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INTEGRATED DRY NO_x/SO₂ EMISSIONS CONTROL SYSTEM ENVIRONMENTAL MONITORING REPORT

Calcium-Based Dry Sorbent Injection System Test Period:

April 30, 1993 through November 2, 1993

Calcium DSI Air Toxics Test October 19-20, 1993

Dioxins/Furans Air Toxics Text October 11-13, 1993

DOE Contract Number DE-FC22-91PC90550

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CONTENTS

I.	Project	Status 1
	Α.	Test Summary 1
	В.	Summary of Environmental Monitoring 1
II.	Summa	ary of Compliance Monitoring Results
	Α.	Sulfur Dioxide Monitoring 3
	B .	Opacity Monitoring
	C.	Aqueous Stream Monitoring 4
Ш.	Summa	ry of Supplemental Monitoring Results
	Α.	Gaseous Species Monitoring 5
	В.	Particulate Monitoring 5
	C.	Aqueous Stream Monitoring
	D.	Solids Stream Monitoring 6
IV.	Summa	ary of Air Toxics Monitoring Results
	Α.	Uncertainty Analysis 15
	В.	Treatment of Non-Detectable Measurements 17
	C.	Treatment of Blank Values
	D.	Gaseous Species Monitoring
		Trace Metals
		Anions
		Baseline Dioxin and Furan Emissions
		FFDC Efficiency
	E.	Solids Stream Monitoring
		Calcium-Based Sorbent Analysis
		Coal Analysis
		Fly Ash
	•	Bottom Ash
	F.	Mass Balance Results
	G.	Summary of Test Results 40
Appen	OIX A: 3	State Emission Reports

- Appendix B: Aqueous Stream Compliance Data
- Appendix C: Calcium-Based DSI System Data Summary

TABLES

Table 1:	Arapahoe 4 SO 2 Emissions 3
Table 2:	Water Use by Flue-Gas Humidification System 6
Table 3:	Proximate Analysis for Baseline Air Toxics Testing 7
Table 4:	Ultimate Analysis for Baseline Air Toxics Testing 7
Table 5:	Proximate Analysis for Calcium-Based DSI System Air Toxics Testing
Table 6:	Ultimate Analysis for Calcium-Based DSI System Air Toxics Testing
Table 7:	Target Compounds for Calcium-Based DSI System 10
Table 8:	Target Compounds 11
Table 9:	Laboratories for Air Toxics Analyses 12
Table 10:	Stream Mass Flow Data 13
Table 11:	Average Operating Conditions and Continuous Emissions Data
Table 12:	Test Methods Different from EMP 16
Table 13:	Summary of Bias Values Used for Uncertainty Calculations
Table 14:	Trace Metal Emission Results for Calcium-Based DSI System
Table 15:	Comparison of Alternative Digestion Methods and INAA
Table 16:	Comparison of Fuel vs FFDC Inlet Measurements 23
Table 17:	Acid-Forming Anion Emission Results for Calcium- Based DSI System
Table 18:	Baseline Polychlorinated Dibenzo-P-Dioxin (PCDD) and Polychlorinated Dibenzofuran (PCDF) Emissions 27
Table 19:	FFDC Removal Efficiency (Calcium-Based DSI Test Period)
Table 20:	Air Toxics Analysis of Hydrated Lime
Table 21:	Trace Metals Analysis of Coal 33
Table 22:	Air Toxics Analysis of Ash for Calcium-Based DSI 36
Table 23:	Mass Balance Results for Calcium-Based DSI TestPeriod
Table 24:	Summary of Fuel Input, FFDC Inlet, and FFDC Outlet Levels
Table 25:	Distribution of Trace Metals Across Output Streams 42
Table 26:	Summary of Opacity Violations Appendix A-1

FIGURES

Figure 1: Sam	pling Locations		14
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ABBREVIATIONS

ASME	American Society of Mechanical Engineers						
ASTM	American Society of Testing and Materials						
CARB	California Air Resources Board						
CDH	Colorado Department of Health						
CEM	Continuous emissions monitor						
CO	Carbon monoxide						
CO 2	Carbon dioxide						
CVAA	Cold vapor atomic absorptions						
EMP	Environmental Monitoring Plan						
EPA	Environmental Protection Agency						
FC/VM	Fixed carbon/volatile matter						
FFDC	Fabric filter dust collector						
GC/MS	Gas chromatography/mass spectroscopy						
GFAA	Graphite furnace atomic absorption						
HF	Hydrofluoric acid						
HHV	Higher heating value						
IC	Ion chromatography						
ICP	Inductively coupled plasma						
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy						
INAA	Instrumental Neutron Activation Analysis						
ISE	Ion specific electrode						
MS	Mass spectrometry						
NO	Nitric oxide						
NO _x	Oxides of nitrogen						
O 2	Molecular oxygen						
РАН	Polycyclic aromatic hydrocarbons						
PCDD	Polychlorinated dibenzo-p-dioxins						
PCDF	Polychlorinated dibenzofurans						

PID	Photoionization detector
PM ₁₀	Particulate matter less than 10 microns
PSCC	Public Service Company of Colorado
PTC	Power test code
QA	Quality assurance
SO 2	Sulfur dioxide
SO 3	Sulfur trioxide
VOC .	Volatile organic compounds

UNITS

Btu	British Thermal Unit
°F	degree Fahrenheit
DSCFM	dry standard cubic feet per minute
DSCF	dry standard cubic feet, 68°F and 1 atm
gpm	gallons per minute
gr	grains
kg	kilogram
lb	pound (mass)
lb/10 ¹² Btu	pound per trillion British thermal units
lb/MMBtu	pounds per million British thermal units
m ³	cubic meter
mg	milligram (10 ⁻³ gram)
μg	microgram (10 ⁻⁶ gram)
μ g/Nm ⁻³	microgram per normal cubic meter (0°F,1 atm)
MMBtu	Million Btu
MWe	Megawatt-electric
ng	nanogram (10 ⁻⁹ gram)
ng/Nm ⁻³	nanogram per normal cubic meter (0°F, 1 atm)
pCi	pico-Curie
ppm	parts per million
ppmc	parts per million corrected to 3% O ₂ , dry
ppmd	parts per million, dry
ppmw	parts per million by weight

I. Project Status

A. Test Summary

The dry sorbent injection (DSI) system was tested with calcium-based sorbents from April 30, 1993 through November 2, 1993 at Public Service Company of Colorado's (PSCC) Arapahoe Unit 4 Steam Electric Generating Station.

The test consisted of two phases: (1) Optimization of the operating parameters and (2) Parametric tests on the optimized system to assess the performance as various boiler operating parameters were modified. Nearly 200 different tests were completed over this period. Calcium was injected both into the boiler at a temperature range of approximately 1000°F and into the inlet to the fabric filter dust collector (FFDC). Testing was conducted both with and without flue-gas humidification. After these two phases were completed, a series of air toxics tests were conducted. These tests measured air toxics during the injection of calciumbased reagents before the FFDC and during humidification. In addition, baseline air toxics tests for dioxins and furans were repeated.

B. Summary of Environmental Monitoring

The purpose of this report is to document the environmental monitoring that was completed as part of the calcium injection test series. Monitoring was completed according to the *Environmental Monitoring Plan for the Integrated Dry NO_x/SO*₂ *Emissions Control System*, dated February 1992 and its addendum dated July 1993.

Generally, the testing went well and there were no significant environmental events during the test period and there were no excursions of any compliance requirements during testing. A significant amount of supplemental monitoring was completed to determine the emissions while operating and testing the DSI system with calcium-based reagents. The test series report *Calcium-Based Dry*

Sorbent Injection, dated December 1994 contains a complete discussion of the calcium test program.

Additional supplemental monitoring to collect data for 21 potential air toxics was completed during the calcium injection testing. Sampling for this testing was conducted October 19 and 20, 1994. Additional baseline testing to determine a number of dioxins and furans was also conducted without the calcium injection system in operation. This baseline sampling was conducted October 11, 12, and 13, 1993.

II. Summary of Compliance Monitoring Results

A. Sulfur Dioxide Monitoring

Regulation 1, VI.A.3.a.(ii) of the State of Colorado states that the maximum emission of sulfur dioxide (SO_2) is 1.2 lb/MMBtu. An Altech 180 continuous emission monitoring (CEM) system was installed at Arapahoe Unit 4 in June 1992. This monitor was used to collect emissions data during this test program. However, the monitor was not used for compliance monitoring during this test series.

 SO_2 emissions for compliance monitoring were calculated from the amount of sulfur in the fuel. Table 1

summarizes this data. Emissions calculated to

Quarter (1993)	Avg. SO 2 Content (lb/MMBtu)	SO ₂ Violations
2nd	0.844	None
3rd	0.861	None
4th	0.850	None

Table 1: Arapahoe 4 SO₂ Emissions

be above the regulatory limit of 1.2 lb/MMBtu are provided to the state quarterly. The test period covered most of the second, all of the third, and part of the fourth quarters of 1993. Appendix A contains copies of the reports documenting this information to the Colorado Department of Health (CDH).

B. Opacity Monitoring

According to Regulation 1, II.A.1., PSCC must report to the CDH anytime Arapahoe Unit 4 exceeds 20% opacity due to any air pollutant. The unit uses a Lear Siegler RM41 continuous opacity monitor to measure and record opacity.

During the test period, the average daily opacity ranged from 0.7 to 6.8%. Arapahoe Unit 4 had thirty one 6-minute opacity excursions exceeding the 20% opacity limit for a 99.93% compliance percentage over the test period. None of these excursions occurred, however, while testing the calcium-based DSI system and all were related to the startup and shutdown of the unit. Appendix A provides copies of the reports documenting this information to the CDH and the compliance rate calculation.

C. Aqueous Stream Monitoring

Colorado Wastewater Discharge Permit No. CO-0001091 requires that Arapahoe Unit 4 must sample and report on various aqueous discharges. Appendix B contains copies of the reports provided to the CDH during the combustion test period for April through November of 1993. Note that there were no violations and that the station was in compliance 100.0% of the test period.

III. Summary of Supplemental Monitoring Results

A. Gaseous Species Monitoring

Significant gas monitoring was done to determine the environmental effects of the Integrated Dry NO_x/SO₂ Emissions Control System and, specifically, the DSI system using calcium-based sorbents. Appendix C contains a summary of all test data obtained during the calcium-based DSI testing conducted April 30 through November 2, 1993. The test summary contains average emissions by test for the following gases:

- Nitric oxide (NO)
- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Oxygen (O_2)
- Sulfur dioxide (SO_2)

B. Particulate Monitoring

Three particulate tests were conducted during the air toxics testing. Environmental Protection Agency (EPA) Method 5 was used to conduct these tests at the FFDC inlet and outlet. The inlet particulate levels ranged from 2.437 to 1.873 gr/DSCF and averaged 2.207 gr/DSCF. The outlet particulate levels were 0.0019, 0.0007, and 0.0006 gr/DSCF and averaged 0.0012 gr/DSCF. The high outlet value (0.0019 gr/DSCF) could be the result of rust and other materials not associated with combustion. The efficiency of the FFDC averaged 99.952%.

C. Aqueous Stream Monitoring

No supplemental monitoring of aqueous streams was planned or required during the calcium-based DSI test program but, the consumptive water use of the fluegas humidification system and urea injection system was recorded for informational purposes. Table 2 shows water use by month.

D. Solids Stream Monitoring

Coal

Coal sampling and analysis was conducted during the air toxics sampling period. Two sets of coal samples were obtained. The first set of samples were obtained during baseline testing for dioxins and furans. The second set of

Month	Gallons	Acre -feet
May 1993	254,185	0.78
June 1993	490,849	1.51
July 1993	339,858	1.04
August 1993	0	0
September 1993	90,503	0.28
October 1993	260,359	0.80
November 1993	0	0
Total	1,435,754	4.41

 Table 2:
 Water Use by Flue-Gas Humidification

 System
 System

samples were obtained during the air toxics testing with the calcium-based DSI system.

Table 3 lists the proximate analysis and Table 4 lists the ultimate analysis of the coal burned during the repeat of the baseline dioxin and furan sampling. Originally dioxin and furan sampling was completed under baseline conditions during the selective non-catalytic reduction air toxics test period completed March 8, 1993 through March 11, 1993. Due to contamination of native isomers in the method blanks, samples, and archived resin a valid measurement could not be obtained and the testing was repeated during the current air toxics test period. Except for the percent ash values which are slightly higher than normal, the results show good agreement and are typical for the bituminous coal fired at Arapahoe Unit 4.

	Test 1		Test 2		Test 3		Average	
Ргорсту	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis
%Moisture	10.34	-+	10.10		10.22		10.22	
%Ash	9.62	10.73	11.58	12.88	11.78	13.12	10.99	12.24
% Volatile	34.46	38.43	33.87	37.68	33.60	37.42	33.98	37.84
% Fixed Carbon	45.58	50.84	44.45	49.44	44.40	49.46	44.81	49.91
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Btu/lb	11,197	12,488	10,962	12,193	10,933	12,177	11,051	11,030
FC/VM	1.32	1.32	1.31	1.31	1.32	1.32	1.32	1.32
lb SO ₂ /MMBTu @ (100%)	0.79)	0.80	6	0.8	4	0.8	3

Table 3: Proximate Analysis for Baseline Air Toxics Testing

	Test 1		Test 2		Test 3		Average	
Property	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis
% Moisture	10.34		10.10		10.22		10.22	
%Carbon	64.42	71.85	62.77	69.82	61.97	69.02	63.05	70.23
%Hydrogen	4.43	4.94	4.35	4.84	4.51	5.02	4.43	4.93
%Nitrogen	1.57	1.75	1.51	1.68	1.56	1.74	1.55	1.72
% Sulfur	0.44	0,49	0.47	0.52	0.46	0.51	0.46	0.51
%Ash	9.62	10.73	11.58	12.88	11.78	13.12	10.99	12.24
%Oxygen (diff)	9.18	10.24	9.22	10.26	9.50	10.59	9.30	10.36
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 4: Ultimate Analysis for Baseline Air Toxics Testing

Table 5 lists the proximate analysis and Table 6 lists the ultimate analysis of the coal burned during the air toxics testing during the calcium-based DSI system. Generally, Arapahoe Unit 4 burns Colorado coal from the Yampa mine, but PSCC occasionally purchases spot market Colorado coal from the Edna mine.

	Test 1		Test	Test 2		Test 3		Average	
Property	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis	
% Moisture	11.33		12.15		11.60		11.69		
%Ash	8.49	9.58	7.96	9.06	7.80	8.82	8.08	9.15	
% Volatile	34.92	39.38	34.96	39.79	35.01	39.60	34.96	39.59	
%Fixed Carbon	45.26	51.04	44.93	51.15	45.59	51.58	45.26	51.26	
Total	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	
FC/VM	1.30	1.30	1.29	1.29	1.30	1.30	1.30	1.30	
Btu/ib	11,034	12,444	10,959	12.475	11,076	12,529	11.023	12,482	
lb SO √ MMBtu	1.0	5	1.0	19	1.0	03	1	.06	

The higher sulfur levels in the analyses indicate that Arapahoe Unit 4 fired its alternate coal both days of air toxics testing for the calcium-based DSI system.

Table 5: Pro	oximate Analysis	for Calcium-Based	DSI System	Air Toxics	Testing
--------------	------------------	-------------------	------------	------------	---------

	Test	1	Test	2	Test	3	Ачега	ge
Property	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis
%Moisture	11.33		12.15		11.60		11.69	
%Carbon	62.71	70.72	62.29	70.91	63.14	71.42	62.71	70.95
%Hydrogen	4.38	4,94	4.30	4.90	4.36	4.93	4.35	4.92
% Nitrogen	1.59	1.79	1.61	1.83	1.64	1.85	1.61	1.82
% Sulfur	0.58	0.65	0.60	0.68	0.57	0.65	0.58	0.66
%Ash	8.49	9.58	7.96	9.06	7.80	8.82	8.08	9.15
%Oxygen (diff)	10.92	12.32	11.09	12.62	10.89	12.33	97	12.59
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 6: Ultimate Analysis for Calcium-Based DSI System Air Toxics Testing

<u>Fly ash</u>

Supplemental monitoring of fly ash and bottom ash was also completed during the calcium injection testing. The samples were obtained in order to perform mineralogical, elemental, anion, and leachate analyses. These analyses take a significant amount of time to perform. These results will be reported in the environmental monitoring section of the *Final Report, Volume 2: Project Performance and Economics*.

IV. Summary of Air Toxics Monitoring Results

A total of 21 potential air toxics was measured at Arapahoe 4 with the calcium-based DSI system operating. Table 7 lists the air toxics that were sampled during the calcium-based DSI testing. Table 8 compares the target air toxics measured during each of the four test series. This report presents baseline dioxin data and air toxics data for the calcium-based DSI system.

Refer to the other three

Trace Metals	Arsenic Cadmium Copper Mercury Selenium Calcium Barium Chromium	Lead Molybdenum Phosphorous Beryllium Cobalt Manganese Nickel Vanadium
	Chromium	Vanadium
	Calcium	Sodium
Anions ¹	Chloride Fluoride	Sulfate

1. Elemental precursors of these anions measured in the fuel (Cl, F, S).

Table 7: Target Compounds for Calcium-Based DSI System

environmental monitoring reports for more information on the other tests conducted.

Sampling of the baseline dioxins was conducted on October 11, 12, and 13, 1993. The air toxics tests for the calcium-based DSI system were conducted on October 19 and 20, 1993. No sampling occurred during sootblowing operations.

				Test Pe	riod		······································
Target	Compounds	Low-NOx	SNO	CR	Calcium-	Based DSI	Sodium-
		Combustion	Baseline ³	SNCR	Baseline	Sodium	Based DSI
Trace Metals		x		x		x	x
Acid-Forming Anions		x		x		x	x
Volatile Organic	Benzene/toluene	x	x				
Compounds	Formaldehyde	x					
Semi-Volatile	РАН	x					
Organic Compounds	PCDD/PCDF		X ²		x		
Solid Particulate		x		x		x	x
Radio Nuclides		x					
Trace Metals	Total/hexavalent chromium		x				
Speciation	Mercury		x				
Nitrogen Compounds		x		x			
HHV, Ultimate/ Proximate Analysis		x	x	x	x	x	x
Loss-On- Ignition		x		x		x	x

1. Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF).

lists the laboratories used to analyze the collected samples.

2. Due to anomalous contamination of native 2,3,7,8,PCDD/PCDF isomers in the method blanks, samples, and archived resin, the results of these tests are invalid and were repeated during the calcium-based DSI test period.

