 60 Appendix A or SW-846, except as noted.

SECTION 2

UNIT DESCRIPTION, PROCESS OPERATION, AND ASSOCIATED PARAMETERS

The configuration of Boswell Unit 2 is described, and process operation and key operating parameters during the study are identified, in this section. A process flow diagram showing sampling/testing locations is also provided.

2.1 UNIT DESCRIPTION

The Boswell Energy Center is located in Cohasset, Minnesota, and is owned and operated by Minnesota Power Company. The power plant is comprised of four coal-fired units numbered 1 through 4. Units 1 and 2 are each rated at 69 MWe, Unit 3 is rated at 350 MWe, and Unit 4 is rated at 500 MWe. Unit 2, built in 1957, was studied in this program. This unit, equipped with a Riley Stoker front-fired boiler, burns western subbituminous coal delivered to the station by train from the Powder River Basin area of Montana and Wyoming, primarily from the Rosebud seam. Average coal characteristics for this study were 8.4% ash, 0.70% sulfur, 24.8% moisture, and approximately 8,800 Btu/lb higher heating value.

A process flow diagram of Boswell Unit 2 is shown in Figure 2-1. Program sampling/testing locations are shown therein. Unit 2 is operated from a control room (see Figure 2-2) which is common to both Units 1 and 2.

At Unit 2, coal is transferred from storage bunkers through feeders directly into four pulverizers located on the ground floor. Pulverized coal is transported via primary air through 9 burners on the front of the furnace. Secondary combustion air is introduced to the furnace through a windbox. The combustion gases leave the furnace and enter the convective pass section of the boiler which is comprised of vertically divided superheater and reheater sections. Main and reheat steam temperatures are controlled primarily by dampers at the outlets of the superheater and reheater sections, and/or by a superheater/reheater bypass duct. Superheater and reheater attemperation sprays are available, but seldom used.

Next, the combustion gases are directed through an economizer section followed by an air preheater section. Some entrained particulate (i.e., soot) is deposited on various boiler wall and tube surfaces. Unit 2 is equipped with a series of sootblowers to remove this slagging and fouling material. The sootblowers are used on an irregular basis. That is, when heat transfer patterns change, the sootblowers are used to clean the contaminated surfaces and regain optimum steam temperature control and thermal efficiency. Selected sootblowing sequences are normally executed at least once per shift, but not necessarily at the same time during each shift.

At this unit, the economizer hoppers are maintained full, resulting in the carryover of overhead ash (i.e., fly ash) to downstream collection equipment.

Unit 2 uses a Joy-Western baghouse for particulate control. The original mechanical particulate collector has been removed, although the housing remains as part of the ductwork leading to the retrofitted baghouse. The baghouse consists of eight compartments each containing 1,920 Teflon-coated fiberglass bags, has an air-to-cloth ratio of 1.974:1, and uses reverse air for cleaning. It is designed for 99.7% particulate collection efficiency. The flue gas exit temperature is 300-400°F under normal operating conditions. ~~Boswell Unit 2 has no other~~ APCE currently installed.

Flue gas is discharged from Units 1, 2, and 3 via a common stack. Maintenance is effected by directing gas flow from the common stack to an adjacent 250-foot stack using dampers in the breeching of each unit. The 250-foot stack originally served Units 1 and 2 prior to the construction of Unit 3. Since there are no provisions for emission measurement on the 250-foot as flow rate at the sampling locations), or changes in coal firing rate or load (which could have caused significantly varying ash quality and/or emission rate excursions during test runs) did not occur. The ultimate objective in each case was to obtain data and samples representative of typical, steady-state process operating conditions throughout the study which would promote comparability between data sets. This objective was realized during this investigation. There were no process operational problems or deviations from plan that had any significant affect on sampling, testing or data gathering activities, results or attainment of objectives.

The test team process observers coordinated all investigative activities with control room operators. The observers monitored and documented the following process operating parameters or activities that were most likely to affect sampling/testing results:

- Swings in unit load and reasons for variance.
- Sootblowing and ash pulling activities.
- Changes in excess air or fuel flow rate.
- Any other unusual operating event.

Unit load during the entire test program varied less than $\pm$ 1.5 MWe from the target value of 61 MWe. This variation was well within the pre-established guideline target of $\pm$ 3.5 MWe. Excess O_2 concentration periodically exceeded the $\pm$0.5% variance criteria specified in the test plan by 0.1 to 0.2% due to process control limitations. However, the swings were consistent and typical of routine process operations, and the average excess O_2 variance was maintained within the guideline. The overall impact of this minor deviation from plan on emissions is negligible.

Commensurate with study design, sootblowing was delayed until after the completion of daily testing, an 8 to 9 hour period. Normal plant practice is to execute sootblowing at least once per shift. The additional soot accumulation on boiler surfaces and the resultant reduced heat transfer efficiency caused the stack gas stream temperature to increase about 20 to 30 °F above normal

TABLE 2-3

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER - UNIT 2 - COHASSET, MINNESOTA
SUMMARY OF COAL FEED PARAMETERS AND HEAT INPUT RATES[1]

PARAMETER	UNITS	TEST DAY 1 - 6/23/93	TEST DAY 2 - 6/24/93	TEST DAY 3 - 6/25/93	TEST DAY 4 - 6/26/93	TEST DAY 5 - 6/27/93	TEST DAY 6 - 6/28/93
		INORGANIC TESTS	ORGANIC TESTS	INORGANIC TESTS	ORGANIC TESTS	INORGANIC TESTS	ORGANIC TESTS
Coal Feed Rate[2]	lb/hr (dry)	54,600	55,100	56,300	55,340	55,530	55,086
Coal Feed Rate[2]	lb/hr (wet)	72,870	73,853	74,850	73,270	73,700	72,900
Coal Ash Content	%[3]	8.84	8.14	8.25	8.52	7.99	8.58
Coal Heating Value	Btu/lb[2]	8,692	8,749	8,839	8,815	8,871	8,820
Coal Sulfur Content	%[2]	0.71	0.73	0.67	0.66	0.73	0.69
Heat Input Rate (f-factor)	10^6 Btu/hr	633	647	662	646	654	643

[1]All coal fired was subbituminous from the Powder River Basin area of Wyoming and Montana.

[2]Calculated coal feed rate from F-Factor.

[3]Analysis on as received basis. Detailed coal analytical results are presented in Volume III, Appendix D.

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magnitude as sample values. When the results are then used for risk assessments or policy decisions, treatment of the data becomes important. This discussion describes how blank and non-detect values were treated in developing/presenting reported results.

4.1.1 Non-Detects

The discussion presented below explains how averages, sums, and reported emission values were calculated for all species given various combinations of detected and nondetected values.

All values detected. The arithmetic average or sum is used, as appropriate.

All values below the detection limit. For individual test runs or species, the data are reported as "ND < (detection limit)." For cases where all three runs were below the detection limit, the average is reported as nondetected less than the average detection limit of the three runs.

