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
Reference:	70
Title:	Characterizing Toxic Emissions from a Coal-Fired Power Plant Demonstrating the AFGD ICCT Project and a Plant Utilizing a Dry Scrubber /Baghhouse System. Final Draft Report. Springerville Generating Station Unit No. 2. Southern Research Insititute, Birmingham, Alabama. December, 1993.

Coal Ref 24

Characterizing Toxic Emissions from a Coal-Fired Power Plant Demonstrating the AFGD ICCT Project and a Plant Utilizing a Dry Scrubber/Baghouse System

DOE Contract No DE-AC22-93PC93254

See 3/22/94 letter (next page) benzene, toluene, m-p-xylene conc DA

DRAFT FINAL REPORT

SPRINGERVILLE GENERATING STATION UNIT NO. 2

December 17, 1993

Submitted by

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Submitted to

U. S. Department of Energy
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SRI Report No. SRI-ENV-93-1049-7960

Table 7-23 for data obtained in the Southern Research laboratory, including vapor samples from the impingers in the Multiple Metals Train (Method 29), is 46%; that for data obtained by a subcontractor (Brooks Rand), based on vapor samples from carbon sorptive traps, is 106%. This comparison reinforces the repeated arguments throughout this report for giving preference to the Brooks Rand analytical data.

For the major metals, the closures were much better. (There were no components of these data resting on non-detections.) The minimum closure based on average element flow rates was 85% for iron; the maximum was 129% for aluminum.

1.7 Emission Factors

The emission factors given in this report (Section 7.3) are based on stack concentrations, thus reflecting whatever net control occurs in the spray dryer and the baghouse. For trace metals, the emission factors range from a value less than 0.02 $g/10^{12}$ J for beryllium to a value exceeding 200 $g/10^{12}$ J for boron. The difference between these extremes comes about because beryllium is supplied to the system at a very low rate and is collected with high efficiency because it occurs measurably only in the particulate matter, whereas boron is supplied as a high rate and it occurs mainly in the gas phase. The emissions factors for the metals are as follows:

	Emission Factor [a]	
Elements	$g/10^{12}$ J	$lb/10^{12}$ Btu
Antimony	0.018 ± 0.018	0.041 ± 0.041
Arsenic	0.064 ± 0.109	0.15 ± 0.25
Barium	6.06 ± 1.97	14.1 ± 4.58
Beryllium	< 0.02	< 0.04
Boron	262 ± 7	609 ± 16
Cadmium	0.011 ± 0.010	0.026 ± 0.022
Chromium	0.045 ± 0.027	0.10 ± 0.06
Cobalt	< 0.1	< 0.3
Copper	0.42 ± 0.09	0.98 ± 0.21
Lead	0.30 ± 0.09	0.70 ± 0.21
Manganese	4.85 ± 0.58	11.3 ± 4.4
Mercury [b]	1.80 ± 0.30	4.18 ± 0.69
Molybdenum	0.62 ± 0.04	1.4 ± 0.09
Nickel	< 0.1	< 0.3
Selenium	< 0.016	< 0.038
Vanadium	0.45 ± 0.18	1.0 ± 0.42

a. The uncertainty factor is proportional to the standard deviation in the stack concentration, just as the emission factor is proportional to the stack concentration itself (see Table 6-38).
b. Based on concentrations found with carbon traps, not the Method 29 impingers (see Table 6-39).

3.0 SITE DESCRIPTION

3.1 Power Plant Configuration

Springerville Generating Station Unit No. 2 is owned and operated by the Tucson Electric Power Company (TEP), and is located near Springerville, Arizona. The plant is a zero-discharge design, burning subbituminous coal from the Lee Ranch Mine in New Mexico. The coal has an average sulfur content of 0.7% and an ash content of 19%. Typical gross electrical generation at full load is 397 MW, and the net generating capacity is approximately 360 MW. (During our testing Unit No. 2 was operated at maximum capacity, with 422 MW gross and 383 net electrical output.) Unit No. 2 began commercial operation in 1990.