3. Some baseline tests were repeated in the SNCR test period.

Table 8: Target Compounds

PSCC contracted with Carnot, Inc. of Tustin, California to complete the air toxics work at Arapahoe Unit 4. Fossil Energy Research Corp. of Laguna Hills, California provided some assistance at the site and with data collection. Table 9

Analysis	Laboratory	Location
Solid particulate	Carnot, Inc	Tustin, CA
Chloride and sulfate (as necessary for confirmation)	Carnot, Inc	Tustin, CA
Acid-forming anions	Curtis and Tompkins	Berkeley, CA
Trace metals	Curtis and Tompkins	Berkeley, CA
Semi-volatile organic compounds	Zenon Environmental Laboratories	Burlington, Ontario, Canada
LOI for ash	Commercial Testing and Engineering	Denver, CO
Trace metals and anions analysis of fuel and ash	Curtis and Tompkins	Berkeley, CA
Coal preparation and ultimate analysis, including anions	Commercial Testing and Engineering	Denver, CO
Neutron activation analysis	Massachusetts Institute of Technology	Cambridge, MA
Coal preparation	A.J. Edmonds	Long Beach, CA
Ash preparation and anion analysis	Commercial Testing and Engineering	Denver, CO
Ash preparation	Carnot	Tustin, CA

Table 9: Laboratories for Air Toxics Analyses

The Environmental Monitoring Plan (EMP) addendum for air toxics includes details on the method used to determine the total mass flow of the air toxics. In addition to the measured concentrations of the air toxics in the sample, mass flows of the solid and gas are required. Table 10 lists the mass flowrates for the flue gas and the solids used to determine the mass flow of the toxics. The actual flue-gas flowrate is used for each of the trace metal, particulate matter, and anion tests. The flue-gas flowrates for the VOC and cyanide tests were from the major test conducted concurrently. The existing plant equipment was used to measure the coal flow. The measured particulate loading and flue-gas flowrate was used to calculate the flowrate of the fly ash and the stack ash. The coal input and the fly ash flowrates were used to calculate the bottom ash flowrate.

Stream	Test	Location	Test 1	Test 2	Test 3
	Trans Manula	Inlet	271,100	279,700	276,300
	I race Metals	Outlet	279,200	288,700	279,700
	Particulate	Inlet	252,500	263,000	272,700
Flue Gas Flow	Matter	Outlet	260,000	268,900	275,900
Rate (DSCFM)	A	Inlet	252,500	263,000	272,700
	Anions	Outlet	260,000	268,900	275,900
	Dioxins and	Inlet	232,600	199,100	225,200
	Furans	Outlet	234,900	204.700	206,900
	Coal Flow (lb/h)		101,800	105,400	104,300
	Fly Ash Flow (lb/h)		8,359	8,351	7,474
Bo	ntom Ash Flow (Ib/	h)	3,638	3,889	4,593
1	otal Ash Flow (lb/b))	11,997	12,240	12,067
S	tack Ash Flow (lb/h)	4.2	1.6	1.4

Table 10: Stream Mass Flow Data

Table 11 lists the average operating conditions of Arapahoe Unit 4 during the calcium and baseline air toxics testing. All three baseline dioxin tests were conducted at 75 Mwe. A problem occurred on the first day of testing that limited load to 75MWe. The problem was corrected the following day but the remaining tests were conducted at the same load to provide three replicate tests. Figure 1 shows a simplified diagram of the unit and shows the five different sample locations. Gaseous samples were obtained at the inlet and the outlet of the FFDC. Solid samples of unpulverized coal, bottom ash, and fly ash were also obtained. This section lists the results of the air toxics testing. For details on the methods used for sampling, analysis, and quality assurance, see the *Environmental Monitoring Plan Addendum for Air Toxics Monitoring*, dated July 1993.





,		Bas	seline Dio:	kins	Calcium-E	ased DSI A	ir Toxics
	горегту	1	2	3	1	2	3
Unit lo	bad (MW, net) ³	76	75	75	112	112	112
Incut	Air (lb/h)	753,000	705,000	716,000	976,000	995,000	1,028,000
input	Coal (lb/h)	67,600	68,900	72,200	101,800	105,400	104,300
Stear	n flow (lb/h)	638,000	632,000	630,000	959,000	966,000	966,000
	Injection rate (lb/min)				51.5	52.4	51.7
	Ca/S				2.06	2.07	2.10
DSI	Sorbent feeder output (A/B) ⁴				56%/68%	57%/69%	56%/68%
	Humidification water (gpm)				70.9	66.8	72.8
	$\%O_2^{l}$, dry	7.70%	7.24%	7.34%	6.11%	6.25%	6.32%
FFDC	CO (ppmd) ²	14.0	19.2	13.2	71.7	231	212
outlet	NO (ppmd) ²	216	194	196	225	221	225
	$SO_2 (ppmd)^2$	308	308	307	280	283	262

1. From Carnot's portable O₂ that sampled at each sample point.

2. From a single point Altech CEM system located in the FFDC outlet duct.

3. The "B" ID fan was off line for the first baseline test. To maintain consistent operating conditions, the remaining tests were operated at 75 MW.

4. Indicates level of operation of "A" and "B" DSI feed systems.

Table 11: Average Operating Conditions and Continuous Emissions Data

Table 12 lists the methods used during this sampling program that differ from the EMP.

A. Uncertainty Analysis

In the tables that follow, a value for uncertainty expressed as a percentage is provided for all data. The calculation method used is based upon ANSI/ASME PTC 19.1-1985, "Measurement of Uncertainty." The uncertainty is based on a 95% confidence interval for the mass emissions for the target species but is expressed as a percentage so that it may be applied to other units. A very important part of the method is assigning an estimated bias error for the major

	Species	EMP Specified Method	Method Used
17700	Arsenic	EPA SW 846-7060 (GFAA)	EPA SW 846-6010 (ICP)
Inlet	Cadmium	EPA SW 846-7131 (ICP)	EPA SW 846-6010 (ICP)
	Chromium	EPA SW 846-7191 (GFAA)	EPA SW 846-6010 (ICP)
	Arsenic	EPA SW 846-7060 (GFAA)	EPA SW 846-6010 (ICP)
FFDC Outlet	Cadmium	EPA SW 846-7131 (ICP)	EPA SW 846-6010 (ICP)
Conce	Chromium	EPA SW 846-7191 (GFAA)	EPA SW 846-6010 (ICP)
	Arsenic	EPA SW 846-7060 (GFAA)	INAA
	Barium	EPA SW 846-6010 (ICP)	EPA SW 846-6010 (ICP with EPA3050 digestion)
	Chlorine	ASTM D-4208 & ISP	INAA
	Sulfate	EPA SW 846-300-IC	ASTM D4239 & LECO SC-132
	Cadmium	EPA SW 846-7131 (ICP)	INAA
	Mercury	EPA SW 846-7470 (CVAA)	INAA
Fuel	Selenium	EPA SW 846-7740 (GFAA)	INAA
	Chromium	EPA SW 846-7191 (GFAA)	EPA SW846-6010 (ICP-AES)
	Lead	EPA SW 846-7421 (GFAA)	EPA SW846-7420 (GFAA)
	Calcium	EPA SW 846-6010 (ICP)	EPA SW 846-6010 (ICP with EPA3050 digestion)
	Sodium	EPA SW 846-6010 (ICP)	EPA SW 846-6010 (ICP with EPA3050 digestion)
	Manganese	EPA SW 846-6010 (ICP)	INAA
	Vanadium	EPA SW 846-6010 (ICP)	INAA
	Barium	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Beryllium	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Cadmium	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Chromium	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Cobalt	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Copper	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
Elverbi	Manganese	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
Bottom	Mercury	EPA SW 846-7470 CVAA	EPA SW 846-7471 ICP-AES
Ash	Molybdenum	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Nickel	EPA SW 846-6010 (1CP)	EPA SW 846-7060 ICP-AES
	Phosphorus	EPA SW 846-6010 (ICP)	EPA SW 846-7060 ICP-AES
	Vanadium	EPA SW 846-6010 (ICP)	EPA SW 846-7060
	Calcium	EPA SW 846-6010 (ICP)	EPA SW 846-7060 (ICP with EPA3050 digestion)
	Sodium	EPA SW 846-6010 (ICP)	EPA SW 846-7471 (ICP with EPA3050 digestion)
	Fluoride	EPA 300.0(IC)	EPA 340.2 (ISE)
	Sulfate	EPA 300.0(IC)	ASTM D4239 & LECO SC-132

Table 12: Test Methods Different from EMP (TBD)

variables. The value presented represents only an approximation of the uncertainty as not all bias errors may be estimated. The uncertainty is also not a measure of long-term trace-species emissions for this boiler, but only the uncertainty for the specific test period. It was assumed that the samples are a normal population distribution. Table 13 summarizes the bias values used to determine uncertainties.

Location	Particle Collection ¹	Flowrate ²	Fuei Flowrate ³	Fly Ash Flowrate ⁴	Bottom Ash Flow Rate ⁴
Inlet	15%	0%	0%	15%	15%
Outlet	0%	0%	N/A	N/A	N/A

1. Bias based on difference between pitot and heat rate flowrates.

2. No bias estimated as measured inlet, measured outlet, and calculated flow agreed within +-5%

3. No bias estimated as calculated flue gas flow agreed with measured outlet flow.

4. Bias equals the inlet particle collection bias.

Table 13: Summary of Bias Values Used for Uncertainty Calculations

B. Treatment of Non-Detectable Measurements

Many of the target species for which a measurement was attempted were not found using the specified sampling and analytical techniques. If a measurement for a target species was not found, the value that could have been measured (i.e. the detection limit) if the trace emissions were present are reported. The "nondetects" are shown as less than the detection limit. The difficulty occurs when averaging various samples of which some or all of the measurements are below the detection limit. The following summarizes the two cases:

• All values below detection limit: The arithmetic average of the detection limit is shown with a "<" sign to indicate that the trace species is less than the reported average detection limit. For example, if a species was not found and the method provided a detection limit of 0.45, the values is reported as <0.45. • Some, but not all, values below detection limit: The value of all measurements above the detection limit are averaged with one-half of the detection limit. For example, if three measurements of 10, 8, and <6 are found, the average would be (10+8+6/2)/3 or 7. Note that no "<" sign is used in these reported averages even though some of the values are below the detection limit. If the average calculated with this method is less than the greatest detection limit; the largest detection limit is reported and a "<" symbol is used. For example, if values of 6, <4, and <2 were reported, the average would be reported as <4 and not (6+4/2+2/2)/3 or 3.</p>

C. Treatment of Blank Values

Three different types of blanks were used as part of the air toxics testing quality assurance (QA) program. The QA program included field blanks, reagent blanks, and laboratory preparation blanks.

Field blanks are samples obtained by assembling a complete sample train at the test site using the same procedures as when obtaining the actual sample. The sample train is then leak checked and disassembled to recover and analyze the sample. Field blanks are not used to "correct" the data generally but are used to provide an indication of the quality of the sample.

Reagent blanks consist of samples of the reagent and/or filters that are collected at the site. Analysis of these samples show if any of the results were caused by existing levels of the trace species in the material used to collect or recover the sample. If measurable values of the trace species are found, the data is usually corrected by subtracting the value measured in the reagent.

Laboratory reagent blanks consist of samples of the chemicals used during the measurement analysis. If measurable values of the trace species are found, the

data is usually corrected by subtracting the value measured in the reagent. Any measurable values in the laboratory reagent may be caused by initial trace species in the chemicals or by the analytical procedures.

In the tables that follow the value of the field blank is shown for reference, but none of the data has been changed due to these measurements. If a measurement has a value near the field blank measurement, there may be some question as to the accuracy of the data and the reported value may NOT be source related. A separate column lists a blank correction percentage for all trace species that were corrected due to either a reagent or laboratory reagent blank. This is an average percentage calculated as follows:

%blank correct =
$$\frac{\sum \left(\frac{blank \ value}{sample \ value}\right)}{number \ of \ samples} \approx 100$$

For example, if three samples contained 10, 5, and 4 mg/kg of a trace species and the reagent blank was 2 mg/kg, the blank correction would be:

blank correction =
$$\left(\frac{2}{10} + \frac{2}{5} + \frac{2}{4}\right) \approx \frac{100}{3} = 37\%$$

Thus, on average, the actual value measured was 37% higher than the value reported in the table. If the blank correction is reported as 0%, no blank correction was calculated and the reported value was the measured value. Note that in most cases a high blank correction value does not mean that the data is inaccurate. If a sample was contaminated with a trace species due to a filter, and the filter was analyzed and the data corrected, it is likely that the data is meaningful.

D. Gaseous Species Monitoring

This section reports the trace metal, acid-forming anion, and FFDC efficiency from the air toxics testing of the calcium-based DSI system. In addition, it reports the furan and dioxin data from the baseline tests.

Trace Metals

Table 14 lists the gaseous trace metal emissions for the calcium-based DSI test period. Although calcium and sodium are neither trace metals or air toxics, Table 14 also lists their results. At the FFDC inlet, all 15 trace metals, calcium, and sodium were reported above their detection limits.

Previous air toxics test series at Arapahoe reported a wide unexplained variation of barium, calcium, and sodium in various solid streams between different test methods. Curtis and Tompkins, the laboratory completing the analysis, investigated and discovered a problem with the ASTM D3683 ashing/acid digestion method of sample preparation. Coal samples were prepared according to ASTM D3683 and also EPA method 3050. The EPA method does not require ashing or digestion using HF acid. A comparison of the data with the two different digestion methods for both the calcium and sodium injection program compared to INAA is shown in Table 15. This data suggests that ASTM D3683 (that uses HF acid digestion) may have a significant low bias. The EPA 3050 method provides better precision between replicates and better accuracy when compared to INAA which does not require sample digestion.

Trace Meals Terr (1) Terr (3)					FFDC Inlet						H	FDC Out	5		
Arsenic ³ $_{\textit{RCM}}$ $_{\it{RCM}}$	Trace Metals	Test 1	Test 2	Test 3	Avg.	Uncert.	Field Blank	Blank Correct	Test 1	Test 2	Test 3	Avg.	Unceri .	Field Blank	Blank Correct
Arsenic 3 27 28 19 25 50 0.14 1.41 0.00 0.12 2.99 0.074 35 Barum $^{3.36}$ 16 333 730 542 443 0.80 0.38 1.7 1.7 0.14 12 190 0.14 50 Barum $^{3.36}$ 10 15 11 12 500 0.38 <0.027 <0.027 <0.027 20 0.14 50 Bervlium 50 48 5.2 5.0 17 0.14 0.62 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027 <0.027			μg/]	E EN		ž	tg/Nm ³	%		1/8 1	lm ³		%	Jeg/Nm ³	×
Barum 1.6 33 730 542 443 0.80 0.3R 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 0.48 <0.027 <0.027 2.0 0.14 3.6 Cadmium 5.0 4.8 5.1 5.0 1.7 <0.035	Arsenic ³	27	28	19	25	50	0.14	1.4L	0.070	0.24	< 0.070	0.12	239	0.074	39L
Beylium1015111252<0.03500<0027<0.028<0.027<0.02729<0.02700Cadmium50485.25.017<0.089	Barium 2.3.6	16	353	730	542	443	0.80	0.3R	1.7	1.7	0.14	1.2	190	0.14	50R
Cadmiun5.04.85.25.017<0.0890.0<0<0.48<0.0700.18349<0.0690Chonium 3 62958180550.261.5R0.140.140.660.322440.1475Chonium 4 90706888<0.350.261.5R0.140.160.680.322440.1475Colati 4 90706888<0.350.261.5R0.140.7668990.12Colati 6 3222343961321.00.280.7 6 0.322440.1475Colati 6 3222343961371200.0830.4R0.291.10.060.322440.1475Lead 27 1037970137250.180.780.270.2729 6 07729 6 077Moyberum 21 $4,4$ 5 0 $3,4$ $4,3$ 33 33 32 $15,9$ 0.27 0.27 0.26 63 0.14 22 Moyberum 21 $4,4$ 5 0 $3,4$ 0.14 0.29 0.12 0.27 0.27 0.26 0.27 $4,2$ 0.74 20 Moyberum 26 $1,3$ 33 33 33 33 33 0.27 0.27 0.28 0.27 $4,2$	Bervllium	10	15	Ξ	12	52	< 0.035	0.0	< 0.027	< 0.027	< 0.028	< 0.027	29	< 0.027	0.0
Chomium 3 62 95 81 80 55 0.26 1.57 0.14 0.75 244 0.14 77 Cobat 43 90 70 68 88 <0.35 0.02 <0.27 <202 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27 <0.27	Cadmium	5.0	4.8	5.2	5.0	17	< 0.089	0.0	< 0.070	0.48	< 0.070	0.18	349	< 0.069	0.0
Cobalt4390706888<0.350.0<0.27<0.28<0.2729<0.2729<0.270Copper63231210379701390.0830.480.530.330.52890.1247Copper5210379701390.0830.480.030.482880.07942Lead2710379701390.0830.480.291.10.050.482880.07947Manganese146125140137250.180.280.270.26630.1426Manganese1445.03.44.333833.215.980.270.26630.1426Mercury4.45.03.44.33.315.980.270.26630.1426Mercury3.62217250.00.774.180.270.26630.1426Mercury3.62317251000.774.180.274.20.274.20.27Mercury3.623100.214.180.274.20.274.20.27Mercury3.62010.30.274.180.274.20.274.20.27Mercury3.62010.30.274.180.270.280.2	Chromium ³	62	95	81	80	55	0.26	1.5R	0.14	0.14	0.68	0.32	244	0.14	75R
Copper 632 322 234 396 132 10 0.2 R 0.70 0.53 0.33 0.52 89 0.12 47 Lead 27 103 79 70 139 0.083 0.4 R 0.29 1.1 0.05 0.48 288 0.079 42 Lead 17 103 79 70 137 25 0.18 0.083 0.4 R 0.21 0.64 27 89 0.14 26 Manganese 146 125 140 137 25 0.18 0.2 R 1.2 0.21 0.64 72 28 0.079 42 Mercury 4.4 5.0 3.4 4.3 35 0.12 0.012 0.27 0.28 0.74 163 0.14 26 Molybdenum 3 21 4.3 3.3 3.3 3.2 15.9 R 0.27 0.27 0.26 63 0.21 4.2 Molybdenum 36 22 117 25 100 0.77 4.1 R 0.27 0.28 0.27 4.2 0.27 Molybdenum 36 22 117 25 100 0.27 0.21 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 4.2 0.27 20.3 0.21 <td>Cobalt</td> <td>43</td> <td>6</td> <td>70</td> <td>68</td> <td>88</td> <td>< 0.35</td> <td>0.0</td> <td><0.27</td> <td>< 0.27</td> <td>< 0.28</td> <td>< 0.27</td> <td>29</td> <td>< 0.27</td> <td>0.0</td>	Cobalt	43	6	70	68	88	< 0.35	0.0	<0.27	< 0.27	< 0.28	< 0.27	29	< 0.27	0.0
Lead 27 103 79 70 139 0.083 $0.4R$ 0.29 1.1 0.05 0.48 238 0.079 42 Manganese 146 125 140 137 25 0.18 $0.2R$ 1.2 0.21 0.84 0.74 163 0.14 26 Mercury 4.4 5.0 3.4 4.3 50 0.12 0.0 0.33 0.19 0.74 163 0.14 26 Mercury 4.4 5.0 3.4 3.3 83 3.2 $15.9R$ 0.27 0.26 653 0.14 26 Mercury 4.4 5.0 3.4 33 83 3.2 $15.9R$ 0.27 0.26 63 0.14 26 Mercury 4.4 5.0 0.12 0.0 0.27 0.26 0.27 4.2 0.27 4.2 Mercury 36 22 100 0.77 $4.1R$ 0.27 0.28 0.27 4.2 0.27 Nickel ³ 36 20.300 $16,100$ 12.500 $16,300$ 62 68.9 0.021 6.079 60.79 60.79 60.79 Posphorus 20.300 $16,100$ 12.500 $16,300$ 62 68.9 0.021 6.079 60.74 4.2 0.27 4.2 Vandium 190 319 2232 247 68 6.018 60.14 6.14 20.14 20.14 20.14 20.14 Vandi	Copper	632	322	234	396	132	1.0	0.2R	0.70	0.53	0.33	0.52	89	0.12	47R
Manganese146125140137250.180.28120.210.840.741630.1426Mercury4.45.03.44.3500.120.000.330.190.270.26630.1426Molybdenum3214333833.215.980.270.270.26630.310Nickel ³ 362217251000.774.180.270.270.280.274.20.27Nickel ³ 36103647296<0.89	Lead	27	103	79	70	139	0.083	0.4R	0.29	1.1	0.05	0.48	288	0.079	42R
Mercury 4.4 5.0 3.4 4.3 50 0.12 0.0 0.33 0.19 0.27 0.26 63 0.31 0 Molybdenum 3 21 43 34 33 33 3.2 $15.9R$ 0.27 0.28 0.27 4.2 0.27 75 Molybdenum 36 22 17 25 100 0.77 $4.1R$ 0.27 0.28 0.27 4.2 0.27 4.2 0.27 Nickel ³ 36 20 103 64 72 96 <0.89 0.0 0.27 0.28 0.27 4.2 0.27 0.2 0.2 0.2 0.2 <t< td=""><td>Manganese</td><td>146</td><td>125</td><td>140</td><td>137</td><td>25</td><td>0.18</td><td>0.2R</td><td>1.2</td><td>0.21</td><td>0.84</td><td>0.74</td><td>163</td><td>0.14</td><td>26R</td></t<>	Manganese	146	125	140	137	25	0.18	0.2R	1.2	0.21	0.84	0.74	163	0.14	26R
Molybdenum 2 4 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 1 0.27 0.27 0.28 0.27 4 2 0.27 7 Nickel ³ 36 22 17 25 100 0.77 4 $1R$ 0.27 0.28 0.27 4 4 4 4 Nickel ³ 56 72 96 72 96 60.89 0.0 60.77 6.77 4	Mercury	4,4	5.0	3.4	4.3	50	0.12	0.0	0.33	0.19	0.27	0.26	63	0.31	0.0
Nickel ³ 36 22 17 25 100 0.77 4.1R 0.27 0.28 0.27 4.2 0.27 4.2 <t <="" td=""><td>Molvbdenum ³</td><td>21</td><td>43</td><td>34</td><td>33</td><td>83</td><td>3.2</td><td>15.9R</td><td>0.27</td><td>0.27</td><td>0.28</td><td>0.27</td><td>4.2</td><td>0.27</td><td>79R</td></t>	Molvbdenum ³	21	43	34	33	83	3.2	15.9R	0.27	0.27	0.28	0.27	4.2	0.27	79R
Selenum 4 50 103 64 72 96 <0.89 0.0 <0.011 <0.070 60.070 88 <0.069 0 Phosphorus 20.300 16,100 12,500 16,300 62 <8.9	Nickel ³	36	22	17	25	100	0.77	4.1R	0.27	0.27	0.28	0.27	4.2	0.27	42R
Phosphorus 20.300 16,100 12,500 16,300 62 <8.9 0.02L <1.4 <1.4 <1.4 29 3.6 0 Vanadium 190 319 232 247 68 <0.18	Selenium 4	20	103	25	72	96	< 0.89	0.0	< 0.070	0.11	< 0.070	< 0.070	88	< 0.069	0.0
Vanadium 190 319 232 247 68 <0.18 0.0 <0.14 <0.14 29 <0.14 0 Calcium 2.56 1,960 1,560 320 8.9 2R 143 151 102 132 50 8.9 14 7.5 34 7.0 16 27 7 7 Sodium 3.56 4,920 2.380 3,290 108 8.9 2R 7.5 34 7.0 16 27 7 7	Phosphorus	20.300	16,100	12,500	16,300	62	< 8.9	0.02L	<1.4	<1.4	<1.4	<1.4	29	3.6	0.0
Calcium 2.5.6 1.170 <90 1,560 320 8.9 2R 143 151 102 132 50 8.9 14 Sodium 3.5 4,920 2.570 2,380 3,290 108 8.9 2R 7.5 34 7.0 16 27 75 75	Vanadium	190	319	232	247	68	< 0.18	0.0	< 0.14	< 0.14	< 0.14	< 0.14	29	< 0.14	0.0
Sodium ^{3.5.6} 4,920 2.570 2.380 3,290 108 8.9 2R 7.5 34 7.0 16 237 27 75	Calcium 2.5.6	1.170	96 ×	1,960	1,560	320	8.9	2R	143	151	102	132	50	8.9	14R
	Sodium ^{3,5,6}	4,920	2.570	2,380	3,290	108	8.9	2R	7.5	34	7.0	16	237	27	75R