Some values are detected and some are nondetects. As an approximation, half of the detection limit for nondetect values and the actual value for detects were 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+0.5+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 nondetected values. In this case, the average is reported as "ND < (the highest detection limit)". For example, 5, ND < 4, and ND < 3 would be reported as "ND < 4".

This approach is also used to obtain test train totals which required analyses of separate fractions for each individual run. Specifically, the volatile organics, metals, and anion test train totals for each run were obtained by addition of test train fractions, which were analyzed separately.

Fractions from the volatile test train included separate analyses of the Tenax and Tenax/charcoal tubes for each sampling period. Separate analyses were conducted on the filterable and condensible test train components for both the metals and anion test trains.

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 emission value that is attributable to detection limits and the amount that is attributable to measured values. In order 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, the result for values of 16, ND < 6, and ND < 5 is reported as 7, with a detection limit ratio of 26% [(3+2.5)/(16+3+2.5)], while the result for values of 12, ND < 6, and 9 is reported as 8, with a detection limit ratio of 13%. The different ratios provide insight as to the extent something is "really there," and is intended to provide better information to those making decisions on risk and policy issues.

4.1.2 Values Outside the Calibration Range

Any reported laboratory data that are below the calibration range of the instrument are flagged with a qualifier (e.g., "J"). Data with the "J" flag have been tentatively identified and tentatively quantified. Data reported above the upper detection limit have been flagged with a qualifier (e.g., "E"). Data with the "E" flag have been positively identified and tentatively quantified. Data with both qualifiers are estimates. "J" and "E" values were considered quantitatively representative when calculating averages. Neither flag indicates a value to be weighted more or less important. The "J" and "E" data qualifiers appear in the respective laboratory analytical report. The data qualifiers do not appear on the calculated data summaries.

4.1.3 Blank Values

The level and treatment of blank values is important in interpreting data, since in some cases species are detected but not at levels significantly higher than blanks. In these cases measured values may not represent emissions, but rather 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.

For methods that do not specify how to apply sample blank corrections, the appropriate blank train values were subtracted. Laboratory and site/reagent blanks were analyzed and the results evaluated for identification of contamination. If a sample compound was blank corrected the data are flagged by a "B". If the value was blank corrected below the detection limit, the value was reported as "ND < (detection limit) BC." A "C" flag indicates that the blank value was greater than the sample value. In no case are the blank corrected values reported below the method detection limit.

4.2 SUMMARY OF FLUE GAS STREAM TEST RESULTS

4.2.1 Filterable Particulate

Simultaneous testing was conducted at the baghouse inlet and outlet flue gas sites to determine the filterable particulate concentrations and mass rates at each location and to determine the overall baghouse removal efficiency. Filterable particulate was determined from the combined

TABLE 4-1 (cont.)

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER – UNIT 2 – COHASSET, MINNESOTA
SUMMARY OF PARTICULATE AND ANION EMISSION TEST RESULTS

BAGHOUSE OUTLET											
Date	6-23-93	6-25-93	6-27-93								
Avg. gas stream volumetric flow, dscf/min.	149900	141700	142000								
CO_2 / O_2, %	14.0 / 5.3	14.5 / 4.8	14.5 / 4.8								
Heat input, 10^6 Btu/hr (F-Factor)	633	662	654								
Coal firing rate, ton/hr (wet basis as fired)	36.4	37.4	36.9								
	RUN 1 mg/Nm^3	RUN 2 mg/Nm^3	RUN 3 mg/Nm^3	AVERAGE mg/Nm^3	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (i)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE lb/10^6 Btu
PARTICULATE	13.63	10.18	10.45	11.42	0	1.92	4.77	5.79	2.62	0.0785	0.0089

	RUN 1 mg/Nm^3	RUN 2 mg/Nm^3	RUN 3 mg/Nm^3	AVERAGE mg/Nm^3	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (i)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE lb/10^{12} Btu
ANIONS											
Particulate Halides, Cl^-	ND < 5.18E-03	ND < 6.59E-03	ND < 5.60E-03	ND < 5.79E-03	100	7.27E-04	1.81E-03	ND < 2.92E-03	ND < 1.32E-03	ND < 3.95E-05	ND < 4.48E+00
Particulate Halides, F^-	3.11E-02	ND < 1.32E-02	ND < 1.12E-02	1.44E-02	28	1.10E-02	2.72E-02	7.43E-03	3.37E-03	1.01E-04	1.16E+01
Particulate Halides, Br^-	ND < 7.77E-03	ND < 9.89E-03	ND < 8.39E-03	ND < 8.69E-03	100	1.09E-03	2.71E-03	ND < 4.37E-03	ND < 1.98E-03	ND < 5.92E-05	ND < 6.73E+00
Hydrogen Halides, HCl	7.47E-01	1.11E+00	1.20E+00	1.02E+00	0	2.40E-01	5.97E-01	5.12E-01	2.32E-01	6.93E-03	7.86E+02
Hydrogen Halides, HF	3.26E+00	3.27E+00	3.03E+00	3.19E+00	0	1.35E-01	3.35E-01	1.61E+00	7.30E-01	2.18E-02	2.48E+03
Hydrogen Halides, HBr	ND < 5.23E-02	ND < 6.13E-02	ND < 1.31E-01	ND < 8.16E-02	100	4.32E-02	1.07E-01	ND < 4.09E-02	ND < 1.86E-02	ND < 5.54E-04	ND < 6.28E+01
Halogens, Cl_2	1.12E-01	8.44E-01	1.57E+00	8.41E-01	0	7.28E-01	1.81E+00	4.18E-01	1.89E-01	5.64E-03	6.37E+02
Halogens, F_2	4.56E-01	1.27E+00	1.48E+00	1.07E+00	0	5.39E-01	1.34E+00	5.33E-01	2.42E-01	7.19E-03	8.14E+02
Halogens, Br_2	ND < 7.87E-02	ND < 4.12E-02	ND < 9.40E-02	ND < 7.13E-02	100	2.72E-02	6.76E-02	ND < 3.61E-02	ND < 1.64E-02	ND < 4.90E-04	ND < 5.57E+01
Total, Cl^-	7.84E-01	1.51E+00	1.95E+00	1.41E+00	0	5.89E-01	1.46E+00	7.08E-01	3.21E-01	9.57E-03	1.08E+03
Total, F^-	3.37E+00	3.75E+00	3.63E+00	3.58E+00	0	1.97E-01	4.90E-01	1.81E+00	8.19E-01	2.45E-02	2.78E+03
Total, Br^-	ND < 9.89E-02	ND < 9.11E-02	1.85E-01	ND < 9.89E-02	34	5.22E-02	1.30E-01	ND < 5.18E-02	ND < 2.35E-02	ND < 7.11E-04	ND < 8.18E+01
Particulate Cyanide, CN^-	ND < 1.30E-03	ND < 1.65E-03	ND < 1.40E-03	ND < 1.45E-03	100	1.82E-04	4.52E-04	ND < 7.29E-04	ND < 3.31E-04	ND < 9.87E-06	ND < 1.12E+00
Total Hydrogen Cyanide, HCN	3.11E-03	7.23E-03	3.95E-03	4.76E-03	0	2.18E-03	5.41E-03	2.39E-03	1.08E-03	3.22E-05	3.66E+00
Total Ammonia, NH_3	ND < 2.07E-02	ND < 2.48E-02	ND < 2.10E-02	ND < 2.22E-02	100	2.27E-03	5.63E-03	ND < 1.12E-02	ND < 5.07E-03	ND < 1.51E-04	ND < 1.72E+01

TABLE 4 – 4 (cont.)