Figure 3-1 is a schematic process diagram for Unit No. 2. The Unit No. 2 boiler was manufactured by Combustion Engineering (CE), and is a corner-fired, balanced-draft design with overfire air for reducing NO_x emissions. Coal is fed to the boiler through CE bowl mill pulverizers. Pyrite is separated from the coal in the pulverizers. At full load, five or six pulverizers feed about 181 million g (200 tons) per hour of coal into 24 burners, and produce 1.2 billion g (2.6 million pounds) per hour of steam. Approximately 22% of the coal ash is retained as bottom ash in the boiler. The bottom ash is removed by a sluice. Soot blowers for the boiler walls are operated on a continuous cycle, and the air heater soot blowers are operated once per shift (twice daily). Pulverizer reject (pyrite) and bottom and economizer ash (sluice) are pumped to dewatering bins, surface water is passed through screens in the bins, and returned back for sluicing operations. The dewatered solids are trucked to the ash disposal area.

Unit No. 2 uses one cooling tower with thirteen cells and one dual-pressure, single-shell condenser. The condensate is treated and recirculated. All makeup water for the unit is obtained from a storage pond supplied by seven nearby wells, or other waste water streams of the unit. Waste water is also treated on site and either sent to evaporation ponds or used as makeup water for other unit processes.

Unit No. 2 uses a Joy/Niro designed Dry Flue Gas Desulfurization (FGD) system. The system has three spray dryer absorber (SDA) modules, with one atomizer per absorber. A small portion of the flue gas (about 15% at full load) bypasses the SDA modules. Under normal conditions, at operation above 60% capacity, all three SDA modules are in service. Fresh lime from Chemstar Lime of Nelson, AZ is slaked in ball mills at the plant. The fresh lime milk has a lag time of one to two hours from the lime milk storage tank to the injection through the atomizers. Solids content for the fresh lime slurry is maintained at 24%. The FGD system uses sorbent/ash recycle from the baghouse to supplement the fresh lime slurry. Recycle feed rate is adjusted to control the temperature of the flue gases leaving the SDA modules to 71 °C (160 °F). Solids content of the slurry feed at the atomizers is kept at about 50%. Air is entrained into the bottoms of the SDA modules to limit solids dropout in the modules. All of the fly ash and slurry residue pass through the SDA absorbers into the baghouse inlet ducts.

PM

Table 4-1
Flue Gas Sampling Methods

Constituent	Method	Traverse/ Single Point	Duration minutes In	Out	Stack
Day 1:					
SDA Module A Inlets, SDA Module A Outlet, & Stack:					
Semi-volatile organics & PCDDs/PCDFs	MM5/SW846-0010	T	216	224	360
Volatile organics	VOST	S	10,20,40	10,20,40	10,20,40
Aldehydes	Impingers	S	~45	~45	~45
Ammonia and Cyanide	Impingers	S	~45	~45	~45
Simulated plume (SVOC, acid gases)	SRI diluter	T	-	-	360
SDA Modules B and C:					
Particle concentration	M17	T	72	-	
Gas flows	M2	T	-	✓	
SDA Bypass:					
Particle concentration	M17	T	56		
Gas flows	M2	T	✓		
Day 2:					
SDA Module A Inlets, SDA Module A Outlet, & Stack:					
Metals	M29	T	196	168	360
Mercury	Carbon trap	S	50	50	50
Acid gases & Radionuclides	M5	T	96	112	360
Particle size distribution	Impactor/cyclone	T[a]	60	40	1850
Size fractionated composition	Dual cyclones	T[b]	-	-	2760
Simulated plume (Metals, Hg)	SRI diluter	T			360
SDA Modules B and C:					
Particle concentration	M17	T	-	56	
Gas flows	M2	T	✓		
SDA Bypass:					
Particle concentration	M17	T	56		
Gas flows	M2	T	✓		
Days 1 & 2:					
Bulk gas composition	Orsat	T[c]	✓	✓	✓

Notes: a. U of W Mk V Impactor at the stack, 5 Series Cyclone at the SDA inlet and outlet.
b. Stack only. Samples from 5 Series Cyclone train for particle size measurement used for the other size-fractionated samples for trace metals analysis.
c. Integrated sample taken in conjunction with M5 type sampling.