" < "indicates that the quantity measured was less than the detection limit thus the detection limit is shown Note:

1. "R" indicates reagent blank correction. "L" indicates laboratory blank correction.

2. Tests Ba #1-Out and Ca #2-In not included in averages.

Subtracting reagent blank lowered result below the detection for Ar #1-Out; Ba #3-Out; Cr #1-, 2-Out; Mb #1-, 2-, 3-Out; Ni #1-, 2-, 3-Out; and Na 3-Out. ń

Average calculated by dividing non-detects in half was less than highest non-detect, so highest non-detect used for average. 4

5. Results included, even though neither trace metals nor air toxics.

Values for these metals at the FFDC inlet are reported but believed to be invalid due to a problem with sample preparation (see text). 6.

Table 14: Trace Metal Emission Results for Calcium-Based DSI System

	Reagent	D3683 mg/Kg	E3050 mg/Kg	INAA mg/Kg
Barium	sodium	5,976	24,390	33,122
	calcium	6,670	17,447	28,925
Calcium	sodium	122,740	213,404	NP
	calcium	78,917	204,879	NP
Sodium	sodium	14,843	64,322	105,096
	calcium	31,849	27,423	46,099

Table 15: Comparison of Alternate Digestion Methods with INAA

EPA method 29, multi-metals method, also uses HF acid for digestion of solid matter collected in the sample train. Due to the potential negative bias that may be caused with HF acid, all data collected for barium, calcium, and sodium from the solid samples using Method 29 are believed invalid and are presented for information only. Table 16 compares the inlet fuel levels to the values measured at the FFDC inlet determined from the Method 29 test using HF digestion. Note the very large discrepancy in the inlet values. It is believed that the fuel values are more accurate and that the FFDC inlet values for the three elements presented are invalid. They are shown in this table only to note the large variation that was believed due to the HF digestion techniques. Note that the

inlet values are based on a large amount of particulate matter that is present at the FFDC inlet. Due to the very low particulate at the FFDC outlet, the possible interference with HF digestion is not believed to significantly affect the outlet data. While the fly ash and coal samples could be re-analyzed after the discovery of the possible HF interference, it was not possible to re-analyze the Method 29 train.

	Fuel lb/10 ¹² Btu	FFDC Inlet lb/10 ¹² Btu	Percent Difference
barium	17,400	431	3,937%
calcium	205,000	1,240	16,432%
sodium	27,400	2,580	962%

Table 16: Comparison of fuel vs FFDC Inlet Measurements

Uncertainties for copper, lead, and nickel were 100% and greater. The wide spread between the replicate tests caused the high uncertainty for these three elements. A review of the data logs and sample methods did not reveal any errors that could explain the differences.

The FFDC outlet trace metal emissions were very low with many at or near their detection limit. The high uncertainty values are due mainly to a wide variation of replicate tests. Due to the very low measured emissions, the reagent or laboratory blank corrections were also relatively high for many elements.

<u>Anions</u>

Anions were measured from both the front (solid/liquid phase) and the back-half (gaseous phase) of each particulate train. As expected, the majority of all anions occur in the gaseous phase. Results of the testing are presented in Table 17.

At the FFDC inlet, the sample-train measured 465 ppm of gaseous sulfate and the CEM measured 460 ppm of SO_2 . The gaseous fraction represents SO_2 plus any SO_3 in the vapor phase. The sample-train measured 3 ppm of solid-phase sulfate at the FFDC inlet, representing sulfuric acid mist and solid-phase sulfate present at the 250°F filter temperature. At the FFDC outlet, the sample-train measured 287 ppm of gaseous sulfate and the CEM measured 275 ppm of SO_2 .

					FDC Inlet						IHI	C Outlet			
Acid Form	ing Anions	Test 1	Test 2	Test 3	Avg.	Ипсеп.	Field Blank	Blank Correct	Test 1	Test 2	Test 3	Avg.	Uncert.	Field Blank	Blank Correct
	_		udd	3		z	wmqq	%		vudd	*		%	ppmw	4 /0
	Total	0.59	0.75	0.64	0.66	36	N/A		0.25	0.32	0:30	0.29	33	N/A	
Chlorine (CI _)	Gaseous	0.56	0.72	0.61	0.63				0.24	0.30	0.29	0.28			
	Solid	0.035	0.034	0.031	0.033			0	< 0.017	0.020	0.012	< 0.017			0
	Total	8.5	=	11	10	38	N/A		0.12	0.58	<0.06	0.24	293	N/A	
Fluorine (F ⁻)	Gaseous	8.2	10	11	9.6				0.09	0.54	<0.06	0.22			
	Solid	0.23	0.50	0.35	0.36			0	0.034	0.039	0.019	0.031			0
	Total	455	477	474	469	17	N/A		302	297	262	287	15	N/A	<u></u>
Sulfate (SO , ⁻²)	Gaseous	452	474	470	465				302	297	262	287			
•	Solid	2.9	3.1	3.3	3.1			IR	0.068	0.015	0.019	0.034			32R

" < "indicates that the quantity measured was less than the detection limit thus the detection limit is shown.

-

2. "R" indicates reagent blank correction. "L" indicates laboratory blank correction.

3. Solid fraction consists of filter and front-half rinse.

4. Gaseous fraction consists of bicarbonate/carbonate and 3% peroxide rinses.

Table 17: Acid-Forming Anion Emission Results for Calcium-Based DSI System

Baseline Dioxin and Furan Emissions

Table 18 lists the gaseous polychlorinated dibenzo-P-dioxin (PCDD) and polychlorinated dibenzofuran (PCDF) emissions at the FFDC inlet and outlet. Note that sampling and analysis techniques were optimized to lower detection limits to an average 10 times lower than that of normal dioxin and furan tests.

All dioxins and furans were measured near or below their detection limits. At the FFDC outlet, OCDD and 23478 PeCDF were the only individual isomers detected in all three samples. However, these isomers were also detected in the field blank, so their detected levels may not be entirely source related.

In Table 18, the column headed by "EPA Equiv." lists the EPA toxic equivalent for each specie. These values can be used for comparing risk and are used in the establishment of emission limits for municipal solid waste (MSW) incinerators. These equivalent values were calculated by multiplying the average actual emission of a specie by its EPA risk factor.

The total emissions of EPA equivalent toxics at the FFDC inlet was 0.0015 ng/Nm^3 and consisted of 0.0008 ng/Nm^3 of detected species and 0.0007 ng/Nm^3 of nondetects. Thus, 47% of the total EPA equivalent at the inlet of the FFDC was due to nondetects. The total emissions of EPA equivalent toxics at the FFDC outlet was 0.0014 ng/Nm^3 and consisted of 0.0003 ng/Nm^3 of detected species and 0.0012 ng/Nm^3 of nondetects. Thus, the nondetects at the outlet relate to 86% of the total EPA equivalent toxics. For comparison, well controlled MSW incinerators typically have on the order of 1 ng/Nm³ of equivalent toxic emissions, three orders of magnitude higher than Arapahoe Unit 4.

			j	FDC Inlet						-	FFDC Outle	_		
PCDD/PCDF	Test 1	Test 2	Test 3	Avg.	Uncert .	Field Blank	EPA Equiv.	Test 1	Test 2	Test 3	Avg.	Uncert.	Field Blank	EPA Equiv.
		N/gu)		ž	N/gn	۲ E		√/gn	{m }		%	N/gu	л Г
2178-TCDD 1.2	< 0.0006	0.0006	0.0006	0.0005	95	< 0.0006	0.0005	0.0006	< 0.0004	< 0.0005	< 0.0005	74	< 0.0005	0.0005
17378 PeCDD	< 0.0006	0.0002	< 0.0004	< 0.0006	78	< 0.0006	0.0003	< 0.0007	< 0.0005	< 0.0005	< 0.0005	48	< 0.0005	0.0003
173478 HxCDD ²	< 0.0007	0.0007	0.0007	0.0006	88	< 0.0008	0.0001	0.0007	< 0.0007	0.0006	0.0006	8	< 0.0012	0.0001
173678 HrCDD	< 0.0004	0.0002	< 0.0003	< 0.0004	48	< 0.0005	0.0000	< 0.0004	< 0.0004	< 0.0002	< 0.0003	83	< 0.0007	0.000
173789 HxCDD	< 0.0006	< 0.0002	< 0.0004	< 0.0004	108	< 0.0007	0.0000	<0.0006	< 0.0006	< 0.0003	< 0.0005	88	< 0.0010	0.000
1734678 HnCDD 1.2	< 0.0008	0.0004	0.0004	0.0004	43	< 0.0008	0.0000	0.0010	< 0.0006	< 0.0004	< 0.0006	136	< 0.0005	0.0000
OCDD	< 0.0011	0.0037	0.0020	0.0021	191	0.0036	0.0000	0.0042	0.0012	0.0008	0.0021	225	0.0010	000010
1378 TCDE	< 0.0020	< 0.0011	< 0.0013	< 0.0014	16	< 0.0018	0.0001	< 0.0022	< 0.0018	< 0.0018	< 0.0020	36	< 0.0011	0.0002
17378 PeCDE	< 0.0005	< 0.0002	0.0002	<0.0005	92	< 0.0005	0.000	< 0.0004	< 0.0002	< 0.0001	< 0.0002	127	< 0.003	0.000
23478 PeCDF	0.0005	0.0004	0.0004	0.0004	42	< 0.0005	0.0002	0.0005	0.0004	0.0004	0.0004	62	0.0004	0.0002
123478 HxCDF	< 0.0006	< 0.0002	< 0.0004	< 0.0004	126	< 0.0004	0.0000	0.0004	< 0.0004	< 0.0002	< 0.0004	75	< 0.0004	0.000
123678 HxCDF	< 0.0004	< 0.0002	< 0.003	<0.003	89	< 0.0002	0.000	< 0.0003	< 0.0003	<0.001	< 0.0002	104	<0.0004	0.0000
234678 HxCDF	< 0.0007	< 0.0003	< 0.0004	< 0.0005	101	< 0.0004	0.0000	< 0.0004	< 0.0004	< 0.0002	< 0.0003	8	< 0.0004	0.0000
123789 HxCDF	< 0.0007	< 0.0004	< 0.0004	< 0.0005	107	< 0.0004	0.0001	< 0.0004	< 0.0005	< 0.0002	< 0.0004	95	< 0.0005	0.000
1234678 HpCDF	< 0.0004	< 0.0003	< 0.0003	< 0.0004	45	< 0.0007	0.0000	< 0.0005	< 0.0003	< 0.0002	< 0.0004	106	<0.0004	0.0000
1234789 HnCDF	<0.0006	< 0.0005	< 0.0005	< 0.0005	44	< 0.0010	0.000	< 0.0008	< 0.0005	< 0.0004	< 0.0005	103	<0.0006	0.0000
OCDF	< 0.0006	< 0.0004	< 0.0006	< 0.0005	51	< 0.0010	0.0000	< 0.0006	< 0.0008	< 0.0005	< 0.0006	61	<0.0006	0.0000
Total TCDD 1.2	< 0.0006	0.0006	0.0006	0.0005	95	< 0.0006	1	0.0006	< 0.0004	< 0.0005	< 0.0005	74	< 0.0005	1
Total PeCDD	< 0.0006	0.0002	< 0.0005	< 0.0006	62	< 0.0006	:	< 0.0007	< 0.0005	< 0.0005	<0.0006	50	< 0.0005	}
Total HxCDD	< 0.0005	0.0008	0.0005	0.0005	132	< 0.0006	1	6000.0	< 0.0005	0.0004	0.0005	167	<0.0009	}
Total HoCDD 1.2	<0.0008	0.0004	0.0004	0.0004	43	< 0.0008	:	0.0010	< 0.0006	< 0.0005	< 0.0006	119	< 0.0005	1
Total TCDF	0.0019	0.0023	0.0028	0.0023	41	0.0019	1	0.0019	0.0016	0.0015	0.0017	26	0.0014	;
Total PeCDF	0.0011	0.0007	0.0014	0.0011	80	< 0.0005	!	0.0011	0.0007	0.0007	0.0008	68	0.004	1
Total HxCDF	< 0.0006	0.0003	< 0.0004	< 0.0006	69	< 0.0006	1	0.0004	< 0.0004	< 0.0004	< 0.0004	28	< 0.0004	1
Total HpCDF	< 0.0005	< 0.0004	< 0.0004	< 0.0004	41	< 0.0008	:	< 0.0006	< 0.0004	< 0.0004	< 0.0005	73	< 0.0005	1
Total	0.0119	0.0144	0.0137	0.0133	27	;	0.0015 ³	0.0185	0.0104	0.0093	0.0127	100	:	0.0014 ³
													-	

" < "indicates detection limit and that species was not detected.

1. By convention, the calculated mean cannot be smaller than the largest detection limit value. When this happens, the mean is reported as not detected below highest detection limit.

Table 18: Baseline Polychlorinated Dibenzo-P-Dioxin (PCDD) and Polychlorinated Dibenzofuran (PCDF) Emissions

2. Detection limits varied by sample, a straight average with non-detects divided by two was taken, highest non-detect rule was deemed inappropriate.

3. Total EPA toxic equivalent (2, 3, 7, 8, TCDD Equivalent)

27

FFDC Efficiency

Table 19 shows the FFDC removal efficiency for trace metals, anions, calcium, and sodium. The FFDC did not affect flue gas concentrations of PCDDs or PCDFs. The FFDC averaged 98.6% removal efficiency for trace metals and 99.95% for particulates.

The FFDC's removal efficiency for mercury was 93.7%, significantly higher than was obtained in previous testing without calcium injection with humidification. Fly ash unburned carbon during this testing averaged 11.21%. Water was also injected into the flue gas to improve calcium utilization. The water injection cooled the flue gas to approximately 150°F. It is believed that the combination of low flue gas temperature and high unburned carbon in the fly ash allowed the higher than expected mercury removal.

As was discussed in the trace metals section, sodium, calcium, and barium are believed to be severely biased low. Thus the data for these three elements is presented for informational purposes but the relative numbers are considered invalid.

The combination of the FFDC with calcium injection with humidification obtained significant removal of the acid-forming anions. Removal of both chloride and fluoride were 55.1% and 97.5% respectively. The removals are comparable to previous testing with urea injection but are significantly higher than the original baseline which were 10% for chloride and 20% for fluorides. SO₂ removal during the test was approximately 37% due to the calcium and humidification system.

Species	5	Inlet	Outlet	FFDC Removal
Trace Me	etals	lb/10 ¹² Btu	1b/10 ¹² Btu	%
Arsenic		20	0.09	99.5
Barium ²		431	0.94	99.8
Beryllium		9.5	< 0.02	>99.8
Cadmium		3.9	0.15	96.2
Chromium		63	0.26	99.6
Cobalt		53	< 0.22	>99.6
Copper		310	0.42	99.9
Lead		55	0.38	99.3
Manganese		108	0.59	99.4
Mercury		3.4	0.21	93.7
Molybdenum		26	0.22	99.1
Nickel		19	0.22	98.9
Selenium		57	< 0.06	>99.9
Phosphorus		12,800	<1.1	>99.99
Vanadium		1 94	< 0.11	>99.9
Calcium ^{1,2}		1,240	106	91.4
Sodium ^{1,2}		2,580	13	99.5
Average				98.6
Total Particulat	e	4.27 lb/MMBtu	0.0021 lb/MMBtu	99.95%
Acid-Forming	g Anions	lb/10 ¹² Btu	lb/10 ¹² Btu	%
Chloride (Cl)	Solid	41	<21	>48.9
	Gas	784	353	54.9
	Total	825	371	55.1
Fluoride (F)	Solid	241	21	91.3
	Gas	6,460	150	97.7
	Total	6,700	167	97.5
Sulfate	Solid	10,600	115	98.9
	Gas	1.57(10 %	9.89(10 ⁵)	37.1
	Total	1.58(10 %)	9.90(10 ⁵)	37.5

NOTES:

" < "indicates that the quantity measured was less than the detection limit; thus the detection limit is shown.