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER – UNIT 2 – COHASSET, MINNESOTA
SUMMARY OF MAJOR, MINOR, AND TRACE ELEMENTS EMISSION TEST RESULTS (1)

BAGHOUSE OUTLET	RUN 1 $\mu g/Nm^3$	RUN 2 $\mu g/Nm^3$	RUN 3 $\mu g/Nm^3$	AVERAGE $\mu g/Nm^3$	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (i)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE $lb/10^{12}$ Btu
Date	6-23-93	6-25-93	6-27-93								
Avg. gas stream volumetric flow, dscf/min.	140100	140900	139200								
CO_2 / O_2, %	14.5 / 4.9	14.5 / 4.9	14.2 / 4.9								
Heat input, 10^6 Btu/hr (F-Factor)	633	662	654								
Coal firing rate, ton/hr (wet basis as fired)	36.4	37.4	36.9								
Aluminum (Al)	3205.04	2298.13	2181.01	2561.40	0	560.48	1392.43	1.25E+00	5.68E-01	1.70E-02	1.93E+03
Antimony (Sb)	ND < 0.42	ND < 0.43	ND < 1.86	ND < 0.91	100	0.83	2.05	ND < 4.41E-04	ND < 2.00E-04	ND < 5.99E-06	ND < 6.77E-01
Arsenic (As)	0.44	ND < 0.43	ND < 0.44	ND < 0.44	50	0.005	0.01	ND < 2.14E-04	ND < 9.70E-05	ND < 2.88E-06	ND < 3.24E-01
Barium (Ba)	92.57	44.42	188.81	108.60	0	73.52	182.64	5.30E-02	2.40E-02	7.19E-04	8.16E+01
Beryllium (Be)	ND < 0.17	ND < 0.17	ND < 0.17	ND < 0.17	100	0.003	0.01	ND < 8.41E-05	ND < 3.81E-05	ND < 1.14E-06	ND < 1.29E-01
Boron (B)	1581.50	584.43	230.21	798.72	0	700.67	1740.69	3.91E-01	1.77E-01	5.32E-03	6.09E+02
Cadmium (Cd)	ND < 0.84	ND < 0.87	ND < 0.87	ND < 0.86	100	0.014	0.04	ND < 4.21E-04	ND < 1.91E-04	ND < 5.70E-06	ND < 6.48E-01
Calcium (Ca)	646.45	716.95	532.19	631.86	0	93.24	231.64	3.09E-01	1.40E-01	4.19E-03	4.76E+02
Chromium (Cr)	3.39	2.51	2.21	2.70	0	0.61	1.53	1.32E-03	6.00E-04	1.79E-05	2.04E+00
Cobalt (Co)	1.11	0.64	1.04	0.93	0	0.26	0.64	4.54E-04	2.06E-04	6.17E-06	7.01E-01
Copper (Cu)	3.28	2.01	4.27	3.19	0	1.13	2.82	1.56E-03	7.06E-04	2.11E-05	2.40E+00
Iron (Fe)	543.82	504.96	592.87	547.21	0	44.06	109.45	2.68E-01	1.21E-01	3.63E-03	4.12E+02
Lead (Pb)	3.55	ND < 2.17	5.06	3.23	11	1.45	3.60	1.58E-03	7.16E-04	2.15E-05	2.44E+00
Magnesium (Mg)	265.91	270.59	282.03	272.84	0	8.29	20.60	1.33E-01	6.05E-02	1.81E-03	2.05E+02
Manganese (Mn)	15.06	17.72	40.88	24.55	0	14.20	35.28	1.20E-02	5.44E-03	1.62E-04	1.84E+01
Mercury (Hg)	2.21	1.82	3.68	2.57	0	0.98	2.43	1.25E-03	5.69E-04	1.70E-05	1.93E+00
Molybdenum (Mo)	0.78	0.30	4.09	1.73	0	2.06	5.13	8.40E-04	3.81E-04	1.14E-05	1.29E+00
Nickel (Ni)	4.15	1.43	2.20	2.59	0	1.40	3.48	1.27E-03	5.75E-04	1.72E-05	1.97E+00
Potassium (K)	78.02	65.76	83.77	75.85	0	9.20	22.85	3.71E-02	1.68E-02	5.03E-04	5.71E+01
Phosphorus (P)	22.67	34.98	49.31	35.65	0	13.33	33.12	1.74E-02	7.90E-03	2.36E-04	2.67E+01
Selenium (Se)	4.33	4.11	4.44	4.29	0	0.16	0.41	2.10E-03	9.52E-04	2.85E-05	3.23E+00
Sodium (Na)	445.62	247.07	86.59	259.76	0	179.85	446.82	1.27E-01	5.77E-02	1.73E-03	1.97E+02
Titanium (Ti)	112.82	52.86	63.22	76.30	0	32.05	79.62	3.73E-02	1.69E-02	5.07E-04	5.78E+01
Vanadium (V)	1.32	1.68	3.13	2.04	0	0.96	2.39	9.98E-04	4.53E-04	1.35E-05	1.53E+00

(1) No results are shown for sulfur since the element was determined by continuous emissions monitoring performed at the baghouse outlet and was not quantified using Draft EPA Method 29. Silicon results are not reported due to high background levels of this element inherent in the Draft EPA Method 29 procedure.

TABLE 4-16 (cont.)