Table 6-35. Metal Conc...

	SDA Inlet	SDA Outlet	Stack
Trace metals	µg/Nm³	µg/Nm³	µg/Nm³
Antimony	8.0	17.0	<0.01
Arsenic	139	830	0.62
Barium	26,900	84,800	13.6
Beryllium	110	382	<0.1
Boron	8,400	42,800	846
Cadmium	194	673	0.80[b]
Chromium	668	2550	0.25
Cobalt	266	970	<0.4
Copper	895	3430	1.4
Lead	85.7	341	1.0
Manganese	6930	26,100	45.9[a]
Mercury	5.76	25.0	11.4
Molybdenum	85.3	468	1.93
Nickel	395	1580	<0.4
Selenium	68.5	402	<0.01
Vanadium	2030	7580	1.0
Major metals	g/Nm³	g/Nm³	µg/Nm³
Aluminum	1.87	6.67	12.3
Calcium	0.406	5.57	6.62
Iron	0.542	1.90	3.12
Magnesium	0.118	0.439	1.11
Titanium	0.090	0.308	0.839

[a]Rejected as an outlier — Dixon's 10% significance level.
[b]Rejected as an outlier — Dixon's 5% significance level.

PRELIMINARY DATA

Table 6-36. Metal Concentrations in Flue Gas on June 5, 1993

	SDA Inlet	SDA Outlet	Stack
Trace metals	μg/Nm³	μg/Nm³	μg/Nm³
Antimony	4.4	19.3	0.05
Arsenic	233	924	<0.01
Barium	29,600	105,000	19.9
Beryllium	113	385	<0.1
Boron	10,700	44,500	857.
Cadmium	220	759	0.014
Chromium	836	2760	<0.2
Cobalt	309	1080	<0.4
Copper	1120	3870	1.1
Lead	130	264	0.88
Manganese	6850	26,000	14.7
Mercury	12.6	13.5	9.02
Molybdenum	160	449	2.18
Nickel	500	1680	<0.4
Selenium	129	466	<0.054
Vanadium	2520	8530	1.4
Major metals	g/Nm³	g/Nm³	μg/Nm³
Aluminum	2.14	7.29	18.3
Calcium	0.453	6.47	8.07
Iron	0.552	2.01	3.34
Magnesium	0.100	0.498	1.10
Titanium	0.134	0.342	0.734

[a]Rejected as an outlier — Dixon's 10% significance level.
[b]Rejected as an outlier — Dixon's 5% significance level.

PRELIMINARY DATA

Table 6-37. Metal Concentrations in Flue Gas on June 8, 1993.

	SDA Inlet	SDA Outlet	Stack
Trace metals	μg/Nm³	μg/Nm³	μg/Nm³
Antimony	8.0	18.4	0.12
Arsenic	1.8	901.	<0.01
Barium	45,900	97,500	26.6
Beryllium	214[b]	389	<0.1
Boron	2,940	42,400	891
Cadmium	381	745	0.06
Chromium	1300	2810	<0.2
Cobalt	566	1040	<0.4
Copper	1940	3840	1.8
Lead	204	315	1.2
Manganese	12,200[b]	26,200	17.4
Mercury	6.69	9.81	8.51
Molybdenum	237	501	2.0
Nickel	885	1630	<0.4
Selenium	156	400	0.28[a]
Vanadium	4200	8320	2.17
Major metals	g/Nm³	g/Nm³	μg/Nm³
Aluminum	3.75	7.14	22.9
Calcium	0.877[a]	6.11	10.9
Iron	1.03[b]	2.01	5.14[a]
Magnesium	0.240	0.478	1.59
Titanium	0.182	0.343	1.10

[a]Rejected as an outlier — Dixon's 10% significance level.
[b]Rejected as an outlier — Dixon's 5% significance level.

PRELIMINARY DRAFT