">"indicates that the percentage removal is based on a detection limit so the expected minimum removal rate.

1. Included even though neither trace metals or air toxics.

2. Values for these metals are reported but are believed invalid due to a problem with sample preparation. (see text)

 Table 19:
 FFDC Removal Efficiency (Calcium-Based DSI Test Period)

E. Solids Stream Monitoring

Calcium-Based Sorbent Analysis

Table 20 lists the trace metal and anion analysis results for the calcium-based sorbent (calcium hydroxide) and humidification water. Although calcium and sodium are neither trace metals nor air toxics, Table 20 also lists them.

The humidification water contained negligible amounts of trace metals but significant amounts of calcium, sodium, and acid-forming anions. The total mass input of air toxics due to the sorbent and water added to the process was insignificant in comparison to the amounts in the coal. Notable exceptions were molybdenum and chloride. The sorbent water contained 41% of the total mass input of molybdenum and 46% of the input chlorides. Other air toxics that were input due to the sorbent and water were much lower and ranged from 0 to 10% of those input from other sources on a mass basis.

****	1		
	Calcium	Sorbent	Contract
Element	Test 22	Blank	H ₂ O
		Correct	
	mg/kg	%	μg/L
Arsenic	<1.2	0	< 5.0
Barium	9.0	0	34
Beryllium	< 0.49	0	< 2.0
Cadmium	<1.2	0	< 5.0
Chromium ¹	5.1	0	< 10
Cobait	<4.9	0	< 20
Copper	5.3	0	< 5.0
Lead	< 0.73	0	< 3.0
Manganese ¹	45	22.4	< 10
Mercury	< 0.091	0	< 0.20
Molybdenum	6.2	0	25
Nickel ¹	5.3	0	< 20
Selenium	< 61	0	< 250
Phosphorous	195	0	< 100
Vanadium	7.9	0	< 10
Calcium	NP	0	27,000
Sodium	NP	0	17,000
Chloride	< 5.0	0	22.973
Fluoride	34	0	960
Sulfate	170	0	104,350

1. Prep blank levels were higher than the sample values, so the samples were not blank corrected.

 Table 20:
 Air Toxics Analysis of Hydrated

 Lime

Coal Analysis

Previous air toxics testing at Arapahoe has shown the importance of obtaining representative solid samples. This is a difficult task due to the scale and current equipment. Coal sample procedures were modified and the ASTM D2234 collection method was followed more closely during the sodium- and calcium-based DSI test periods than during the low-NO_x combustion and SNCR test periods. In addition, the ASTM D2013 preparation method was followed during the sodium- and calcium-based DSI test periods. For barium, lead, calcium, and sodium, EPA Method 3050 was used for coal digestion instead of ASTM D3683.

For many trace metal data points, there were two or three sets of results. On average, there were three sets of data with some having as many as six sets. For example, one point had results from:

- Curtis & Tompkins analysis using conventional digestion.
- Curtis & Tompkins analysis using EPA 3050 digestion.
- Standard Laboratory's analysis.
- Curtis & Tompkins triplicate analysis using conventional digestion.
- Curtis & Tompkins triplicate analysis using EPA 3050 digestion.
- INAA.

Except for a few cases, the results from these different sources did not agree. Ideally, if the data for one element from one set was consistent with expected levels and other process streams, then the data for elements within the same data set processed by the same lab and method would also be consistent. Unfortunately, a common bias for a data set could not be found. Therefore, the
use of a particular data set depended solely on its agreement with levels determined in other input and output streams from the same test program.

For the low-NO_x combustion and SNCR test periods, INAA was selected as the analytical technique most likely to produce representative data sets for arsenic, barium, mercury, selenium, and chloride because INAA:

- Could achieve lower detection limits for arsenic, mercury, selenium, and chloride.
- Results for barium agreed with USGS and Cyprus Yampa Valley coal data. ICP-AES results were biased low.

Since INAA is not a proven analytical technique for trace metal analysis of coal, it was not chosen to analyze an element unless there was a clear technical justification to discard the conventional data.

For the coal samples from the sodium- and calcium-based DSI test periods, INAA was the only technique used to analyze arsenic, mercury, selenium, and chloride. With the use of EPA 3050 digestion technique for barium, the ICP-AES analysis results for barium are no longer severely biased and are now consistent with expected levels. For sodium-based DSI test, the conventional analytical results for cadmium, chromium, manganese, and vanadium were considered as qualitative and discarded.

Table 21 lists the analysis of the coal for trace metals and acid-forming anions. Although calcium and sodium are neither trace metals nor air toxics, Table 21 also lists them. All trace metals were detected in each replicate. Most elements show relatively good precision (uncertainty less than 100%). A single high nickel reading caused uncertainty of 120%. While high the nickel readings are in the range expected for this coal.

			Base Te:	st Method					S	VV		
Trace Metals	Test 1	Test 2	Test 3	Avg	Uncert.	Blank Correct	Test 1	Test 2	Test 3	Avg.	Uncert.	Blank Correct
		a m	/kg		5	6		Вш	/kg		%	
Arcenic ²	dN	AP	đz	dZ	dN	0	0.54	0.48	0.51	0.51	14	0
Barium ¹	30	173	174	192	42	0	285	347	325	319	25	0
Bervllium	0.37	0.28	0.41	0.35	46	0						
Cadmium ^{2.3}	0.12	< 0.10	< 0.12	< 0.11	1	0	0.05	0.08	0.047	0.048	86	0
Chromium	2.6	1.9	2.9	2.5	52	0	1.7	1.6	2.1	1.8	39	0
Cobalt	1.3	0.8	1.0	1.0	99	0	0.81	0.91	0.82	0.85	17	0
Copper	5.2	3.4	4.5	4 .4	23	0						
Lead	3.4	3.1	3.8	3.4	24	0						
Manganese	14	Ξ	23	16	104	0	6.7	7.8	8.4	7.6	28	
Mercury ²	NP	NP	AN	NP	NP	0	0.024	0.035	0.030	0.030	46	0
Molvbdenum	0.52	0.32	0.42	0.42	60	0	0.9	0.8	0.9	0.9	14	0
Nickel	2.4	0.0	1.4	1.6	120	0						
Selenium ²	NP	NP	NP	NP	dN	0	1.29	1.37	1.14	1.27	77	0
Phosphorus	450	338	376	388	37	0						
Vanadium	7.5	4.5	6.7	6.2	63	0	5.9	4.7	7.2	5.9	51	
Colonium 1.4	7 200	7 280	011 0	2.260	16	0						
Sodium 1.4	432	265	211	302	95	0	496	475	554	508	20	0
Anions		Вш	/kg		6	ć		Bm	/kg		8	
Chloride (CL) ⁽²⁾	;		1	1	;	0	13	25	19	19	78	0
Fluorine (F)	80	70	70	73	20	0						
Sulfate	17,400	18,000	17,100	17,500	16	0						
" < "indicates that the detection limit is	e quantity me shown.	asured was lo	ess than the de	etection limit t	thus the	1. Analysis 2. INAA re	performed a sults were us	fier an EPA sed for these	3050 digestion trace species r	(acid only). ather than the	base method.	
									•			

"NP" indicates not performed.

All values are reported on an as-received basis for the coal.

Cadmium average less than highest nondetect and reported as such.
Included even though neither are trace metals or air toxics.

Table 21: Trace Metals Analysis of Coal

33

Fly Ash

Table 22 lists the results for the fly ash and bottom ash from the calcium-based DSI test period. Although calcium and sodium are neither trace metals nor air toxics, Table 22 also lists them. Cadmium is the only element reported below its detection limit. The results for barium, calcium, and sodium from Test-1 were not used in the average. The combination of EPA 3050 digestion and ICP-AES analysis is used only for these three elements, therefore a problem with the digestion or ICP analysis may have affected these results. The conventional digestion of the sodium sample for Test-1 also yielded a value an order of magnitude higher than the other samples. This suggests that EPA 3050 digestion failed to dissolve the entire samples of barium and calcium and that the sodium sample was contaminated. Test-3 for sodium appears to be negatively biased when compared with output stream levels.

Matrix effects and certain digestion techniques make the analysis of selenium very difficult. Selenium is by far the most problematic of potential air toxics elements to analyze. With the discovery that hydrofluoric (HF) acid was interfering with GFAA, ash samples were re-analyzed using EPA 3050 digestion. This method eliminated the need for diluting the ash samples to minimize interference as well as most of the questionable results and high detection limits. However, the ash results for selenium obtained with EPA 3050 digestion from the sodium- and calcium-based DSI test periods are not consistent with expected levels. Despite high detection limits and poor precision, the conventional ash results for selenium agree, on average, with expected values and are used in the mass balance.

Bottom Ash

Overall, sample preparation does not appear to have biased the results of the bottom ash. The average results for arsenic, cadmium, mercury, and molybdenum were below the detection limit. Except for selenium and sodium, the replicates show good agreement. As with the fly ash, the conventional digestion methods used to analyze selenium often produce spurious data points. Also, since bottom ash levels of sulfate contribute less than 1% of the total sulfate stream, the spread in the sulfate results is considered negligible.

		8	ottom Ash/Sl	uice Water ⁷					Ρ	Ash		
	Test 1	Test 2	Test 3	Avg.	Ипсеп.	Blank Correct	Test 1	Test 2	Test 3	Avg.	Uncert.	Blank Correct
Trace Metals		mg/l	ß		65	29		/gm	kg		ж	
Arsenic	< 1.2	<1.3	<1.2	<1.2	40	0	5.9	3.7	3.3	4.3	84	0
Barium	006	1,100	1,000	000.1	29	0	580	1,100	066	1,045	31	0
Beryllium	3.9	3.6	3.8	3.8	27	0	3.7	2.9	2.7	3.1	37	0
Cadmium ⁴	<1.1	<1.1	<1.1	<1.1	40	0	<1.1	<1.3	<1.4	<1.3	41	0
Chromium	23	20	23	22	27	0	27	20	20	22	50	0
Cobalt	15	14	16	15	29	0	91	14	13	14	27	0
Copper 5	120	47	49	72	16	0	42	47	43	44	20	0
I.cad	23	22	21	22	28	0	45	29	30	35	68	0
Manganese	100	83	180	121	111	0	150	96	100	115	68	0
Mercury	< 0.020	< 0.020	< 0.020	< 0.020	44	0	0.15	0.32	0.27	0.25	16	0
Molybdenum 4	4.5	<4.3	< 3.9	<4.3	37	0	4.6	7.8	7.5	6.6	70	0
Nickel	15	13	19	16	4	0	17	16	10	14	69	0
Selenium ³	÷	23	< 9.7	=	233	0	18	<13	7.8	11	148	0
Phosphorus	5.100	5,900	5,900	5,630	27	0	3,900	4,600	4,300	4,270	22	0
Vanadium	49	50	54	51	28	0	57	46	45	49	31	0
Calcium ^{1.6}	19,700	23,700	21,400	21,600	28		22,000	160,000	150,000	155,500	26	
Sodium ^{1.6}	1,320	1.370	1,310	1,340	33		63,000	2,600	1,700	2,150	27	
Acid-Forming Anions		mg/l	8		65	20		/bm	kg		8	
Chloride as Cl	240	262	214	238	29	0	120	82	72	16	72	0
Fluoride as F ^{- (2)}	6.9	6.2	5.1	6.1	34	0	1,100	73	72	1,100	N/A	0
Sulfate	186	260	1,680	710	297	0	66,500	49,400	59,900	58,600	33	0
" < "indicates that the quar	nity measured	was less thai	1 the detection	n limit; thus t	the detection	limit is show	'n. 5.#	1-Bottom Asl	h was higher	than fuel input	and not used	in average.

1. Replicates for #1-Fly Ash for Ba, Ca, and S not used in average, since not consistent with expected values.

2. Fi results for #2- and #3-Fly Ash not used in average because of incomplete water extraction.

Since detection limits varied by sample, highest non-detect not used for average.
Highest non-detect used for bottom ash average.

Table 22: Air Toxics Analysis of Ash for Calcium-Based DSI

6. Included even though neither are trace metals nor air toxics.

7. Trace metals results from bottom ash solid fraction only. For anions, Ca, and Na, solid and liquid fractions analyzed separately and combined proportionately by weight after sluice water blank corrections

F. Mass Balance Results

Mass balances are an important quality check on toxics emissions data. Using different sample and analytical techniques to measure toxics in both gaseous and solid forms is difficult. Mass balances provide a quick means for determining how well various analytical methods agree. The low absolute quantities of the measured materials, however, makes the occurrence of a 100% mass balance very unlikely.

There are three major sources of potential error in the mass balance: operating conditions, analytical difficulties, and sample collection and handling. Since Arapahoe Unit 4 operated at or near steady-state conditions and the daily tests show that the same coal was fired throughout the tests, operating conditions are not likely to contribute any significant sources of error. Analytical difficulties usually only affect the results of individual replicates or species, so they are considered with each species. Normally, analytical difficulties outweigh sampling problems. On a utility coal-fired unit, however, obtaining representative samples from process streams flowing at thousands of pounds per hour adds a major source of potential error. It should also be noted that uncertainties only represent consistency, not accuracy.

In addition, recent findings from other Department of Energy (DOE) sponsored programs indicate that the sample digestion methods of EPA Method 29 are not effective for large quantities of ash and introduce a 20 to 60% negative bias. The difficulty of finding a correct digestion method and the need for different digestion methods for different elements casts doubt on the validity of the sample preparation procedures of both EPA Method 29 and the ASTM methods which use only one digestion method for all elements.

Only compounds dependent on the fuel inputs can be balanced. Since semivolatile organic compounds depend on combustion parameters, they cannot be balanced. The boiler/FFDC mass balance uses the coal and calcium-based sorbent as its inputs and the bottom ash, fly ash, and FFDC outlet as its outputs. The boiler mass balance uses the coal for its only input and the FFDC inlet and the bottom ash as its outputs. For the sorbent results, nondetects are treated as zeroes if the detection limit is greater than 25% of the fuel input (selenium, for instance) or if the element is not expected to exist in the sorbent (arsenic and mercury, for example).

Table 23 shows the mass balance results for the calcium-based DSI test period. Based on fuel-input and fly ash levels, the FFDC results for mercury appear to be positively biased. For the boiler/FFDC balance, most species were in the range of 69 to 130%, except for barium, cobalt, and phosphorous. The following may have affected the results for these elements:

- Since the fuel input for barium is considered accurate, the barium levels in the ash are considered negatively biased by 30 to 40%.
- The fuel input for cobalt appears to be biased low.
- Since previous tests produced good closure for phosphorous, the phosphorous levels in the sorbent may be biased low. The phosphorous levels in the bottom ash, however, are higher than those in previous tests, so these values may also be causing the poor closure results.

	Inp	uts	Intermediate		Outputs		Mass Ba	lance
Species	Fuel	DSI ¹ (Calcium)	FFDC Inlet	Bottom Ash	Fly Ash	FFDC Outlet	Boiler/ FFDC ²	Boiler ²
Trace Metals	16/10	¹² Btu	lb/10 ¹² Btu		1b/10 ¹² Btu		%	
Arsenic ³	47	< 3.4	20	< 4.4	30	0.093	75	52
Barium	17 400	26	NV	3,580	7,300	0.94	62	
Beryllium	32	<1.4	9.5	13	22	< 0.022	105	72
Cadmium ³	5.4	< 3.4	3.9	< 3.9	< 8.8	0.15		72
Chromium	224	14	63	79	157	0.26	99	63
Cobalt	93	<14	53	54	101	< 0.22	144	115
Copper	396	14	310	172	308	0.42	117	122
Lead	310	<2.1	55	79	244	0.38	104	43
Manganese	1 450	123	108	448	812	0. 59	80	38
Mercury ³	2.7	< 0.25	3.4	< 0.072	1.7	0.21	74	128
Molybdenum	38	18	26	<15	46	0.22	110	108
Nickel	141	15	19	57	102	0.22	102	54
Selenium ³	115	< 174	57	38	77	< 0.057	100	83
Phosphorus	35 200	532	12,800	20,300	29,800	< 1.1	140	94
Vanadium	565	22	194	183	346	< 0.11	90	67
Average Metals							100	79
Calcium ⁴	205,000	1.47(10 %)	NV	77,300	1.08(10 %)	106	69	
Sodium	27,400	522	NV	4,780	15,000	13	71	
Acid-Forming Anions	ю/10	¹² Bru	lb/10 ⁻¹² Btu		1b/10 ¹² Btu		%	,
Chloride (Cl) ³	1,720	712	825	848	645	371	77	98
Fluoride (F)	6,650	122	6,700	21	7,680	167	116	101
Sulfate	1.59(10 ^ዓ)	3,670	1. 58 (10 ^{\$})	2,790	410,000	990,000	88	100
Average Anions							94	100

"<"indicates that the quantity measured was less than the detection limit; thus the detection limit is shown.

"NP" indicates not performed, "NV" indicates not valid.

1. Sorbent input stream includes trace metal and anion levels in both the calcium sorbent and the sorbent water.

2. Boiler/FFDC mass balance calculated using: (outlet + fly ash + bottom ash)/(fuel + sorbent). Boiler mass balance calculated using: (inlet + bottom ash)/fuel.

3. Fuel concentrations from INAA.

4. Calcium sorbent flow rate as {(weight% of Ca) * (Ca flow rate) * (10^{6}) } + (sorbent H₂O flow rate).

Table 23: Mass Balance Results for Calcium-Based DSI Test Period

G. Summary of Test Results

Table 24 summarizes the fuel input, FFDC inlet, and FFDC outlet results for each of the test periods. Yampa coal was fired at Arapahoe Unit 4 for low- NO_x combustion, SNCR, and sodium-based DSI test periods. For the calcium-based DSI test period, Edna coal was fired at Arapahoe Unit 4. It is not clear whether the significantly higher values for many trace metals in the coal tested during the sodium- and calcium-based DSI test periods is due to more representative techniques or the coal matrix. The higher levels in the FFDC of these trace metals, however, indicates that changes in the coal matrix caused the higher levels in the fuel input.

The increase of the trace metal levels in the FFDC inlet are consistent with the fuel input levels. However, if the FFDC inlet is considered as a point of uncontrolled emissions, the emissions levels are consistently in the same range.

Improved FFDC removal efficiency with sorbent injection may account for the lower levels of chromium, copper, manganese, nickel, and vanadium in the sodium- and calcium-based DSI test periods. Both sodium and calcium injection before the FFDC significantly reduced the FFDC outlet levels of phosphorous, chloride, fluoride, and sulfate. The lower levels of arsenic, mercury, and selenium suggest that calcium injection removes these elements more effectively than sodium injection.