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER - UNIT 2 - COHASSET, MINNESOTA
SUMMARY OF SEMIVOLATILE ORGANICS AND PAHs EMISSION TEST RESULTS

BAGHOUSE OUTLET	RUN 1	RUN 2	RUN 3								
Date	06-24-93	06-26-93	06-28-93								
Avg. gas stream volumetric flow, dscf/min.	145100	142000	141700								
CO_2 / O_2, %	13.9 / 5.6	14.2 / 5.3	14.2 / 5.2								
Heat input, 10^6 Btu/hr (F-Factor)	647	646	643								
Coal firing rate, ton/hr (wet basis as fired)	36.9	36.6	36.5								
	RUN 1 µg/Nm³	RUN 2 µg/Nm³	RUN 3 µg/Nm³	AVERAGE µg/Nm³	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (i)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE lb/10^{12} Btu
SEMIVOLATILE ORGANICS											
n-Nitrosodimethylamine	ND < 1.064	ND < 1.087	ND < 1.291	ND < 1.147	100	0.125	0.311	ND < 5.72E-04	ND < 2.60E-04	ND < 7.80E-06	ND < 8.87E-01
Phenol	ND < 0.418	0.826	0.635	0.557	13	0.204	0.507	2.77E-04	1.25E-04	3.78E-06	4.29E-01
2-Methylphenol	ND < 0.544	2.506	1.104	1.294	7	1.011	2.511	6.42E-04	2.91E-04	8.77E-06	9.95E-01
Acetophenone	0.839	0.947	0.983	0.923	0	0.075	0.186	4.60E-04	2.09E-04	6.28E-06	7.13E-01
3,4-Methylphenol	ND < 0.250	1.660	0.742	0.842	5	0.716	1.778	4.18E-04	1.90E-04	5.71E-06	6.48E-01
Naphthalene (1)	ND < 1.139	ND < 1.407	ND < 1.141	ND < 1.229	100	0.154	0.383	ND < 6.13E-04	ND < 2.78E-04	ND < 8.36E-06	ND < 9.50E-01
Biphenyl	ND < 0.218	ND < 0.223	ND < 0.248	ND < 0.230	100	0.016	0.041	ND < 1.15E-04	ND < 5.20E-05	ND < 1.56E-06	ND < 1.78E-01
Di-n-butylphthalate	ND < 1.802	ND < 1.761	ND < 3.964	ND < 2.509	100	1.260	3.131	ND < 1.25E-03	ND < 5.67E-04	ND < 1.71E-05	ND < 1.94E+00
bis(2-Ethylhexyl)phthalate	ND < 2.144	3.571	ND < 2.170	ND < 2.170	38	0.817	2.029	ND < 1.09E-03	ND < 4.93E-04	ND < 1.47E-05	ND < 1.68E+00
POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)											
Naphthalene (1)	8.14E-01	ND < 4.94E-02	6.24E-02	3.00E-01	3	4.38E-01	1.09E+00	1.52E-04	6.89E-05	2.06E-06	2.35E-01
2-Methylnapthalene	5.31E-02	3.14E-02	3.88E-02	4.11E-02	0	1.10E-02	2.74E-02	2.06E-05	9.33E-06	2.80E-07	3.19E-02
2-Chloronapthalene	9.83E-04	4.85E-04	9.79E-04	8.16E-04	0	2.86E-04	7.12E-04	4.08E-07	1.85E-07	5.56E-09	6.32E-04
Acenapthylene	7.67E-03	1.01E-03	1.19E-02	6.86E-03	0	5.49E-03	1.36E-02	3.42E-06	1.55E-06	4.67E-08	5.31E-03
Acenapthene	1.52E-01	1.80E-03	2.14E-03	5.21E-02	0	8.68E-02	2.16E-01	2.64E-05	1.20E-05	3.57E-07	4.08E-02
Fluorene	3.72E-03	2.91E-03	2.78E-02	1.15E-02	0	1.41E-02	3.51E-02	5.69E-06	2.58E-06	7.79E-08	8.84E-03
Phenanthrene	2.77E-01	1.34E-01	4.04E-01	2.72E-01	0	1.35E-01	3.36E-01	1.36E-04	6.15E-05	1.85E-06	2.10E-01
Anthracene	3.40E-04	6.29E-04	2.31E-02	8.02E-03	0	1.30E-02	3.24E-02	3.97E-06	1.80E-06	5.44E-08	6.17E-03
Fluoranthene	5.68E-02	3.33E-02	2.31E-01	1.07E-01	0	1.08E-01	2.68E-01	5.31E-05	2.41E-05	7.27E-07	8.25E-02
Pyrene	9.64E-03	7.11E-03	1.29E-01	4.85E-02	0	6.95E-02	1.73E-01	2.40E-05	1.09E-05	3.29E-07	3.73E-02
Benzo(a)anthracene	2.16E-03	1.80E-03	1.43E-02	6.08E-03	0	7.10E-03	1.76E-02	3.02E-06	1.37E-06	4.13E-08	4.68E-03
Chrysene (2)	6.81E-03	5.23E-03	3.41E-02	1.54E-02	0	1.62E-02	4.03E-02	7.63E-06	3.46E-06	1.04E-07	1.18E-02
Benzo(b)fluoranthene (3)	1.34E-03	1.38E-03	7.85E-03	3.53E-03	0	3.75E-03	9.31E-03	1.75E-06	7.94E-07	2.39E-08	2.72E-03
Benzo(k)fluoranthene (3)	1.07E-04	3.59E-05	1.14E-03	4.29E-04	0	6.19E-04	1.54E-03	2.12E-07	9.63E-08	2.91E-09	3.30E-04
Benzo(e)pyrene	4.27E-03	9.88E-04	3.80E-03	3.00E-03	0	1.78E-03	4.41E-03	1.51E-06	6.84E-07	2.05E-08	2.30E-03
Benzo(a)pyrene	2.86E-04	ND < 1.71E-04	ND < 2.72E-04	ND < 2.72E-04	44	6.30E-05	1.56E-04	ND < 1.35E-07	ND < 6.10E-08	ND < 1.85E-09	ND < 2.09E-04
Perylene	3.06E-01	ND < 1.22E-04	ND < 1.38E-04	1.02E-01	0	1.76E-01	4.38E-01	5.16E-05	2.34E-05	6.99E-07	7.98E-02
Indeno(1,2,3-cd)pyrene	ND < 3.58E-04	ND < 4.49E-04	3.63E-05	ND < 4.49E-04	92	2.17E-04	5.39E-04	ND < 2.23E-07	ND < 1.01E-07	ND < 3.04E-09	ND < 3.45E-04
Dibenzo(a,h)anthracene	ND < 1.14E-04	ND < 1.60E-04	8.34E-05	ND < 1.60E-04	62	3.85E-05	9.56E-05	ND < 7.93E-08	ND < 3.60E-08	ND < 1.08E-09	ND < 1.23E-04
Benzo(g,h,i)perylene	ND < 7.15E-04	ND < 7.01E-04	ND < 5.98E-04	ND < 6.71E-04	100	6.37E-05	1.58E-04	ND < 3.35E-07	ND < 1.52E-07	ND < 4.57E-09	ND < 5.19E-04

Sum is 3.05 x10^{-3}

(1) Naphthalene was determined during both the low resolution SVOC and high resolution PAH analysis procedures.
(2) Reported values include Triphenylene.
(3) Reported values include a contribution from Benzo(j)fluoranthene.
NOTE: Only detected semivolatile compounds are listed.