		Fuel I	aput			FFDC	Inlet			FFDC (Dutlet	
Parameter	Low-NO _x Combustion	SNCR	DSI (Sodium)	DSI (Calcium)	Low-NO _x Combustion	SNCR	DSI (Sodium)	DSI (Calcium	Low-NO _x Combustion	SNCR	DSI (Sodium)	DSI (Calcium)
		101/91	Bu			01/q	² Btu			IP/10	Ba	
Arsenic	43	56	62	47	23	13	30	20	0.75	0.15	0.47	0.093
Barium	37,600	29,700	24,400	17,400	234	192	189	431	1.1	1.1	2.5	0.94
Beryllium	20	48	34	32	9.0	7.5	9.0	9.5	< 0.021	< 0.023	< 0.023	< 0.022
Cadmium	< 4.5	< 5.3	3.5	5.4	2.3	2.0	3.6	3.9	0.12	< 0.066	< 0.058	0.15
Chromium	97	125	272	224	50	51	135	63	0.66	0.30	0.15	0.26
Cobalt	84 148	114	122	93	30	26	43	53	<0.21	< 0.23	< 0.23	<0.22
Copper	241	324	568	396	169	206	245	310	1.1	1.3	0.59	0.42
Lead	185	195	358	310	5 4	46	80	55	0.44	0.40	0.36	0.38
Manganese	379	458	2,340	1,450	195	88	113	108	1.0	0.89	0.29	0.59
Mercury	1.9	1.7	4.6	2.7	1.3	1.9	1.2	3.4	< 0.29	0.41	0.41	0.21
Molybdenum	9.0	44	45	38	01	12	32	26	0.17	0.27	0.23	0.22
Nickel	53.5	30 30	175	141	30	29	62	61	1.5	0.45	0.23	0.22
Selenium	73	127	47	115	22	12	< 66	57	0.36	< 0.064	0.36	<0.057
Phosphorous	36,700	27,700	48,500	35.200	14,300	9,300	11,600	12,800	6.7	4.6	1.5	<1.1
Vanadium	266	379	779	565	135	120	178	194	0.24	0.29	0.13	< 0.11
Calcium	đz	185,000	213,000	205.000	NP	880	192	1.240	NP	29	33	106
Sodium	NP	29,300	64,300	27,400	NP	2,700	1,750	2,580	NP	367	112	13
Chloride	2,000	1,400	1,370	1,720	795	1,010	864	825	626	719	811	371
Fluoride	7,600	7,400	9,140	6,650	4,780	5,780	7.670	6,700	4,290	4,810	1140	167
Sulfate	1.18(10 %)	1.15(10 b)	1.17(10 %)	1.59(10 %)	10.6(10 %)	9.88(10 5)	1.14(10%)	1.58(10 %)	9.83(10 ⁵)	1.17(10 %)	3.69(10 ⁻⁵)	9.9(10 5)
Cyanide	N/A	N/A	N/A	N/A	~	<12	AN	đ	<7	6>	NP	NP
Ammonia	N/A	N/A	N/A	N/A	<100	12,000	đN	đ	N/A	7,000	NP	NP

" < "indicates that the quantity measured was less than the detection limit thus the detection limit is shown. "NP" indicates test not performed.

Table 24: Summary of Fuel Input, FFDC Inlet, and FFDC Outlet Levels

41

Table 25 compares the trace metal levels in the output streams as a percentage of the fuel input. A larger distribution of the trace metals in the bottom ash improved the mass balances for the sodium- and calcium-based DSI test periods. The bottom ash levels for the SNCR test period appear negatively biased by 15% of fuel input. For the low-NO_x combustion test period, the bottom ash levels appear negatively biased by 20% of fuel input and the fly ash levels appear negatively biased by 15% of fuel input. The use of the same collection methods for all four test periods suggests that the closer adherence to ASTM preparation methods during the sodium- and calcium-based DSI test periods improved the trace metal results. Also, the use of more representative sampling techniques for fly ash during these test periods appears to have reduced the occurrence of poor trace metal results seen during the low-NO_x combustion test period.

T (D) I	Output S	Stream (% of Fu	el Input ¹)	Total
Test Period	Bottom Ash	Fly Ash	FFDC Outlet	(% Closure)
Low-NO _x Combustion ²	9	53	2	64
SNCR	14	67	2	83
DSI (Sodium)	28	63	1	92
DSI (Calcium)	31	68	1	100

1. Fuel input for sodium- and calcium-based DSI test periods include the sorbent injection streams.

2. The fuel result for molybdenum appears to be severely biased low. The percentages for the low-NO_x combustion test period are based on an average of the molybdenum levels in the fuels from the SNCR and sodium-based DSI test periods.

Table 25: Distribution of Trace Metals Across Output Streams

INTEGRATED DRY NO_x/SO₂ EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Calcium-Based Dry Sorbent Injection System Test Period: April 30, 1993 through November 2, 1993

Calcium DSI Air Toxics Test October 19-20, 1993 Dioxins/Furans Air Toxics Test October 11-13, 1993

Appendix A: State Emission Reports

Opacity Compliance Calculation

Table 26 summarizes the number of 6minute opacity exceedances reported to the CDH during the testing period. These data are from the compliance reports sent to the CDH that follow.

There were a total of 31 exceedances for a total of 186 minutes above 20% opacity. The calculation used to compute the Arapahoe 4's compliance with the 20% opacity limit is shown below.

Month	Number of Violations
April 30	0
May	5
June	2
July	0
August	5
September	14
October 1-20	5
Total	31



$$\% compliance = 100 - \left(\frac{compliance time}{operation time} \times 100\right)$$

= 100 - $\left(\frac{186 \text{ min} \times \frac{1 \text{ h}}{60 \text{ min}}}{2,108.3 \text{ h} - \left(28 \text{ days} \times \frac{24 \text{ h}}{day}\right) - \left(1 \text{ day} \times \frac{23 \text{ h}}{day}\right) + 1,979 \text{ h} + \left(20 \text{ days} \times \frac{24 \text{ h}}{day}\right) \times 100}\right)$
= 100 - 0.08005
= 99.92%



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Public Service Company of Colorado P.O. Box 840 Denver, CO 80201- 0840

July 29, 1993

Mr. Roy Doyle Air Pollution Control Division Colorado Department of Health 4300 Cherry Creek Drive South Denver, CO 80222-1530

RE: Second Quarter, 1993 Excess Emissions Report, Arapahoe Units #1-4

Dear Roy:

Attached is the excess emissions report for the second quarter, 1993, for the Public Service Company of Colorado Arapahoe Steam Electric Generating Station, Units #1-4.

Dates not reported on the attached emissions report are those in which the units were not running. The operating hours for Units #1-4 during the quarter were: Unit #1 - 1,498.8 hours, Unit #2 - 1,508.9 hours, Unit #3 - 1,405.5 hours and Unit #4 - 2,108.3 hours.

Feel free to contact me at 294-2810 with any questions in this regard.

Sincerely,

Pite J. Cohlmia

Peter J. Cohlmia Chief Environmental Scientist

PJC:tc

Attachments

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Page 1 of 4

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6/79

QUARTERLY EXCESS EMISSIONS REPORT (EER)

Fossil Fuel-Fired Steam Generators, Subpart D

1 Jack

Suggested Format for Sources in Region VIII* Minimum Requirements Under Section 80.7 (see Instructions) Part 1 - This report includes all the required information under section 60.7 for $^{\infty,p}$ 8. Quarterly emission reporting period ending: -March 31 (June 30) September 30 December 31 b. Reporting year: 1993 c. Reporting date: 07/14/93 d. Person completing report: Mark Spomer e. Station name: Arapahoe Station f. Plant location: 2601 South Platte River Drive Person responsible for review and integrity of g. report: Peter J. Cohlmia ħ. Mailing address for person in 1-g above: P. O. Box 840. Denver. Colorado 80201 i. Phone number for 1-g above: _294-2810 Part 2 - Instrument information, complete for each instrument. Unit 3 8. **Opacity Monitor:** Unit 1 Unit 2 Unit 4 b. Manufacture: Lear Siegler L.S. L.S. L.S. Model No: **RM41 RM41 RM41 RM41** C. Serial No: 568 1369 d. 1409

1/77

6/79

Part 3 - Excess emissions (by pollutant)

8.

Installation:

Use Table I: Attach separate narrative per instructions.

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Page 2 of 4

Part 4 - Conversion factors

a. Zero and Cal values used, by instruments:

Zero	Unit 1 0.0	Unit 2 0_0	Unit 3 0_0	Unit 4
Cal	52.5	51.7	58.0	48.5

Part 5 - Continuous Monitoring System operation failures

See Table II: Complete one sheet for <u>each</u> monitor attach separate narrative per instructions.

Part 6 - Certification of report integrity, by per in 1-g above:

THIS IS TO CERTIFY THAT TO THE BEST OF MY KNOWLEDGE, THE INFORMATION PROVIDED IN THE ABOVE REPORT IS COMPLETE AND ACCURATE.

NAME Peter J. Cohlmia SIGNATURE Peter J. Cohlmin

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The <u>Chief Envi</u>ronmental Scientist

Date _ 7/29/93

* Suggested Format for Subpart D sources in:

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Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming



<u>Opacity</u> Attached is additional information for excesses occurring during the **Third** Quarter

As defined in the instructions form the applicable section of the Federal Register; attached narrative of causes, etc.

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Page 4 of 4

Continuous Monitoring System Operation Failures

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Date	Time* From - To	Instrument	Effect on Instrument Output
5/17/93	0815 to 5/17/93 0900	Lear Siegler	Removed for calibration

(B) 292-12-1994

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OPACITY MONTHLY DATA REPORT

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POWER PLANT: A UNIT: 4	RAPAHOE SOURCE = CUR	ENTA ALLA	
REPORT START TI	ME: QUARTER = 2	4/1993	

- 1 <u>-</u>			<u> </u>	· · · · · · · · · · · · ·	ريد ريد			
DAY		VIOL	ATION CATE	GORY			WEIGHT	AVERAGE
	•	В	С		D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-	45%	OVER 45%		χ.
4/01	0	0	0	··	0	0	24	3.4
4/02	0	0	0		0	0	24	3.4
4/03	D	0	0	ń. 1	0	0	24	3.4
4/04	0	0	0		0	0	23	3.2
4/05	0	0	0		0	. D	24	3.1
4/06	0	0	0		0	0	24	3.4
4/07	0	0	0		0 .	0.2	24	3.6
4/08	0	0	0		0 ***	0	24	3.5
4/09	0	0	0	•	0	0	24	3.3
4/10	0	0	0		0	0	24	3.5
4/11	0	0	0		D :	0	- 24	3.3
4/12	0	0	0		0	C 34 6 + 350 O 37 ∰	- 24	3.6
4/13	0	0	0		0		-24	3.4
4/14	0	0	0	÷.,	0	05	24	3.4
4/15	0	0	0	•	0		24	3.3
4/16	0	0	0		0	0	24	3.3
4/17	0	0	0		0	19 19 10 10 10 10 10 10 10 10 10 10 10 10 10	24	3.3
4/18	0	0	0		0	0 75 7	24	3.5
4/19	0 '	0	0	• • • • • •	0	0	24	3.5
4/20	0	0	0	•	0	i	24	3.3
4/21	0	0	0		0	0.1	24	3.3
4/22	0	0	0		0	0	24	3.5
4/23	0	0	0		0	0	24	3.7
4/24	0	0	0		0	0	24	3.6
4/25	0	0	0		0	0 44	24	3.4
4/26	0	0	0	• .	0	0 5 10	24	3.6
4/27	D	0	0		0	0	24	3.4
4/28	Ó	0	0		0	0	24	3.4
4/29	Ō	ō	Ō		Ō	Ō	24	3.5
4/30	0	0	0		0	0	24	3.4
MONTHL	Y				,			
TOTALS	0	0	0		0	· O	719	3.4

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DOWED	DIANT						
UNIT	4 Sector	SOUR	CE - CURRE	NT			
REPORT	START T	IME: QUAR	TER = 2	5/1993			faltage 12a – 1 e. tr. 1
DAY		VIOL	ATION CATE	GORY -		WEIGHT	AVERAG
	A	B	С	D	E	FACTOR	OPACIT
	20-25%	25-30%	30-35%	35-452	OVER 45%	· _	Χ.
5/01	0	0	D	0		24	з.
5/02	0	0	0.	.0	0.0	24,	з.
5/03	0	0	o .'	0	0	24	з.
5/04	0	0	0	0		-1 24	з.
5/05	0	0	0	0	0	24	з.
5/06	0	D	0			24	3.
5/0/	0	U	D ;			24	3.
5/08	4	0	U .			24	5.
5/09	0	0	0	0		24	3.
5/10	0	0	0	n v	· · · · · ·	24	3.
5/12	ñ	0	0	n i	ŕ	24	3.
5/13	n	n	n n	0 100	NO TO NOT	······································	3.
5/14	ñ	Ő	0		.	24	۵. ۵
5/15	0	0	0	0	n	24	4
5/16	ů n	ñ	ů n	0 :2014 <u>-</u> 20	244 (2000) - Ο Φατιζότης Π	24	4
5/17	n	Õ	ñ	0	• 0	24	4
5/18	0	Ő	ő	0 0	Ő	24	4-
5/19	0 ·	Õ	0	o 🐨	·····	24	4
5/20	0	0	Ō	Ō	· 0	24	4
5/21	Ō	0	Ō	D	Ō	24	4
5/22	0	0	0	0	0	24	4
5/23	0	0	0	0	0	24	4.
5/24	0	0	0	0	0	24	4.
5/25	0	0	0	0	0	24	4
5/26	0	0	0	0 _ '	0	24	4.
5/27	0	0	0	0	0	24	4
5/28	0	0	0	0	D	24	4.
5/29	0	0	0	0	0	24	4.
5/30	0	0	0	0	D	24	4.
5/31	0	D	. O	0	<u> </u>	24	4,

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****	*****	******	••••••••••••••••••••••••••••••••••••••	CITY MONTH	LY DATA	REPORT	*****	*****
	POWER	PLANT	ARAPAHOE					
· · ·	REPOR	T START T	IME: QUAR	TER = 2	6/1993			
	DAY		VIO	- ATION CATE	908Y		WEIGHT	AVERAGE
	2	A 20-25%	B 25-30%	C 30-35%	D 35-45%	E OVER 45	FACTOR	OPACITY %
	6/01	0	0	0	0.0	147 - 15 O T.	24	4.3
,	6/02	0	0	0	0 🖞	· 0	24	4.2
	6/03	0	0	0	0	12 - 0	24	4.2
	6/04	0	0	0	0	τ	24	4.2
	6/05	0	0	0	0	. 0	24	6.9
:	6/06	0	0	0	0	· 0	24	3.7
	6/07	0	0	0	0	0,5	24	4.2
	6/08	0	0	0	0	1	24	3.5
	6/09	0	0	0	0	.0.	24	4.0
	6/10	0	0	0	· O	0	24	3.3
	6/11	0	0	0	0	0	24	3.6
	6/12	0	0	0	0	0	24	3.4
	6/13	0	0	0	0	0	24	3.6
	6/14	0	0	0	0	0	24	3.4
	6/15	0	0	0	0	0	24	3.7
	6/16	0	0	U O	0	0	24	3.6
	6/17	0	U	U	U	U	24	3.9
	5/18	0	0	0	0		24	4-3
	6/19	0 '	0	2	0	0	24	3.6
	6/20	0	0	0	0	D	24	3.2
	6/21	0	0	D	0	0	24	3.3
	6/22	0	0	0	0	0	24	3.3
	6/23	0	0	D	0	0	24	3.3
	6/24	0	0	0	0	0	24	3.5
	6/25	0	0	0	0	0	24	3.4
	6/26	0	0	0	0	· · · · O	24	3.2
	6/27	0	0	D	U	U	24	3.3
	6/28	0	0	Ū O	Ű	Ű	24	3.0
	6/29 6/29	U	U	U	0	U O	24	3.4 2 A
	0/30	U	U	U	U		24	J.7
	MONTHL	 Y						
•	TOTALS	0	0	2	O	0	720	3.7

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* FORM (B) 292-12-1994	I	0			; · · · · ·
******	OPACITY Violation	Report	*********	********	****
POWER PLANT: Unit: 4 Report Perio	ARAPAHOE Source - Cl d: Quarter -	URRENT 2 1993			
REASON CODES FO Hourly exclusi Upset exclusio	R: ONS = none NS = none				····
START DATE-TIME	END DATE-TIME	MIN-Z MAX	(-% AVG-%	TYPE	VIOLATION REASON
05/08/1993 12:12 05/08/1993 12:30 05/08/1993 12:54 05/14/1993 11:54 06/19/1993 04:00	05/08/1993 12:17 05/08/1993 12:41 05/08/1993 13:05 05/14/1993 12:05 06/19/1993 04:11	21.8 2 21.0 3 24.3 2 36.3 4 30.4 3	L.8 21.8 3.0 29.5 5.0 24.6 0.1 38.2 L.7 31.1	VIÓ UN VIO UN VIO UN VIO UN VIO UN	IT STARTUP IT STARTUP IT STARTUP SPECIFIED CALIB NOT COUNTE IT STARTUP

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Public Service Company of Colorado

Governmental and Environmental Affairs P. O. Box 840 Denver, CO 80201 - 0840

October 28, 1993

Mr. Roy Doyle Air Pollution Control Division Colorado Department of Health 4300 Cherry Creek Drive South Denver, CO 80222-1530

RE: Third Quarter, 1993 Excess Emissions Report, Arapahoe Units #1-4

Dear Roy:

Attached is the excess emissions report for the third quarter, 1993, for the Public Service Company of Colorado Arapahoe Steam Electric Generating Station, Units #1-4.

Dates not reported on the attached emissions report are those in which the units were not running. The operating hours for Units #1-4 during the quarter were: Unit #1 - 740.5 hours, Unit #2 - 679.2 hours, Unit #3 - 932.3 hours and Unit #4 - 1,979 hours.

Feel free to contact me at 294-2810 with any questions in this regard.

Sincerely,

It J. Cohlmin

Peter J. Cohlmia Chief Environmental Scientist

PJC:tc

502 .861 From Marilyn

Attachments

Page 1 of 4

QUARTERLY EXCESS EMISSIONS REPORT (EER)

Fossil Fuel-Fired Steam Generators, Subpart D Suggested Format for Sources in Region VIII* Minimum Requirements Under Section 60.7 (see instructions)

Part 1 - This report includes all the required information under section 60.7 for

a. Quarterly emission reporting period ending:

March 31 June 30 (September 30) December 31

- b. Reporting year: <u>1993</u>
- c. Reporting date: <u>10/14/93</u>
- d. Person completing report: <u>Mark Spomer</u>
- e. Station name: <u>Arapahoe Station</u>
- f. Plant location: <u>2601 South Platte River Drive</u>
- g. Person responsible for review and integrity of report: <u>Peter J. Cohlmia</u>
- h. Mailing address for person in 1-g above:

P. O. Box 840, Denver, Colorado 80201

i. Phone number for 1-g above: ________

Part 2 - Instrument information, complete for each instrument.

a.	Opacity Monitor:	: Unit 1	Unit 2	Unit 3	Unit 4
b.	Manufacture:	Lear Siegler	L.S.	L.S.	L.S.
c.	Model No:	RM41	RM41	RM41	RM41
d.	Serial No:	568	1409	1369	997
e.	Installation:	1/77	6/79	6/79	7/79

Part 3 - Excess emissions (by pollutant)

Use Table I: Attach separate narrative per instructions.

Part 4 - Conversion factors

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a. Zero and Cal values used, by instruments:

Zero	Unit 1	Unit 2	Unit 3	Unit 4
	0.0	0.0	0.0	0.0
Cal	_52.5_	51.7	58.0	48.5

Part 5 - Continuous Monitoring System operation failures

See Table II: Complete one sheet for <u>each</u> monitor attach separate narrative per instructions.

Part 6 - Certification of report integrity, by per in 1-g above:

THIS IS TO CERTIFY THAT TO THE BEST OF MY KNOWLEDGE, THE INFORMATION PROVIDED IN THE ABOVE REPORT IS COMPLETE AND ACCURATE.

NAME Peter J. Cohlmia SIGNATURE RT Cohlania Title Chief Environmental Scientist Date ______ 193

* Suggested Format for Subpart D sources in:

Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming

Page 3 of 4

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TABLE I

Excess Emissions

Date Time* From -- To Pollutant Magnitude* Lb/106 BTU

_____SO²____

No violations

<u>Opacity</u>

Attached is additional information for excesses occurring during the Third Quarter

* As defined in the instructions form the applicable section of the Federal Register; attached narrative of causes, etc.

Continuous Monitoring System Operation Failures

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Date	Time*	From	То	Instrument	Effect on Instrument Output
7/14/93	0900	to 7/14	1545	#3 L.S.	Calib. and filter audit
7/28/93	0755	to 7/28	1400	#2 L.S.	Calib. and filter audit
9/10/93	0800	to 9/13	1423	#1 L.S.	Calib. and filter audit
9/27/93	0640	to 9/27	1355	#4 L.S.	Calib. and filter audit

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	OPACITY MONTHLY_DATA-	REPORT,
POWER PLANT:	ARAPAHOE	

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UNIT: 4 SOURCE = CURKENT REPORT START TIME: QUARTER = 3 7/1993

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DAY		VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
	A	В	С	D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		X.
7/01	D	0	0	0	0	24	3.1
7/02	0	0	0	0	0	24	3.1
7/03	0	0	0	0	0	24	3.6
7/04	0	0	. 0	0	0	24	3.3
7/05	0	0	0	0	0	24	3.4
7/06	0	0	0	0	0	24	3.1
7/07	0	0	0	0	0	24	3.3
7/08	0	0	0	0	0	24	3.5
7/09	0	0	0	D	0	24	3.4
7/10	0	0	0	0	0	24	2.9
7/11	0	0	0	0	0	24	З.б
7/12	0	0	0	0	0	24	3.2
7/13	0	0	0	Ø	0	24	3.9
7/14	0	0	0	0	0	24	4.4
7/15	0	0	0	0	0	24	4.3
7/16	0	0	0	0	0	24	4.1
7/17	0	0	0	0	0	24	4.3
7/18	0	0	0	0	0	24	3.9
7/19	O	0	0	0	0	24	4.3
7/20	0	0	0	0	0	24	4.4
7/21	0	0	0	D	0	24	4.0
7/22	0	0	0	0	0	24	4.0
7/23	0	0	0	0			4.3
7/24	0	0	0	0	0	24	4.3
7/25	0	0	0	0	0	24	3.9
7/26	0	0	0	0	Also and a	24	3.8
7/27	0	0	0	0	ι, Ο	. 24	4.0
7/28	0	0	0	0	0	24	4.0
7/29	0	0	0	Ο.,		.24 _	
7/30	0	0	0	0	20.0	24	4.2
7/31	0	0	0	0	of the second se	24	3.9
MONTHL	Y						·)
TOTALS	0	0	0	Ø	0	744	3.8
PORT CO	MPLETE			4 4 1			n maria de la companya de la company La companya de la comp La companya de la comp

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POWER PLANT: ARAPAHOE UNIT: 4 SOURCE = CURRENT REPORT START TIME: QUARTER = 3 8/1993

DAY		VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
	•	В	С	D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		Z
8/01	0	0	0	0	0	24	4.2
8/02	. 0	0	0	0	0	24	4.4
8/03	0	0	0	0	0	- 24	4.8
8/04	0	0	0	0	0	24	4.3
8/05	0	0	0	0	0	24	4.2
8/06	0	0	0	0	0	24	4.2
8/07	0	0	0	0	0	24	З.9
8/08	0	0	0	0	0	24	3.9
8/09	0	0	0	0	0	24	З.В
8/10	Ō	0	0	0	D	24	4.3
8/11	0	0	0	0	D	24	4.2
8/12	0	0	0	0	0	24	4.6
8/13	0	0	0	0	0	24	4.4
8/14	0	0	0	0	0	24	4.1
8/15	0	0	0	0	0	24	4.0
8/16	0	0	0	0	- O	24	4.0
B/17	0	0	0	0		24	3.9
8/18	0	0	0	0	0,	- 24	4.5
8/19	0	0	0	0	0	24	4.3
8/20	0	0	0	0	् र कोर्डेंस के 0 में अप्रध्येत	24	4.5
8/21	0	0	0	0	0	24	4.0
8/22	0	0	0	0	0 "	24	3.7
8/23	0	0	0	0			3.6
8/24	0	0	0	0	0	24	3.4
8/25	0	0	0	0	0.0	24	3.6
8/26	0	0	0	· O ·	C	24	4.3
8/27	0	0	0	0	0	23	5.9
8/28	0	0	0	0	0	24	5.6
8/29	. 0	2	1	1			5.9
8/30	0	0	0	Ο.		24	4.9
8/31	0	0	0	0	0	an 224	4.9
MONTHL	Y .						
TOTALS	0	2	1	1	1	743	4.3
PORT CO	MPLETE				THE FIT	Ser le constante de la constant	• .

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***************************************	****	*******	*****
POWER PLANT: ARAPAHOE	•		<u></u>
UNIT: 4 SOURCE = CURRENT REPORT START TIME: QUARTER = 3 9/1993			

DAY		VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
	•	B	С	D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		Z
9/01	0	0	D	0	0	24	5.0
9/02	0	0	0	0	0	24	4.9
9/03	0	0	0	0	0	24	4.8
9/04	0	0	0	0	0	24	5.2
9/05	0	0	0	0	and the second second	24	5.1
9/06	0	0	0	0		-24	4.9
9/07	0	0	0	0	0	24	5.4
9/08	0	0	0	0	angeren gester Diese gester von	24	5.3
9/09	0	0	0	0	0	24	5.2
9/10	0	0	0	0	0 1	24	5.3
9/11	0	0	0	0 🕂	THE PARTY OF STATE	24	5.4
9/12	0	0	0	0		16	5.3
9/13	0	0	0	0	0.44	24	5.5
9/14	0	0	0	0	The second second	24	* 5.3
9/15	0	0	0	0	0	`_ <u>§</u> - 24	5.3
9/16	0	0	0	0	0.4	- 24	5.6
9/17	0	0	0	. 0		24	5.3
9/18	0	0	0	0	2. 0	12:4 24	5.1
9/19	0	0	0	0	····	4. 724	4.8
9/20	0	0	0	0	~~0	24	5.2
9/21	0	0	0	0	0	24	5.4
9/22	0	0	0	0	0	. 24	5.4
9/23	1	3	0	1	Contraction of the second s	1	. 5.9
9/24	3	1	1	2	2	24	6.8
9/25	0	0	0	0	0	24	5.1
9/26	0 -	0	0	0		24	5.4
9/27	0	0	0	ρ	0	20	3.3
9/28	0	0	0	0	D	24	0.9
9/29	0	0	0	0	D	24	1.1
9/30	0 	0	0	0 	0	24	1.1
MONTHL	Y			-			
TOTALS	4	4	1	3	2	716	4.8

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FORM	(8)	292	-12	1994
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FORM (8) 292-12-1994		0		
*****	OPACITY. Violation.	Report		****
POLIED DI ANT	ADADAMOE			
PUWER PLANI:	AKAPAHUL		E CE Prometer (B. 1997)	-
Report Period		3 1993		
REASON CODES FOR				
HOURLY EXCLUSIO	NS = none			
UPSET EXCLUSION	IS = none			
START DATE-TIME	END DATE-TIME	MIN-Z MAX-	2 AVG-2 TY	PE VIOLATION REASON
07/13/1993 15:00	07/13/1993 15:05	36.1 36.	1 36.1 VI	D CAUB-NOT GOATED
08/29/1993 15:00	08/29/1993 15:05	29.6 29.	6 29.6 VI	D UNIT STARTUP
08/29/1993 17:00	08/29/1993 17:23	29.1 45.	3 35.8 VI	D UNIT STARTUP
09/23/1993 11:36	09/23/1993 12:05	22.9 36.	9 28.9 VO	F UNIT SHUTDOWN
09/24/1993 02:24	09/24/1993 02:29	59.6 59.	6 59.6 VI	D UNIT STARTUP
09/24/1993 02:36	09/24/1993 03:11	21.4 50.	8 35.4 VI	D UNIT STARTUP
09/24/1993 04:36	09/24/1993 04:41	22.0 22.	0 22.0 VI	D UNIT STARTUP
09/24/1993 05:06	09/24/1993 05:11	29.8 29.	8 29.8 VI	O COAL MILL OPERATION
09/27/1993 13:06	09/27/1993 13:11	44.8 44.	8 44.8 VI	O CALLA AUDIT
		- -		COUNTED

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Public Service Company of Colorado

Governmental and Environmental Affairs P. O. Box 840 Denver, CO 80201 - 0840

January 27, 1994

Mr. Roy Doyle Air Pollution Control Division Colorado Department of Health 4300 Cherry Creek Drive South Denver, CO 80222-1530

RE: Fourth Quarter, 1993 Excess Emissions Report, Arapahoe Units #1-4

Dear Roy:

Attached is the excess emissions report for the fourth quarter, 1993, for the Public Service Company of Colorado Arapahoe Steam Electric Generating Station, Units #1-4.

Dates not reported on the attached emissions report are those in which the units were not running. The operating hours for Units #1-4 during the quarter were: Unit #1 - 2,033.7 hours, Unit #2 - 2,068.2 hours, Unit #3 - 2,070.3 hours and Unit #4 - 2,181.9 hours.

Feel free to contact me at 294-2810 with any questions in this regard.

Sincerely,

Pata J. Ce Almin

Peter J. Cohlmia Chief Environmental Scientist

PJC:tc

Attachments

Page 1 of 4

OUARTERLY EXCESS EMISSIONS REPORT (EER)

Fossil Fuel-Fired Steam Generators, Subpart D Suggested Format for Sources in Region VIII* Minimum Requirements Under Section 60.7 (see instructions)

Part 1 - This report includes all the required information under section 60.7 for

a. Quarterly emission reporting period ending:

March 31 June 30 September 30 (December 31)

b. Reporting year: <u>1993</u>

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- c. Reporting date: <u>01/12/94</u>
- d. Person completing report: <u>Mark Spomer</u>
- e. Station name: <u>Arapahoe Station</u>
- f. Plant location: <u>2601 South Platte River Drive</u>
- g. Person responsible for review and integrity of report: <u>Peter J. Cohlmia</u>
- h. Mailing address for person in 1-g above:

P. O. Box 840, Denver, Colorado 80201

i. Phone number for 1-g above: 294-2810

Part 2 - Instrument information, complete for each instrument.

a.	Opacity Monitor:	: Unit 1	Unit 2	Unit 3	Unit 4
b.	Manufacture:	Lear Siegler	L.S.	L.S.	L.S.
c.	Model No:	RM41	RM41	RM41	RM4 1
d.	Serial No:	568	1409	1369	997
e.	Installation:	1/77	6/79	6/79	7/79

Part 3 - Excess emissions (by pollutant)

Use Table I: Attach separate narrative per instructions.

Page 2 of 4

Part 4 - Conversion factors

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a. Zero and Cal values used, by instruments:

Zero	Unit 1	Unit 2	Unit 3	Unit 4
	0.0	0.0	0.0	0.0
Cal	53.4		58.0	49.5

Part 5 - Continuous Monitoring System operation failures

See Table II: Complete one sheet for <u>each</u> monitor attach separate narrative per instructions.

Part 6 - Certification of report integrity, by per in 1-g above:

THIS IS TO CERTIFY THAT TO THE BEST OF MY KNOWLEDGE, THE INFORMATION PROVIDED IN THE ABOVE REPORT IS COMPLETE AND ACCURATE.

NAME leter. Cohlmin J. Cohlow. SIGNATURE __ Title Chief Environmental Suntit Date

* Suggested Format for Subpart D sources in:

Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming

Page 3 of 4

TABLE I

Excess Emissions

Date Time* From -- To Pollutant Magnitude* Lb/106 BTU

<u>_____SO² -</u>

No violations

<u>Opacity</u>

Attached is additional information for excesses occurring during the Third Quarter

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* As defined in the instructions form the applicable section of the Federal Register; attached narrative of causes, etc.

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والافتار والمارية فالمتحاط والمتحاد والمحادية والمحد	OPACITY	MONTHLY-DATA-REPORT		
****	**************	*****************	***********	***********
POWER PLANT:	ARAPAHOE	and the second		•
110177.0	0011005	01100 C 117		

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UNIT: 4 SOURCE = CURRENT REPORT START TIME: QUARTER = 4 10/1993

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DAY		WEIGHT	AVERAGE				
	A	B	С	D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		Z
10/01	0	0	0	0	0	24	1.0
10/02	0	0	0	0	0	24	1.2
10/03	0	0	0	0	0	24	1.4
10/04	0	0	0	0	0	24	1.7
10/05	0	· 0	0	0	0	24	1.9
10/06	0	0	0	0	0	24	1.8
10/07	0	0	0	0	0	24	1.7
10/08	0	0	0	0	0	24	0.8
10/09	.1 . •	0	<u>1</u> +	18 19 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	5.45×4	24	2.2
10/10	0	0	0	- 14	0	24	1.1
10/11	0	0	0	0	0	24	1.2
10/12	0	0	0	0	0	24	1.0
10/13	0	0	0	0	0	24	1.2
10/14	0	0	0	0	0	24	1.7
10/15	Ô	0	0	0	0	24	1.7
10/16	0	0	0	0	0	24	1.5
10/17	0	0	0	0	0	24	1.7
10/18	0	0	0	0	0	24	1.2
10/19	0	0	0	0	0	24	0.9
10/20	0	0	0	0	0	24	0.7
10/21	0	0	0	0	0	24	1.3
10/22	0	0	0	0	0	24	1.6
10/23	O	0	0	0	0	24	1.9
10/24	0	0	0	0	0	24	1.7
10/25	0	0	0	0	0	24	1.5
10/26	0	0	0	0	0	24	1.5
10/27	0	0	0	0	0	24	1.6
10/28	0	0	0	0	0	24	1.2
10/29	0	0	0	0	0	24	1.8
10/30	0	0	0	0	0	24	2.1
10/31	0	0	0	0	0	25	2.0
MONTHE	Y						
TOTALS	1.	0	1	2 .	1	745	1.5

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DFM (B) 292-12-1994

****	*****	******
	-OPACITY-MONTHLY DATA REPORT	
POWER PLANT: ARAPAN		******
UNIT: 4 Report start time:	SOURCE = CURRENT QUARTER = 4 11/1993	

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DAY		VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
	A	B	С	D	Ε	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		X
11/01	0	0	0	0	ο	24	1.6
11/02	0	0	0	0	0	24	2.1
11/03	0	0	0	0	0	24	1.7
11/04	0	Q	0	0	. 0	24	1.4
11/05	0	0	0	0	0	24	1.3
11/06	0	0	0	0	0	24	1.2
11/07	0	0	0	0	0	24	1.2
11/08	0	0	0	0	0	24	1.4
11/09	0	0	Q	0	0	24	1.4
11/10	0	0	0	0	0	24	1.4
11/11	0	0	. 0	0	0	24	1.5
11/12	0	0	0	0	0	24	1.4
11/13	0	0	0	0	0	24	0.8
11/14	0	0	0	0	0	24	1.1
11/15	0	0	0	0	0	24	1.3
11/16	0	0	0	0	0	24	1.4
11/17	0	0	0	0	0	24	1.3
11/18	0	0	0	0	0	24	1.1
11/19	0	0	D	0	· O	24	1.4
11/20	0	0	0	` O	0	24	1.0
11/21	0	0	0	0	0	24	1.3
11/22	0	0	0	0	0	24	1.5
11/23	D	0	0	0	0	24	2.0
11/24	0	0	0	0	0	24	1.6
11/25	0	0	0	0	0	24	1.6
11/26	0	0	0	0	0	24	1.2
11/27	0	0	0	0	0	24	1.0
11/28	0	0	0	0	0	24	1.4
11/29	0	0	0	0	0	24	1.2
11/30	0	0	0	0	0	24	1.6
MONTHL	Y						
TOTALS	D	0	0	0	0	720	1.4

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******	*****	*******	*****
	OPACIT	MONTHLY DATA REPORT	
POWER PLANT :	ARAPAHOE		
UNIT: 4	SOURCE	CURRENT	

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REPORT START TIME: QUARTER = 4 12/1993

DAY	*=+++++	VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
	A	В	C	D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		Z
12/01	0	0	0	0	Ď	24	1.4
12/02	0	0	0	0	0	24	1.3
12/03	0	0	0	0	0	24	1.4
12/04	0	0	0	0	0	24	0.9
12/05	0	0	0	0	0	24	1.4
12/06	0	0	0	0	0	24	1.8
12/07	0	0	0	0	0	24	1.3
12/08	0	0	0	0	0	24	1.5
12/09	0	0	0	0	0	24	1.2
12/10	0	0	· 0	0	0	24	1.0
12/11	0	0	0	0	0	24	1.5
12/12	0	Ó	0	0	0	24	1.4
12/13	0	0	0	0	0	24	1.3
12/14	0	0	0	0	0	24	1.4
12/15	0	0	0	0	0	24	1.9
12/16	0	0	0	0	0	24	1.7
12/17	0	0	0	0	0	24	1.7
12/18	0	0	0	0	0	24	1.8
12/19	0	0	0	0	0	24	1.9
12/20	0	0	0	0	0	24	1.5
12/21	0	Ó	0	D	D	24	1.8
12/22	0	0	0	0	0	24	1.6
12/23	D	D	0	D	D	24	1.7
12/24	0	0	0	0	0	24	1.3
12/25	Ô	0	D	D	0	24	1.2
12/26	O	0	0	0	0	24	1.4
12/27	0	0	0	D	D	24	1.9
12/28	0	0	0	0	0	24	1.4
12/29	Û	0	0	D	0	24	1.8
12/30	Ο.	0	0	0	0	24	1.9
12/31	0	0	0	0	0	24	1.8
MONTHL	Y						
TOTALS	0	0	O	0	0	744	1.5

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INTEGRATED DRY NO, /SO $_{\rm 2}$ EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Calcium-Based Dry Sorbent Injection System Test Period: April 30, 1993 through November 2, 1993

Calcium DSI Air Toxics Test October 19-20, 1993 Dioxins/Furans Air Toxics Test October 11-13, 1993