TABLE 4-17

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER – UNIT 2 – COHASSET, MINNESOTA
SUMMARY OF DIOXIN AND FURAN EMISSION TEST RESULTS

BAGHOUSE OUTLET	RUN 1	RUN 2	RUN 3								
Date	06-24-93	06-26-93	06-28-93								
Avg. gas stream volumetric flow, dscf/min.	145100	142000	141700								
CO_2 / O_2, %	13.9 / 5.6	14.2 / 5.3	14.2 / 5.2								
Heat input, 10^6 Btu/hr (F-Factor)	647	646	643								
Coal firing rate, ton/hr (wet basis as fired)	36.9	36.6	36.5								
	RUN 1 ng/Nm^3	**RUN 2 ng/Nm^3**	**RUN 3 ng/Nm^3**	**AVERAGE ng/Nm^3**	**DETECTION LIMIT RATIO (%)**	**STANDARD DEVATION (i)**	**95 % CI**	**AVERAGE lb/hr**	**AVERAGE kg/hr**	**AVERAGE kg/Mg**	**AVERAGE lb/10^{12} Btu**
DIOXINS											
2,3,7,8-TCDD	1.79E-03	ND < 8.98E-04	9.07E-04	1.05E-03	14	5.11E-04	1.27E-03	5.26E-10	2.38E-10	7.15E-12	8.14E-07
1,2,3,7,8-PeCDD	7.15E-04	5.39E-04	ND < 1.81E-03	ND < 1.81E-03	42	6.91E-04	1.72E-03	ND < 8.97E-10	ND < 4.07E-10	ND < 1.23E-11	ND < 1.39E-06
1,2,3,4,7,8-HxCDD	5.36E-04	ND < 1.44E-03	ND < 3.63E-03	ND < 3.63E-03	83	1.59E-03	3.95E-03	ND < 1.79E-09	ND < 8.14E-10	ND < 2.46E-11	ND < 2.79E-06
1,2,3,6,7,8-HxCDD	8.94E-04	7.19E-04	ND < 1.81E-03	ND < 1.81E-03	36	5.88E-04	1.46E-03	ND < 8.97E-10	ND < 4.07E-10	ND < 1.23E-11	ND < 1.39E-06
1,2,3,7,8,9-HxCDD	1.07E-03	ND < 1.26E-03	ND < 1.81E-03	ND < 1.81E-03	59	3.85E-04	9.58E-04	ND < 8.97E-10	ND < 4.07E-10	ND < 1.23E-11	ND < 1.39E-06
1,2,3,4,6,7,8-HpCDD	ND < 1.79E-03	ND < 1.80E-03	1.81E-03	ND < 1.80E-03	50	1.29E-05	3.19E-05	ND < 9.06E-10	ND < 4.11E-10	ND < 1.23E-11	ND < 1.40E-06
OCDD	ND < 8.94E-03	ND < 1.44E-02	1.81E-03	ND < 1.44E-02	87	6.30E-03	1.56E-02	ND < 7.13E-09	ND < 3.23E-09	ND < 9.73E-11	ND < 1.10E-05
Total TCDD	1.43E-02	8.98E-03	1.27E-02	1.20E-02	0	2.73E-03	6.78E-03	5.99E-09	2.72E-09	8.17E-11	9.29E-06
Total PeCDD	7.15E-03	5.39E-03	5.44E-03	5.99E-03	0	1.00E-03	2.49E-03	3.00E-09	1.36E-09	4.08E-11	4.64E-06
Total HxCDD	6.26E-03	8.98E-04	9.07E-04	2.69E-03	0	3.09E-03	7.68E-03	1.35E-09	6.15E-10	1.84E-11	2.10E-06
Total HpCDD	ND < 3.58E-03	ND < 1.80E-03	ND < 1.81E-03	ND < 2.40E-03	100	1.02E-03	2.54E-03	ND < 1.20E-09	ND < 5.44E-10	ND < 1.63E-11	ND < 1.86E-06
Total PCDD	3.40E-02	2.34E-02	2.18E-02	2.64E-02	0	6.64E-03	1.65E-02	1.32E-08	5.98E-09	1.80E-10	2.04E-05
FURANS											
2,3,7,8-TCDF	1.07E-02	7.19E-03	5.44E-03	7.79E-03	0	2.69E-03	6.69E-03	3.90E-09	1.77E-09	5.30E-11	6.03E-06
1,2,3,7,8-PeCDF	8.94E-03	7.19E-03	5.44E-03	7.19E-03	0	1.75E-03	4.35E-03	3.59E-09	1.63E-09	4.90E-11	5.57E-06
2,3,4,7,8-PeCDF	8.94E-03	5.39E-03	5.44E-03	6.59E-03	0	2.04E-03	5.06E-03	3.30E-09	1.50E-09	4.49E-11	5.11E-06
1,2,3,4,7,8-HxCDF	1.07E-02	7.19E-03	7.25E-03	8.39E-03	0	2.03E-03	5.03E-03	4.20E-09	1.90E-09	5.71E-11	6.50E-06
1,2,3,6,7,8-HxCDF	2.86E-03	2.87E-03	2.90E-03	2.88E-03	0	2.06E-05	5.11E-05	1.44E-09	6.52E-10	1.96E-11	2.23E-06
1,2,3,7,8,9-HxCDF	5.36E-04	ND < 1.08E-03	ND < 1.81E-03	ND < 1.81E-03	73	6.41E-04	1.59E-03	ND < 8.97E-10	ND < 4.07E-10	ND < 1.23E-11	ND < 1.39E-06
2,3,4,6,7,8-HxCDF	3.58E-03	1.80E-03	3.63E-03	3.00E-03	0	1.04E-03	2.59E-03	1.50E-09	6.80E-10	2.04E-11	2.32E-06
1,2,3,4,6,7,8-HpCDF	7.15E-03	7.19E-03	3.63E-03	5.99E-03	0	2.05E-03	5.08E-03	2.99E-09	1.36E-09	4.08E-11	4.64E-06
1,2,3,4,7,8,9-HpCDF	1.79E-03	1.80E-03	ND < 3.63E-03	ND < 3.63E-03	34	1.06E-03	2.63E-03	ND < 1.79E-09	ND < 8.14E-10	ND < 2.46E-11	ND < 2.79E-06
OCDF	3.58E-03	1.80E-03	1.81E-03	2.40E-03	0	1.02E-03	2.54E-03	1.20E-09	5.44E-10	1.63E-11	1.86E-06
Total TCDF	1.04E-01	6.47E-02	6.53E-02	7.79E-02	0	2.24E-02	5.56E-02	3.90E-08	1.77E-08	5.31E-10	6.04E-05
Total PeCDF	8.94E-02	5.03E-02	4.35E-02	6.11E-02	0	2.48E-02	6.15E-02	3.06E-08	1.39E-08	4.16E-10	4.74E-05
Total HxCDF	3.40E-02	2.87E-02	2.36E-02	2.88E-02	0	5.20E-03	1.29E-02	1.44E-08	6.52E-09	1.96E-10	2.23E-05
Total HpCDF	1.07E-02	1.08E-02	5.44E-03	8.98E-03	0	3.07E-03	7.62E-03	4.49E-09	2.04E-09	6.12E-11	6.95E-06
Total PCDF	2.41E-01	1.56E-01	1.40E-01	1.79E-01	0	5.46E-02	1.36E-01	8.96E-08	4.07E-08	1.22E-09	1.39E-04