Appendix B: Aqueous Stream Compliance Data

DEFENSION OF THE OWNER OWNER OWNER OWNER OWNER				001001							
	ADG 0024	2 L		LT NUMBER	5.0			•		:	1
				NOW	FORING PERIC	0				-	
AGILITY ARAUAUAL			FROM C	MO DM	V VO VEAR	AVG ON					
			(20-21)	(22.23) (24	25/ (26-27/ (18-291 (30-31) N	VOTE: Read Instru	ctions before	completi	ng this fo	En.
PARAMETER		(J Card Only) QU) (46-33)	NTITY OR LOADIN (54-61)	07	(4 Card Only) (38-45)	QUALITY OR CONC (46-53)	CENTRATION (54-61)		NO.	UENCY	AMPLE
(32-37)		AVERAGE	MUMIXAM	UNITS	MINIMUM	AVERAGE	MUMIXYM	UNITS	2-63) (64	1 4818	(69-70)
EMPERATURE	SAMPLE BAMPLE MEABUREMENT						68.200	(12)	0 20	/30	
ИНСЕК ВЕФ ТИЛИСИЛИТТ 10011 1 0 0 FETHENT GROSS VALUE	PERMIT REQUIREMENT						B6.000 D411y Max.	DEGF	2	1	1 I SN
Ŧ	BAMPLE MEABUREMENT				7.490		8,750	(12)	50	/30	
00400 1 0 0 FFLUENT GROSS VALUE	PERMIT REQUIREMENT				6.500 Minimum		9,000 Maximum	ns	1 7	6	œ
00.105, T01AL 155 MSPENDED	BAMPLE Meaburement					21,300	24.000	(19)	4	06/	
00530 1 0 0 20530 1 0 0	PERMIT REQUINEMENT			.		30-Day Avg.	100,000 Daily Max.	MG/L	1	8	HR C II
DIL AND GREASE REON EXTR-GRAV MEIN	BAMPLE Measurement				Cont Ingent			(13)	4	06/	
20556 1 0 0 EFFLUENT GROSS VALUE	PERMIT REQUIREMENT		4.			15,000 30-Day Avg.	20.000 Daily Max.	MG/L	1.	7	8 8
ZINC, TUTAL CAS ZND	gAMPLE Measurement					500°0)	500'0 <i>></i>	(1))	1	06/	
01092 I 0 0 FFLUENT GROSS VALUE	PERMIT AEQUINEMENT			E		0.880 30-Day Avg.	0,880 Daily Max.	MG/L	1/	30 6	2
TLOW, IN CONDUIT OR	8AMPLE Meaburement	0.225	0.778	(03)					99,	06/	
EFLULNI GROSS VALUL	PERMIT REQUIREMENT	1,000 30-Day Avg.	u.	116.0					30	I DE/	NST ,
SHLORTHE TOTAL RESTRUAL	LNIMIJUNIVIM Ilume						60.05	(19)	0 4	067	
111 FHI 91 08022 AVENU	PERMIT REQUIREMENT	*		6			0.110 Daily Max.	MG/L	1/	2 G	R ·
NAME/TITLE PRINCIPAL EXECUTIVE	OFFICER CFR1	IFY UNDER PENALTY OF	LAW THAT I HAVE F	PERSONALLY E	KAMINED Dased			TELEPHONE		DAT	
JEKELS, JAHLS R. 10r.60vt & LNU AFTRS	ON MY OBTAN 15 TRU NFICAN	INCURATE AND COMMATION	NCIVIOUALS IMMEDIATE I BELIEVE THE SUI APLETE I AM AWARE IBMITTING FALSE INFI	LY RESPONSIE BMITTED INFOI THAT THERE A	HE FOR MATION INE SIG			-			
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COMMENT AND EXPLANATION OF ANY VIDLATIONS (Reference all allachments here)

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ODATE P. O. BOX 840.				001091	°	001A	FINAL			Edulat	00-125	
									•			
OCATION			FROM ST	04 01		02 20			• •			-
			112.02)	(22.23) (24.2	51 (26-27)	(16.06) (02.02)	NOTE: Read	instructio	ne before c	ompleting	this form	Ē
PARAMETER		(1 (ard Only) QU (46-33)	ANTITY OR LOADH (54.61)	D Z	(4 Card Only) (38-45)	QUALITY OR C((46-33)	NCENTRATION (34-61)		ž	O. TREQUE	NCV BAN	
(25-32)		AVERAGE	MAXIMUM	UNITE	MUMINIM	AVERAGE	MAXIMU	W	UNITE (62-	19-19) (89-89) (89-89)		.70)
TL AND GRUASE	BAMPLE Meaburement		0	NO NO					0	~ ~	02	
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INTEGRATED DRY NO $_x$ /SO $_2$ EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Calcium-Based Dry Sorbent Injection System Test Period: April 30, 1993 through November 2, 1993

Appendix C: Calcium-Based DSI System Data Summary

Data Used For Duct Injection Trend Plots.

Test	<u>Date</u>	Load	<u>Ca/S</u>	Taop, caic	<u>∆SO2</u>	<u>∆SO2 @ Ca/S=2</u>
582	5/12/93	108	1.54	49	21.2	27.5
605	6/ 28 /93	107	1.63	65	12.1	14.8
605	6/28/93	109	1.66	76	9.2	11.1
605	6/28/93	108	1.76	61	19.1	21.7
605	6/ 29/9 3	108	2.07	40	20.5	19.8
605	6/29/93	106	1.87	43	20.5	21.9
610	7/1/93	109	1.69	36	32.0	37.0
610	7/1/02	105	1.05	25	20 4	37.5
580	5/10/00	100	1.02	20	23.4	32.3
502	5/12/93	108	1.30	03	13.0	
J02	5/12/93	108	1.41	67	16.3	
612	//2/93	104	1.07	38	14.8	
578	5/10/93	100	1.69	59	20.0	23.7
579	5/11/93	100	1.71	56	19.1	22.3
580	5/11/93	100	1.85	50	19.5	21.1
584	5/13/93	100	1.55	48	20.7	26.7
610	7/1/93	100	1.69	36	32.6	38.6
603	6/22/93	95	1.75	47	20.8	23.8
576	5/3/93	100	2 41			ÇQ.0
579	5/11/93	100	0.95	51	12.0	
584	5/13/03	00	0.35	47	12.0	
610	3/13/33	99	0.78	47	11.4	
610	///93	98	1.09	24	22.6	
605	6/28/93	91	1 69	41	22.6	26.7
605	6/28/93	91	1 74	30	20.8	20.7
605	6/28/93	01	1 22	45	16.0	23.5
605	6/20/93	91	1.55	41	22.5	
	0/23/33	00	1.03		23.4	
600	6/16/93	80	1.86	40	23.3	25.1
604	6/22/93	80	1,78	36	17.8	20.0
599	6/15/93	80	0.40	35	2.3	
601	6/17/93	80	0.85	45	12.9	
602	6/21/03	80	0.30	45	30	
610	7/1/02	78	1 42	40	10.3	
612	7/1/30	70	1.42	42	19.3	
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581	5/12/93	70	1,73	44	20.3	23.5
586	5/14/93	70	1.70	20	37.0	43.7
583	5/13/93	70	1.66	38	19.3	23.3
604	6/22/93	50	1.75	45	22.2	25.4
604	6/22/93	59	1.53	45	23.8	31.1
606	6/29/93	60	1 64	38	22.5	27.4
606	6/30/93	58	1 75	38	18.8	21.5
608	7/1/93	60	1 72	34	19.7	21.5
609	7/1/00	60	1 70	20	22.4	22.3
611	7/1/93	00	1.72	29	23.4	27.2
011	(12)93	61	1.59	36	25.5	32.1
705	1 0/19 /93	112	2.06	28	37.0	35.9
706	10/20/93	112	2.07	28	35.4	34.2
707	10/20/93	112	2.10	29	37.8	36.0
709	10/26/93	102	2.03	50	26.9	26.5
712	10/27/93	101	1.97	29	28.1	28.5
715	11/1/93	112	2.23	32	34.4	30.9
717	11/1/93	113	1.90	35	30.9	32.5
719	11/2/93	114	2 04	36	26.8	26.7
720	11/2/03	111	2 10	20	28.6	20.0
721	11/2/00	14.4	2.10	32	20.0	21.2
16.1	11/2/93	114	2.10	30	32.9	30.6

PSCC Arapahoe Unit 4 Calcium/Humidification-Duct Injection. Ca(OH)2 calculations based upon 68%, CaO

	- - -	Boilet	b -1	Sorbe	ut E	pee	Injec	tor cat	5 SO	2 Red	Humid	lification	_			Bag	house	Temps		Hum	d calc
÷	ate & Time	Load	02cr	Loc	A.	ч В.ө	Flow	Ca/S	Com	p Calc	Air	Tgo	ΙwΙ	HZC	₹ <	Č.	i Out	IDin Opsi	s Ta	Tcalc	H2Oe
		ышө	law?		*	*	D/mir		*	*	sdin	ų	Ψ	E C S	•	<u>بع</u> : ا	¥	ų. ų.	Ψ,	ų	M%.
4	/30/93 1420	100	390	Duct	ß	ß	19.2	1.02	Ś	13	3684			35.0	1 05	205	206				8 27
4	/30/93.1500	100	3 90	Duct	ŝ	ሜ	19 2	1 02	80	28	3639			40 0	0.90	194	199				8 25
4	/30/93:1635	100	9 90 9 90	Duct	ß	ន	19 2	1.01	60	9. k	3550			47.0	0.00	175	185				8 28
	5/3/93:1615	100	3 50	Duct	100	<u>0</u>	384	2.41	21	18 0	3457	258	23	54 0	0.60	223	180			149	8 <u>5</u> 3
-	5/6/93:1130	53	7.30	Duct			00	8	2	¢.	4200	248	ŝ	30 0	1.57	. 160	185	170	49	165	6.77
~,	5/6/93:1340	55	2.10	Duct	45	45	17.3	.181	5	80 .¥F.	4186	252	55	310	155	160	_	167		169	6 75
-	5/6/93:1515	55	8 ~	Duct	45	45	17 3	1.85	13	7.1	4145	254	55	35 5	131	150		160		160	6.74
41	3/6/93:1735	55	28	Duct	45	45	17 3	1.84	16	86	4109	255	26	38 5	121	142		154		151	6 87
ŝ	10/93 0800	105	4 10	Duct	٥	o	00	0.00		-23								253			883
ŵ	10/93 1405	100	3 70	Duct	88	88	33 B	1 68	61	153	3990	276	55	48 0	0 89	160	173	179	56	179	834
ŝ	10/93 1600	100	3 60	Duct	88	88	33 B	1 56	22	18 6	3973	278	56	49 0	0.87	160	170	173	53	173	8 83
ŝ	10/93 1800	100	3 60	Duct	96	96	36.9	1 69	53	20 0	3957	282	55	50 0	0.84	160	170	174	53	175	8 93
õ	10/93 2023	100	3 64	Duct	96	96	36.9	171	26	22 4	3960	280	56	50 0	0.84	160	168	174	51	173	116
ភ	10/93 2221	100	3 57	Duct	96	96	36 9	1 86	27	23 0	3974	276	56	49 0	0.86	160	167	173	50	173	66 8
ñ	11/93 0032	100	3 97	Duct	8	8	346	1 62	28	210	4000	271	56	47 0	0.91	160	167	172	50	174	00 6
ŝ	11/93 0230	100	3 94	Duct	85	85	32 7	1 76	ដ	19 1	4029	266	55	45.0	96 0	160	165	171	48	173	66 8
ñ	11/93 0430	100	3 93	Duct	85	95	32 7	171	8	ลิ	4023	266	55	45.0	0 95	160	164	170	47	172	66 8
õ	11/93 0620	100	3 93	Duct	85	85	32.7	1 66	24	20.7	4011	266	55	45 0	0 94	160	164	170	47	172	8 99
ŝ	11/93 0830	100	400	Duct	85	85	32 7	164	20	14 9	3960	270	54	46 0	160	160	164	021	47	174	8 9e
ທີ	11/93.1100	100	400	Duct	0	8	17 4	060	18	12 3	3917	275	26	52 0	0 79	150	162	167	45	167	8 8 9
õ	11/93.1300	100	4 20	Duct	0	8	17.4	094	17	13 2	3875	280	56	540	0 75	150	163	167	46	167	00 6
ŝ	11/93:1500	100	40	Duct	0	8	17.4	0.96	16	11.5	3875	281	54	540	0 75	150	164	170	47	169	9 <u>9</u> 9
ŝ	11/93.1700	100	3.90	Duct	0	8	17.4	0.99	16	11.4	3867	282	S	55 0	0.74	150	163	168	46	168	9 02
õ	11/93:1900	100	3 96	Duct	0	8	17.4	8.1	19	11.6	3866	283	55	55 0	0.72	150	164	168	47	169	9.05
ທີ	11/93-2100	100	3 94	Duct	8	8	346	1.94	26	20.2	3861	284	SS	56 0	0.71	150	162	168	45	168	928
ŝ	11/93 2300	100	3 95	Duct	8	80	308	1.76	23	19 1	3869	278	22	55 0	0 73	150	161	167	44	165	934
ŝ	12/93 0010	70	5.84	Duct	56	56	215	1.80	ส	215	4040	258	55	410	1.06	150	156	160	4	160	7.99
ŝ	12/93 0200	70	5 83	Duct	53	53	204	1.70	25	196	4057	254	55	40.0	111	150	154	156	9 8	159	7.96
ŝ	12/93 0400	20	5 86	Duct	53	53	204	1.69	24	200	4062	253	55	40.0	Π	150	153	155	38	158	7 88
ŝ	12/93.0545	20	5 86	Duct	8	S	204	1.66	5	10 0	4481	252	ŝ	0.0		241	183	188	69	252	7.87
ŝ	12/93:1240	108	3 20	Duct	95	95	36 5	1.81	23	14.8	3866	288	28	55.0	0 74	160	184	189	53	180	951
ഹ	12/93:1420	108	320	Duct	95	36	36 5	1.54	24	212	3810	291	26	63 0	0 69	150	175	180	56	168	9.59
ŝ	12/93-2040	108	331	Duct	95	95	36 5	1 36	16	13.6	3877	288	8	510	0 79	120	201		82	188	949
õ	12/93 2250	108	331	Duct	001	100	38 4	141	19	163	3908	286	57	510	0.81	170	182	190	.63	186	949
ŝ	13/93 0020	70	5 25	Duct	8	80	30.8	1.74	23	212	4013	261	56	44 0	8	142	169	169	3	153	8 30
ŝ	13/93 0300	70	521	Duct	75	75	28 8	164	25	19.3	4049	256	8	42 0	1 06	142	154	155	88	153	8 22
ŝ	13/93 0430	20	5 23	Duct	75	75	28.8	1 67	25	19.2	4046	255	55	110	1 07	142	150	152	Æ	154	8 23
ŝ	13/93.0530	100	348	Duct	100	100	36.4	1 57	ង	18.9	3989	266	55	45 0	0 95	160	160	165	44	171	9.54
õ	13/93:0735	100	3 50	Duct	100	001	38 4	1.55	2	20.7	3897	274	56	52 0	080	152	162	168	46	165	66 6
ŝ	0660-65/61/	66	3.40	Duct	0	100	19.4	0.78	17	1,1,4	3867	277	26	535	0 76	149	160	165	44	164	9.27
ō	14/93.0035	69	5.37	Duct	8	8	23.1	1.68	90	23.8	3998	259	55	46.0	0.94	128	156	156	4	144	8.06
ŝ	/14/93:0230	70	5 27	Duct	80	8	231	1.64	8	24.6	4011	255	22	46.0	0.95	129	144	145	8	142	8.0
١Ö	14/93:0310	20	5 19	Duct	60	8	23 1	1.66	38	36.1	3971	256	56	49.0	0.86	124	140	142	25	136	8 04
ŵ	14/93 0420	70	5 26	Duct	60	8	23 1	1.72	37	37.6	3977	254	55	49 0	0 88	124	137	139	ส	134	8 00
ñ	14/93 0545	20	5 26	Duct	8	3	23 1	1.71	44	39.4	3979	254	20	48 0	0 89	125	136	137	2	136	7 98
ŝ	114/93.0705	2	5 50	Duct	80	8	23 1	1.69	Ŧ	35.1	3971	252	2 9	49 0	0 86	124	134	136	19	132	8.16
nnt																					

pahoe																					
C Ara																					
PSC																					

		GAS AN	AL EC	JO-NOC	3Y (1-12	(;	GAS AN	ALYS	IS IN	ET-WE	J		GAS AF	IALY	SIS OI	UTLET-	WET	:	
Test	Date & Time	0N	8	S02	C02	02	Q	8	S 02	C02	H2O	05	02	8	S02	C02	H20	05	Comments
		PPI -	шdс	шdd	*	Yib.	ppm	Edd	mqq		à.	*	mqq	Edd	E d	*	*	*	
575	4/30/93 1420	235	194	424	13 53	5 25	180	154	348	12 02	8 22	4 90	192	233	332	11 73	10.48	4.90	
575	4/30/93 1500	235	194	424	13 53	5 25	180	180	347	12 05	8 20	4 90	187	281	328	11 89	10 88	4 75	
575	4/30/93 1635	235	194	424	13 53	5 25	179	184	351	12 07	8 26	4 85	187	329	329	11 54	11 54	4 60	
576	5/3/93 1615	225	166	320	13 04	5 27	195	153	268	10 87	7 69	6 30	208	663	227	11 44	11.85	28	
577	5/6/93 1130	199	1	263	10 28	9 20	150	14	235	941	6 76	8 60	164	2	232	9 25	9.38	8 55	Humid
577	5/6/93 1340	199	2	263	10 28	9 20	163	Ξ	228	921	6 63	8.78	163	~	208	9 08	9.39	8 65	
577	5/6/93 1515	199	11	263	10 28	9 20	166	Ξ	225	9 23	6 66	8 72	164	9	198	86 8	9 63	8.67	
577	5/6/93.1735	202	0	259	10 43	8.95	163	2	225	9 22	6 63	8.75	165	Q	193	8.99	9.87	8.60	
578	5/10/93 0800	255	44	370	14 10	5 50	181	50	295	10 94	7 62	7 05	195	183	355	12.96	891	4 60	
578	5/10/93.1405	255	44	370	14 10	5.50	203	225	398	13 62	914	3 65	195	97	295	12 03	11 64	5 05	
578	5/10/93 1600	230 1	94	445	14 78	4 42	194	344	430	13 53	906	3 62	189	68	311	12 15	11 89	4 75	
578	5/10/93 1800	230 1	194	445	14 78	4 42	203	135	427	13 62	CO 6	3 85	184	105	308	12 28	12 07	4 72	
578	5/10/93 2023	230 1	194	445	14 78	4 42	199	104	422	13 59	924	3 BO	186	49	291	12 19	12 08	4 91	
578	5/10/93 2221	219	36	422	14 72	4 70	199	51	385	13 47	918	3.96	189	60	266	12 22	12 02	4 91	
578	5/11/93 0032	241	63	383	14 58	4 92	208	52	367	13 40	9 29	4 00	194	37	259	12 08	11 97	5 05	
578	5/11/93 0230	241	63	383	14 58	4 92	195	126	365	13 67	946	3 70	198	45	261	12 09	11 63	5 03	
578	5/11/93 0430	234	71	392	14 41	4 80	207	50	368	13 39	918	4 05	194	62	265	12 13	11 73	5 00	
578	5/11/93 0620	234	71	392	14 41	4 80	208	55	380	13 43	9 20	4 01	192	57	270	12 12	11 73	5 05	
578	5/11/93 0830	234	11	392	14 41	4 80	212	52	383	13 44	9 15	4 05	168	6	295	12 27	11 69	4 90	
579	5/11/93 1100	234	1	392	14 41	4 80	207	3	375	13 36	906	4 05	190	53	292	12 00	12 08	5 10	
579	5/11/93 1300	234	71	392	14 41	4 80	215	32	352	13 17	66 8	4 38	191	8 6	279	12 05	12 10	200	
579	2/11/33 1500	239 1	123	368	14 36	4 95	213	44	348	13 34	11 6	4 15	192	87	275	11 83	12 24	5 10	
579	5/11/93.1700	239 1	123	368	14 36	4 95	215	57	338	13 30	9 26	4,10	192	116	266	11 87	12.45	5 10	
579	5/11/93.1900	239 1	123	368	14 36	4 95	206	69	339	13 44	9 43	3 87	188	64	267	12 01	12.66	4.85	
580	5/11/93 2100	239 1	23	368	14 36	4 95	214	185	345	13 37	9 68	3.85	185	46	240	11.80	12.93	5 11	
580	5/11/93 2300	239 1	23	368	14 36	4 95	200	155	345	13 68	9.96	3.50	190	82	242	11 98	12.78	4.95	
581	5/12/93 0010	223	8	284	11.80	7.75	201	14	266	11 04	8 20	6.80	179	17	185	9.89	10.94	7.65	
581	5/12/93.0200	223	29	284	11 80	7.75	205	₽ 2	267	11 00	8.17	6 80	182	17	191	9.98	10 84	7.62	
581	5/12/93 0400	223	53	284	11 80	7 75	205	13	270	11 16	8.14	6.72	174	22	193	10.10	10 90	7.48	
581	5/12/93 0545	223	23	284	11 80	7.75	199	5	282	11 59	8 36	6.35	180	90	231	10 48	7.78	7.63	H2O off
582	5/12/93 1240	24D 3	387	387.4	14.62	4 55	214	161	363	13 47	9.71	3.80	196	277	278	12 20	12.71	4.70	
582	5/12/93.1420	240 3	181	387.4	14 62	4.55	- 212	189	430	13.63	999	3.65	169	363	305	1221	13.13	4.50	
582	5/12/93 2040	247 5	557	505	14.41	4 60	205	742	468	13.48	9 84	3.60	198	399	375	12.04	12.42	4.72	
582	5/12/93 2250	247 5	557	505	14 41	4 60	206	860	499	13 54	9 87	3.55	199	344	369	12 11	12.39	4 82	
583	5/13/93.0020	211	13	428	12 20	7.25	190	21	406	11 46	8 51	6.32	167	88	285	10.30	11.56	7 08	
583	5/13/93.0300	211 1	611	428	12 20	7 25	194	16	3 99	11 20	8.32	6.50	172	44	289	10 28	11 29	7.18	
583	5/13/93 0430	211 1	113	428	12 20	7 25	199	16	395	11 35	8 37	6 43	168	53	287	10 33	11 30	7 10	
584	5/13/93 0530	224 2	212	500	14 48	4 60	187	194	480	13 61	68 6	3 60	181	144	345	12 06	12 23	4 85	
584	5/13/93 0735	224	E13	500	14 48	4 60	194	309	487	13 59	69 6	3 68	182	152	340	11 98	12 58	4 90	
584	5/13/93.0930	220 5	573	496	14 31	4 70	191	184	9	13 54	9 65	3 65	160	188	380	11 93	12.57	4 95	
585	5/14/93:0035	210	61	350	12.17	7 20	194	19	328	11.64	8 45	5 98	164	46	217	1021	11.67	7 05	
585	5/14/93:0230	210	61	350	12.17	7.20	200	18	335	11.60	8.47	5.85	170	79	219	10 37	11.67	6 95	
586	5/14/93:0310	210	61	350	12.17	7 20	199	25	325	11.46	8 33	6.15	165	83	186	10.46	11.99	6.75	
586	5/14/93 0420	210	61	350	12.17	7.20	199	39	325	86 11	8 62	5.60	181	38	172	10 37	11 77	8.2	
586	5/14/93 0545	210	61	350	12 17	7 20	200	38	322	11.82	846	5.80	159	164	21	10.40	19.11	5 80	
586	5/14/93 0705	210	61	350	12 17	7 20	Ŕ	24	60 5	11 24	8 17	6.60	173	62	179	10.08	11 56	7 25	O2 changd