TABLE 4–18

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER – UNIT 2 – COHASSET, MINNESOTA
SUMMARY OF FORMALDEHYDE, ALDEHYDES, AND KETONES EMISSION TEST RESULTS

BAGHOUSE INLET	RUN 1	RUN 2	RUN 3								
Date	06-24-93	06-26-93	06-28-93								
Avg. gas stream volumetric flow, dscf/min.	154000	143700	145600								
CO_2 / O_2, %	14.2 / 5.3	14.3 / 5.2	14.4 / 4.7								
Heat input, 10^6 Btu/hr (F-Factor)	647	646	643								
Coal firing rate, ton/hr (wet basis as fired)	36.9	36.6	36.5								
	RUN 1 µg/Nm³	RUN 2 µg/Nm³	RUN 3 µg/Nm³	AVERAGE µg/Nm³	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (i)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE lb/10^{12} Btu
Formaldehyde	11.0	8.4	18.6	12.7	0	5.3	13.2	6.53E-03	2.96E-03	8.91E-05	1.01E+01
Acetaldehyde	40.4	35.5	53.8	43.2	0	9.5	23.6	2.23E-02	1.01E-02	3.04E-04	3.45E+01
Acrolein	ND < 3.1	6.5	2.5	3.5	15	2.1	5.3	1.79E-03	8.11E-04	2.44E-05	2.77E+00
Acetone (1)	64.0	434.3	ND < 1.4	166.3	0	234.0	581.3	8.42E-02	3.82E-02	1.15E-03	1.30E+02
Propanal	ND < 1.8	ND < 2.6	ND < 2.1	ND < 2.2	100	0.4	0.9	ND < 1.12E-03	ND < 5.06E-04	ND < 1.52E-05	ND < 1.73E+00
Crotonaldehyde	6.3	10.3	7.1	7.9	0	2.1	5.2	4.06E-03	1.84E-03	5.54E-05	6.29E+00
n-Butyraldehyde	23.2	34.5	30.8	29.5	0	5.8	14.3	1.51E-02	6.87E-03	2.07E-04	2.35E+01
Methyl Ethyl Ketone	9.4	6.5	9.5	8.5	0	1.7	4.1	4.38E-03	1.99E-03	5.97E-05	6.79E+00
Benzaldehyde	15.1	28.6	20.6	21.4	0	6.8	16.8	1.10E-02	4.98E-03	1.50E-04	1.70E+01
iso-Valeraldehyde	4.6	ND < 6.7	6.0	ND < 6.7	24	1.1	2.6	ND < 3.35E-03	ND < 1.52E-03	ND < 4.58E-05	ND < 5.19E+00
Valeraldehyde	33.6	46.9	39.1	39.9	0	6.7	16.6	2.05E-02	9.30E-03	2.80E-04	3.18E+01
o-Tolualdehyde	20.0	10.9	32.8	21.2	0	11.0	27.4	1.10E-02	4.97E-03	1.50E-04	1.70E+01
m/p-Tolualdehyde	6.3	17.1	11.2	11.6	0	5.4	13.5	5.90E-03	2.68E-03	8.06E-05	9.15E+00
Hexaldehyde	7.3	18.4	9.1	11.6	0	6.0	14.8	5.91E-03	2.68E-03	8.07E-05	9.16E+00
2,5-Dimethyl Benzaldehyde	9.3	42.3	39.6	30.4	0	18.3	45.5	1.55E-02	7.01E-03	2.11E-04	2.40E+01

BAGHOUSE OUTLET	RUN 1	RUN 2	RUN 3								
Date	06-24-93	06-26-93	06-28-93								
Avg. gas stream volumetric flow, dscf/min.	144600	140400	139100								
CO_2 / O_2, %	13.8 / 5.6	14.2 / 5.2	14.5 / 4.8								
Heat input, 10^6 Btu/hr (F-Factor)	647	646	643								
Coal firing rate, ton/hr (wet basis as fired)	36.9	36.6	36.5								
	RUN 1 µg/Nm³	RUN 2 µg/Nm³	RUN 3 µg/Nm³	AVERAGE µg/Nm³	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (i)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE lb/10^{12} Btu
Formaldehyde	ND < 2.0	ND < 2.2	ND < 2.5	ND < 2.2	100	0.3	0.7	ND < 1.10E-03	ND < 4.98E-04	ND < 1.50E-05	ND < 1.70E+00
Acetaldehyde	ND < 1.5	ND < 1.3	ND < 1.5	ND < 1.4	100	0.1	0.4	ND < 7.01E-04	ND < 3.18E-04	ND < 9.56E-06	ND < 1.09E+00
Acrolein	ND < 4.4	3.3	4.0	ND < 4.4	23	0.6	1.4	ND < 2.20E-03	ND < 9.99E-04	ND < 2.98E-05	ND < 3.40E+00
Acetone (1)	4406.2	ND < 1.4	ND < 1.7	1469.3	0	2543.0	6317.8	7.42E-01	3.36E-01	1.00E-02	1.15E+03
Propanal	ND < 2.5	ND < 2.0	ND < 2.3	ND < 2.3	100	0.2	0.6	ND < 1.12E-03	ND < 5.10E-04	ND < 1.53E-05	ND < 1.74E+00
Crotonaldehyde	ND < 7.4	12.8	ND < 9.4	ND < 9.4	40	2.7	6.8	ND < 4.55E-03	ND < 2.06E-03	ND < 6.24E-05	ND < 7.08E+00
n-Butyraldehyde	ND < 12.9	32.0	36.6	25.0	9	12.6	31.2	1.22E-02	5.55E-03	1.67E-04	1.90E+01
Methyl Ethyl Ketone	ND < 7.5	ND < 6.1	ND < 5.9	ND < 6.5	100	0.9	2.2	ND < 3.22E-03	ND < 1.46E-03	ND < 4.39E-05	ND < 4.99E+00
Benzaldehyde	5.9	5.3	11.5	7.6	0	3.4	8.5	3.72E-03	1.69E-03	5.08E-05	5.78E+00
iso-Valeraldehyde	ND < 6.5	ND < 5.4	ND < 6.3	ND < 6.1	100	0.6	1.5	ND < 3.00E-03	ND < 1.36E-03	ND < 4.08E-05	ND < 4.64E+00
Valeraldehyde	ND < 11.0	ND < 9.0	35.0	15.0	22	14.4	35.9	7.32E-03	3.32E-03	1.00E-04	1.14E+01
o-Tolualdehyde	ND < 3.1	ND < 2.5	ND < 2.4	ND < 2.7	100	0.3	0.9	ND < 1.31E-03	ND < 5.96E-04	ND < 1.79E-05	ND < 2.03E+00
m/p-Tolualdehyde	3.2	3.0	ND < 1.6	2.3	11	0.9	2.2	1.16E-03	5.27E-04	1.58E-05	1.80E+00
Hexaldehyde	ND < 8.0	ND < 8.7	3.9	ND < 8.7	68	2.6	6.5	ND < 4.27E-03	ND < 1.94E-03	ND < 5.83E-05	ND < 6.61E+00
2,5-Dimethyl Benzaldehyde	ND < 1.6	45.3	12.4	19.5	1	22.8	56.6	9.54E-03	4.33E-03	1.30E-04	1.48E+01

(1) Commonly used laboratory solvent that was detected in samples and blanks; the reported values may not be representative.

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28-Dec-93

TABLE 4-19

MINNESOTA POWER COMPANY
BOSWELL ENERGY CENTER – UNIT 2 – COHASSET, MINNESOTA
SUMMARY OF VOLATILE ORGANICS EMISSION TEST RESULTS

BAGHOUSE OUTLET	RUN 1 ng/Nm^3	RUN 2 ng/Nm^3	RUN 3 ng/Nm^3	AVERAGE ng/Nm^3	DETECTION LIMIT RATIO (%)	STANDARD DEVATION (1)	95 % CI	AVERAGE lb/hr	AVERAGE kg/hr	AVERAGE kg/Mg	AVERAGE lb/10^{12}Btu
Date	06-24-93	06-26-93	06-28-93								
Avg. gas stream volumetric flow, dscf/min. (1)	144600	140400	141700								
CO_2 / O_2, % (1)	13.8 / 5.6	14.2 / 5.2	14.2 / 5.2								
Heat input, 10^6Btu/hr (F-Factor)	647	646	643								
Coal firing rate, ton/hr (wet basis as fired)	36.9	36.6	36.5								
Chloroethane (Ethyl chloride)	6580	3112	ND < 112	3249	1	3237	8042	1.61E-03	7.32E-04	2.20E-05	2.50E+00
Trichlorofluoromethane	1873	4050	1178	2367	0	1498	3722	1.18E-03	5.33E-04	1.60E-05	1.82E+00
Carbon disulfide	46859	6947	15169	22992	0	21075	52357	1.14E-02	5.18E-03	1.56E-04	1.77E+01
Acetone (2)	111826	119073	94761	108553	0	12482	31010	5.39E-02	2.44E-02	7.35E-04	8.35E+01
Methylene chloride (2)	12475	17793	11539	13936	0	3373	8380	6.92E-03	3.14E-03	9.43E-05	1.07E+01
n-Hexane	3619	1561	833	2004	0	1445	3590	9.95E-04	4.51E-04	1.36E-05	1.54E+00
Vinyl acetate	ND < 56	1617	ND < 56	558	3	901	2239	2.77E-04	1.26E-04	3.78E-06	4.29E-01
2-Butanone	26258	20928	16909	21365	0	4690	11652	1.06E-02	4.81E-03	1.45E-04	1.64E+01
Benzene	231814	120650	47706	133390	0	92713	230330	6.62E-02	3.00E-02	9.03E-04	1.03E+02
Methyl methacrylate	4345	ND < 107	ND < 112	1485	2	2446	6075	7.37E-04	3.34E-04	1.01E-05	1.14E+00
Ethylene dibromide	ND < 56	200	ND < 56	85	22	83	206	4.23E-05	1.92E-05	5.77E-07	6.56E-02
Toluene (2)	8178	6569	6522	7090	0	943	2343	3.52E-03	1.60E-03	4.80E-05	5.45E+00
Tetrachloroethene (PCE)	ND < 56	2132	ND < 56	729	3	1199	2978	3.62E-04	1.64E-04	4.94E-06	5.61E-01
Chlorobenzene	ND < 56	579	ND < 56	212	9	302	751	1.05E-04	4.77E-05	1.43E-06	1.63E-01
Ethylbenzene	681	844	140	555	0	368	915	2.76E-04	1.25E-04	3.76E-06	4.27E-01
m-/p-Xylene	2833	1828	3728	2796	0	951	2362	1.39E-03	6.30E-04	1.89E-05	2.15E+00 Sum is
o-Xylene	345	582	149	359	0	217	539	1.78E-04	8.08E-05	2.43E-06	2.76E-01 2.43
Styrene	4966	1257	608	2277	0	2352	5842	1.13E-03	5.13E-04	1.54E-05	1.75E+00
Cumene	569	349	261	393	0	158	394	1.95E-04	8.85E-05	2.66E-06	3.02E-01

NOTE: Only detected compounds are listed. Detailed test data lists the results of the entire scan.
(1) Volumetric flow rates for runs one and two were obtained from SW-846 Method 0011 (aldehyde/ketone) test run. Volumetric flow rate for run three was obtained from SW-846 Method 0010 (SVOC/PAH) test run.
(2) Commonly used laboratory solvent that was detected in samples and blanks; the reported values may not be representative.

26-Dec-93 c:\shared\airteam\doe\mn\sum01.wk3

TEST REPORT TITLE:	Toxics Assessment Report. Minnesota Power Company. Boswell Energy Center- Unit 2. Volumes I- Main Report. Roy F. Weston, Inc. December, 1993
COAL EF DATABASE REFERENCE NO.	28
FILENAME	DOE8.WK1
FACILITY:	Cohasset, Minnesota

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PROCESS DATA

Coal type a	Subbituminous	
Boiler configuration b	Pulverized, Dry bottom	
Coal source a	Montana/Wyoming	
SCC	10100222	
Control device 1 c	Baghouse	
Control device 2	None	
Control device 3	None	
Data Quality	B	
Process Parameters a	69 MW	
Test methods d	EPA, or EPA-approved, test methods	
Number of test runs e	3	
Coal HHV, as received (Btu/lb) f	8,798	8,692
Coal HHV, as received (Btu/ton)	17,596,000	8,749
Coal HHV, as received (MMBtu/ton)	17.6	8,839

-- 8,815

a Page 2-1 8,871

b Page 2-1 for "pulverized", Conversation with Greg Behrens, Radian Austin, for "dry bottom". 8,820

c Page 2-4 --------------

d Page 1-12 avg 8,798

e See pages listing emission factors

f Page 2-23, average of 8692, 8749, 8839, 8815, 8871, 8820 Btu/lb.

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METALS EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Aluminum	1.93E+03	1.93E-03	3.40E-02
Antimony d	6.77E-01	6.77E-07	1.19E-05
Arsenic c	3.24E-01	3.24E-07	5.70E-06
Barium	8.16E+01	8.16E-05	1.44E-03
Beryllium d	1.29E-01	1.29E-07	2.27E-06
Boron	6.09E+02	6.09E-04	1.07E-02
Cadmium d	6.48E-01	6.48E-07	1.14E-05
Calcium	4.76E+02	4.76E-04	8.38E-03
Chromium	2.04E+00	2.04E-06	3.59E-05

Cobalt	7.01E-01	7.01E-07	1.23E-05
Copper	2.40E+00	2.40E-06	4.22E-05
Iron	4.12E+02	4.12E-04	7.25E-03
Lead b	2.44E+00	2.44E-06	4.29E-05
Magnesium	2.05E+02	2.05E-04	3.61E-03
Manganese	1.84E+01	1.84E-05	3.24E-04
Mercury	1.93E+00	1.93E-06	3.40E-05
Molybdenum	1.29E+00	1.29E-06	2.27E-05
Nickel	1.97E+00	1.97E-06	3.47E-05
Potassium	5.71E+01	5.71E-05	1.00E-03
Phosphorous	2.67E+01	2.67E-05	4.70E-04
Selenium	3.23E+00	3.23E-06	5.68E-05
Sodium	1.97E+02	1.97E-04	3.47E-03
Titanium	5.78E+01	5.78E-05	1.02E-03
Vanadium	1.53E+00	1.53E-06	2.69E-05

a Page 4-14, "Average" values.

SEMIVOLATILE ORGANICS EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
n-Nitrosodimethylamine d	8.87E-01	8.87E-07	1.56E-05
Phenol b	4.29E-01	4.29E-07	7.55E-06
Acetophenone	7.13E-01	7.13E-07	1.25E-05
Biphenyl d	1.78E-01	1.78E-07	3.13E-06
Di-n-butylphthalate d	1.94E+00	1.94E-06	3.41E-05
bis(2-Ethylhexyl)phthalate	1.68E+00	1.68E-06	2.96E-05

a Page 4-43

b Detection limit values (1/2) for one run used in developing EF.

c Detection limit values (1/2) for two runs used in developing EF.

d Pollutant not detected in any sampling runs.

PAH EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Naphthalene b	2.53E-01	2.53E-07	4.45E-06
Acenaphthylene	5.31E-03	5.31E-09	9.34E-08
Acenaphthene	4.08E-02	4.08E-08	7.18E-07
Fluorene	8.84E-03	8.84E-09	1.56E-07
Phenanthrene	2.10E-01	2.10E-07	3.70E-06
Anthracene	6.17E-03	6.17E-09	1.09E-07
Fluoranthene	8.25E-02	8.25E-08	1.45E-06
Pyrene	3.73E-02	3.73E-08	6.56E-07
Benz(a)anthracene	4.68E-03	4.68E-09	8.23E-08

Benzo(b,j,k)fluoranthene	3.05E-03	3.05E-09	5.37E-08
Benzo(a)pyrene c	2.09E-04	2.09E-10	3.68E-09
Indeno(1,2,3-c,d)pyrene c	3.45E-04	3.45E-10	6.07E-09
Benzo(g,h,i)perylene d	5.19E-04	5.19E-10	9.13E-09

a Page 4-43

b Detection limit values (1/2) for one run used in developing EF.

c Detection limit values (1/2) for two runs used in developing EF.

d Pollutant not detected in any sampling runs.

DIOXINS/FURANS EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
2,3,7,8-TCDD b	8.14E-07	8.14E-13	1.43E-11
Total TCDD	9.29E-06	9.29E-12	1.63E-10
Total PeCDD	4.64E-06	4.64E-12	8.16E-11
Total HxCDD	2.10E-06	2.10E-12	3.70E-11
Total HpCDD d	1.86E-06	1.86E-12	3.27E-11
Total OCDD c	1.10E-05	1.10E-11	1.94E-10
Total PCDD	2.04E-05	2.04E-11	3.59E-10
2,3,7,8-TCDF	6.03E-06	6.03E-12	1.06E-10
Total TCDF	6.04E-05	6.04E-11	1.06E-09
Total PeCDF	4.74E-05	4.74E-11	8.34E-10
Total HxCDF	2.23E-05	2.23E-11	3.92E-10
Total HpCDF	6.95E-06	6.95E-12	1.22E-10
Total OCDF	1.86E-06	1.86E-12	3.27E-11
Total PCDF	1.39E-04	1.39E-10	2.45E-09
TOTAL PCDD + TOTAL PCDF	1.59E-04	1.59E-10	2.80E-09

a Page 4-45

b Detection limit values (1/2) for one run used in developing EF.

c Detection limit values (1/2) for two runs used in developing EF.

d Pollutant not detected in any sampling runs.

ALDEHYDES/KETONES EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Formaldehyde d	1.70E+00	1.70E-06	2.99E-05
Acetaldehyde d	1.09E+00	1.09E-06	1.92E-05
Acrolein b	3.40E+00	3.40E-06	5.98E-05
Methyl Ethyl Ketone d	4.99E+00	4.99E-06	8.78E-05

a Page 4-47, ESP Outlet data, only 189 HAPs

c Detection limit values (1/2) for two runs used in developing EF.

VOC EMISSION FACTORS

Pollutant	Emission Factor (lb/10^12 Btu) a	Emission Factor (lb/MMBtu)	Emission Factor (lb/ton)
Chloroethane (ethyl chloride) b	2.50E+00	2.50E-06	4.40E-05
Carbon Disulfide	1.77E+00	1.77E-06	3.11E-05
Methylene Chloride	1.07E-01	1.07E-07	1.88E-06
Hexane	1.54E+00	1.54E-06	2.71E-05
Vinyl acetate d	4.29E-01	4.29E-07	7.55E-06
Benzene	1.03E-02	1.03E-08	1.81E-07
Methyl Methacrylate c	1.14E+00	1.14E-06	2.01E-05
Ethylene Dibromide c	6.56E-02	6.56E-08	1.15E-06
Toluene	5.45E+00	5.45E-06	9.59E-05
Tetrachloroethylene (PCE) c	5.61E-01	5.61E-07	9.87E-06
Chlorobenzene c	1.63E-01	1.63E-07	2.87E-06
Ethylbenzene	4.27E-01	4.27E-07	7.51E-06
Xylenes(m/p + o)	2.43E+00	2.43E-06	4.27E-05
Styrene	1.75E+00	1.75E-06	3.08E-05
Cumene	3.02E-01	3.02E-07	5.31E-06

a Page 4-49

b Detection limit values (1/2) for one run used in developing EF.

c Detection limit values (1/2) for two runs used in developing EF.

PM, FILTERABLE, EMISSION FACTOR a

Emission Factor (lb/MMBtu) b	Emission Factor (lb/ton)
0.0089	1.57E-01

a Page 4-4 says the PM is filterable

b Page 4-7