PSCC Atapahoe Unit 4 Calcium/Humidification-Duct Injection, Ca(OH)2 calculations based upon 68% CaO

		Bolle	Ē	Sorbe	Ĕ	pee	lnjec	tor cal	SSO	2 Red	Humid	ificatio	c			Bag	house	Temp			Humid	calc
Test	Date & Time	Load	02cr	Loc	A.N	e E E	Flox	v Ca/S	Com	p Catc	Air	Igo	Τw	HZO	₹ ¢	Gri	1 Out	õ	Opsis	Ta	Tcalc	H2Oe
		MWe	19w%		*	*	b/mi	e	7	*	sdm	ų.	ų.	щđ		4	ų	ų	÷	۴	۶F	M%
575	4/30/93:1420	<u>0</u>	3.90	Duct	ŝ	ន	19.2	1.02	S	1.3	3684			35.0	1.05	202	206					8.27
575	4/30/93.1500	100	3 90	Duct	50	3	192	1.02	60	2.8	3639			40 0	0.00	194	199					8 25
575	4/30/93.1635	100	3 90	Duct	ß	8	19 2	101	60	4.C	3550			47 0	0.00	175	185					8 28
576	5/3/93-1615	100	3 50	Duct	100	100	364	2.41	21	16 0	3457	258	52	54 0	0.60	223	180				149	8 53
577	5/6/93.1130	53	7 30	Duct			00	8	24	4	4200	248	ŝ	30 0	1 57	160	185		170	49	165	677
517	5/6/93 1340	55	7 10	Duct	45	45	17 3	181	2	4.8	4168	252	55	310	1 55	160	_		167		169	6 75
577	5/6/93.1515	55	2 00	Duct	\$	45	17.3	1 85	23	7 1	4145	254	55	35 5	131	150	_		160		160	674
517	5/6/93.1735	55	28	Duct	45	45	17 3	1 84	16	8 [.] 6	4109	255	56	38 5	121	142			154		151	6 87
578	5/10/93 0800	105	4 10	Duct	0	0	00	800		·2 3									253			8 83
578	5/10/93 1405	001	3 70	Duct	88	88	33 B	1 68	19	153	066E	276	55	48.0	0.09	160	173		179	56	179	8 34
578	5/10/93 1600	100	3 60	Duct	88	88	33 8	1 56	22	186	3973	278	56	49.0	0.87	160	170		173	23	173	8 83
578	5/10/93:1800	100	3 60	Duct	96	96	36 9	1 69	23	20 0	3957	282	55	50 0	0 84	160	170		174	53	175	8 3 3
578	5/10/93 2023	100	364	Duct	96	96	36 9	171	26	22 4	3960	280	56	50 0	0.04	160	168		174	51	173	116
578	5/10/93 2221	<u>0</u>	3 57	Duct	96	8	36 9	1 86	27	23 0	3974	276	20	49 0	0.86	160	167		E71	ß	173	8 9 9
578	5/11/93 0032	<u>0</u>	3 97	Duct	8	8	346	1 82	28	21.0	4000	271	9 9	47 0	0.91	160	167		172	20	174	00 5
578	5/11/93 0230	100	3 94	Duct	85	85	32 7	1 76	ង	191	4029	266	S 5	45 0	96 0	160	165		171	48	173	66 B
578	5/11/93 0430	100	3 93	Duct	85	83	32 7	171	ង	201	4023	266	55	45 0	96 0	160	164		170	47	172	66 B
578	5/11/93 0620	100	3 93	Duct	85	85	32 7	1 66	24	20.7	4011	266	55	45 0	094	160	164		170	47	172	66 B
578	5/11/93.0830	100	4.00	Duct	85	85	32 7	1 64	8	14 9	3960	270	¥9	46 0	160	160	164		170	47	174	8 96
579	5/11/93:1100	100	4 00	Duct	0	8	17 4	06 0	18	12 3	3917	275	56	52 0	0 79	150	162		167	45	167	6 8 0
579	5/11/93:1300	100	4 20	Duct	0	8	17 4	0 94	17	13 2	3875	280	56	54 0	0 75	150	163		167	46	167	006
579	5/11/93.1500	100	400	Duct	0	8	17 4	0 96	16	11 5	3875	281	54	54 0	0 75	150	164		170	47	169	8 96
579	5/11/93:1700	00 100	390	Duct	0	8	174	6 6 0	16	11 4	3867	282	55	55 0	074	150	163		168	46	168	9 02
579	5/11/93.1900	100	396	Duct	0	8	17.4	1.8	19	116	3866	283	55	55 0	0 72	150	164		168	47	169	9 05
580	5/11/93 2100	100	3 94	Duct	8	8	346	194	26	202	3861	284	55	56 0	120	150	162		168	45	168	9 28
580	5/11/93 2300	100	3 95	Duct	80	80	30 B	1.76	23	19.1	3869	278	56	55 0	0 73	150	161		167	44	165	934
581	5/12/93 0010	70	584	Duct	8	<u>8</u>	215	1.80	ង	215	4040	258	ŝ	41.0	1 06	150	156		160	41	160	56 /
581	5/12/93.0200	20	5 83	Duct	53	53	204	1.70	25	19.6	4057	254	55	40 0	1.11	150	154		156	6 E	159	3 96
581	5/12/93.0400	2	5 86	Duct	53	5	204	1.69	2	200	4062	253	55	400	111	150	153		155	38	158	7 88
581	5/12/93:0545	20	5 86	Duct	53	53	8	1.66	2	10.0	4481	252	<u>9</u>	0.0		241	183		188	68	252	7 87
582	5/12/93:1240	108	3 20	Duct	3 6	ŝ	36 5	1.81	53	14.8	3866	268	56	55.0	0.74	160	184		189	65	180	9.51
582	5/12/93:1420	108	320	Duc	95	35	36 5	1.54	24	212	3810	291	8	63 0	0.69	150	175		180	56	168	9.59
582	5/12/93:2040	108	3.31	Duct	95	95	36.5	1.36	16	138	3877	288	56	510	0.79	170	201			82	188	9.49
582	5/12/93-2250	108	3.31	Duct	<u>0</u>	8	38 4	1.41	5	163	3908	286	57	510	0.81	170	182		190	63	186	949
583	5/13/93:0020	70	5 25	Duct	8	8	308	174	33	212	4013	261	20	44 0	8	142	169		169	53	153	6 30
583	5/13/93.0300	2	523	Duct	75	75	28 8	164	55	19.3	4049	256	8	42 0	90	142	154		155	38	153	8 22
583	5/13/93 0430	20	5 23	Duct	75	75	28 8	1.67	22	19 2	4046	255	55	41.0	1.07	142	150		152	æ	154	8 23
584	5/13/93.0530	õ	3.46	Drect	1 00	00	38 4	1 57	ង	189	3969	266	55	45 0	0.95	160	160		165	44	171	954
584	SET0.69/61/2	100	3 50	Duct	<u>10</u>	2	38 4	1 55	24	20.7	3897	274	56	52 0	0.80	152	162		168	46	165	6 3 3
584	5/13/93.0930	6	3.40	Duct	0	5	194	0 78	17	11.4	3867	277	ŝ	535	0.76	149	160		165	4	164	9 27
585	5/14/93.0035	69	5 37	Duct	8	8	23.1	1.68	8	23 8	3998	259	55	46 0	0.94	128	156		156	41	144	8 06
585	5/14/93:0230	20	5.27	Duct	8	8	231	1.64	8	24.8	4011	255	55	46.0	0.95	129	144		145	29	142	800
586	5/14/93:0310	2	5 19	Duct	8	8	23.1	1.66	38	36.1	3971	258	8	0.64	980	124	140		142	25	136	8.04
586	5/14/93.0420	2	5 26	Duct	8	8	23.1	1.72	37	37.6	3977	254	22	064	0.08	124	137		139	ส :	134	800
586	5/14/93 0545	2	5 26	Duct	8	8	23 1	1.71	4	¥ 6E	3979	254	8	9	680	125	136		137	5	136	7 98
586	5/14/93.0705	70	5 50	Duct	8	8	23.1	1.69	41	35 1	3971	252	56	49 0	0.86	124	134		136	6	132	8 16

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	-	GAS AN	IAL E	CON-DI	RY (1-12	5	GAS AP	IALYS	SIS INI	LET-WE	····· 1		GAS AN	IALY.	SIS OL	JTLET	WET	:		
Tesl	Date & Time	9 V	8	S02	C02	02	QN	8	S 02	C02	H2O	80	Ŷ	8	S 02	C02	H2O	05	Comments	
		шdd	Шdd	шdd	*	%dry	шdd	шdd	bom	, *	* !		шdd	Pon	mqq	*	*	*		
575	4/30/93:1420	235	194	424	13.53	5.25	180	154	348	12 02	8 22	4 .90	192	233	332	11.73	10.46	4.90		
575	4/30/93 1500	235	194	424	13 53	5 25	180	180	347	12 05	8 20	4.90	187	281	328	11 89	10 88	4 75		
575	4/30/93 1635	235	194	424	13 53	5 25	179	184	351	12 07	8 26	4 85	187	329	329	11 54	11.54	4.60		
576	5/3/93:1615	225	166	320	13 04	5 27	195	153	268	10 87	7 69	6 30	208	663	227	11 44	11 85	5.00		
577	5/6/93:1130	199	:	263	10 28	9 20	160	14	235	9 41	6.76	8 60	164	2	232	9 25	9.38	8 55	Humid	
577	5/6/93.1340	199	11	263	10 28	9 20	163	=	228	921	6 63	8 7 B	163	2	208	9.08	9.39	8.65		
577	5/6/93.1515	199	Ξ	263	10 29	9 20	166	Ξ	225	9 23	6 66	8 72	164	9	198	8.98	9.63	8.67		
577	5/6/93.1735	202	2	259	10 43	8 95	163	2	225	9 22	6 63	8 75	165	9	193	8.99	9 87	8.60		
578	5/10/93 0800	255	44	370	14 10	5 50	181	50	295	10 94	7 62	7 05	195	183	355	12.96	8.91	4 60		
578	5/10/93.1405	255	44	370	14 10	5 50	203	225	398	13 62	914	3 65	195	97	295	12 03	11 64	5 05		
578	5/10/93 1600	230	194	445	14 78	4 42	194	344	430	13 53	906	3 62	189	83	311	12 15	11 89	4 75		
578	5/10/93 1800	230	194	445	14 78	4 42	203	135	427	13 62	9 0 3	3 85	184	105	308	12 28	12 07	4 72		
578	5/10/93 2023	230	194	445	14 78	4 42	199	104	422	13 59	9 24	3 80	186	6 1	291	12 19	12 08	4 91		
578	5/10/93 2221	219	96	422	14 72	4 70	199	51	385	13 47	918	3 96	189	60	266	12 22	12 02	4 91		
578	5/11/93 0032	241	63	383	14 58	4.92	208	52	367	13 40	9 29	400	194	37	259	12 08	11.97	5.05		
578	5/11/93.0230	241	63	383	14 58	4 92	195	126	365	13 67	946	3 70	198	45	261	12 09	11 63	5 03		
578	5/11/93 0430	234	11	392	14 41	4 80	207	8	368	13 39	918	4 05	194	62	265	12 13	11 73	5 00		
578	5/11/93 0620	234	11	392	14 41	4 80	208	55	380	13 43	9 20	4 01	192	57	270	12 12	11.73	5 05		
578	5/11/93 0830	234	11	392	14 41	4 80	212	52	303	13 44	9 15	4 05	188	91	295	12 27	11.89	4.90		
579	5/11/93 1100	234	11	392	14 41	4 80	207	ŝ	375	13 36	9 06	4 05	190	53	292	12 00	12.08	5 10		
579	5/11/93 1300	234	11	392	14 41	4 80	215	32	352	13 17	66 8	4 38	161	86	279	12 05	12.10	5 00		
579	5/11/93.1500	239	123	368	14 36	4 95	213	44	348	13 34	9 17	4 15	192	87	275	11 83	12 24	5.10		
579	5/11/93:1700	239	123	368	14 36	4 95	215	57	338	13 30	9 26	4.10	192	116	266	11 87	12 45	5 10		
579	5/11/93:1900	239	123	368	14 36	4.95	206	69	339	13 44	9.43	3.07	188	64	267	12 01	12.66	4 85		
580	5/11/93.2100	239	123	368	14 36	4 95	214	185	345	13 37	968	3.85	185	46	240	11 80	12 93	5.11		
580	5/11/93 2300	239	123	368	14 36	4 95	200	155	345	13 68	96 6	3.50	190	85	242	11 98	12.78	4 95		
581	5/12/93.0010	223	29	284	11.80	7.75	201	4	266	11 04	8 20	6.80	179	17	185	9.89	10.94	7.65		
581	5/12/93.0200	223	29	284	11 80	7.75	205	12	267	11 00	8 17	6.80	182	12	191	966	10.84	7 62		
581	5/12/93 0400	223	29	284	11 80	7 75	205	13	270	11 16	814	6 72	174	22	193	10 10	10 90	748		
581	5/12/93 0545	223	29	284	11 80	7.75	199	5	282	11 59	8 36	6.35	180	30	231	10 48	7.78	7 63	H2O att	
582	5/12/93:1240	240	387	387.4	14.62	4 55	214	161	363	13 47	9.71	3.80	196	277	278	12 20	12.71	4 70		
582	5/12/93 1420	240	387	387.4	14.62	4 55	212	189	964	13 63	9.66	3.65	691	363	305	12 21	13,13	4.50		
582	5/12/93.2040	247	557	505	14.41	4.60	205	742	466	13 48	984	3.60	198	9 66	375	12 04	12.42	4 72		
582	5/12/93.2250	247	557	505	14.41	4.60	206	860	499	13 54	9.87	3.55	199	344	369	12 11	12.39	4.82		
583	5/13/93 0020	211	113	428	12.20	7 25	190	5	90	11 46	8.51	6.32	167	88	285	10 30	11 56	7.08		
583	5/13/93.0300	211	113	428	12.20	7 25	194	16	5 6E	11 20	8 32	6.50	172	4	289	10 28	11 29	7.18		
583	5/13/93 0430	211	113	428	12 20	7 25	199	16	395	11 35	8 37	6 43	168	ŝ	287	10 33	11.30	7.10		
584	5/13/93.0530	224	212	500	14 48	4 60	187	194	480	13 61	69 6	3 60	181	144	345	12 06	12 23	4 85		
584	5/13/93 0735	224	213	500	14 48	4.60	194	309	487	13 59	69 6	3.68	182	152	07C	11 98	12 58	4 90		
584	5/13/93.0930	220	373	496	14.31	4.70	191	484	490	13 54	9 65	3.65	180	188	380	11 93	12 57	4 95		
585	5/14/93.0035	210	61	350	12 17	7.20	194	19	328	11 64	8.45	5.98	164	46	217	10.21	11.67	7.05		
585	5/14/93:0230	210	61	350	12.17	7.20	202	8	335	11 60	8 47	5.85	170	62	219	10.37	11.67	6.95		
586	5/14/93.0310	210	61	350	12.17	7.20	199	25	325	11 46	8 33	6.15	165	63	186	1046	11.99	6.75		
586	5/14/93:0420	210	61	350	12 17	7.20	199	39	32b	11.98	8.62	5.60	181	38	172	10.37	11.77	2 00		
586	5/14/93.0545	210	61	350	12 17	7 20	20	88	322	11 82	8 46	5.80	159	164	2	10 40	16 11	6.80		
586	5/14/93 0705	210	61	350	12 17	7.20	201	54	309	11 24	8 17	6.60	173	62	179	10 08	11.56	7 25	O2 changd	

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CC Arapahoe Unit 4 Calcium/Humidification-C
SCC Arapahoe Unit 4 Calcium/Humidification-C

-		Bolle	_	Sorber	it Fee	-	Injecto	r cat ∆	SO2 Re	n Hun	idifical	lion.			Bag	l esuor	Temps		ШШ	d catc	
Test	Date & Time	Load	02cr	Loc	A.w	B.e	Flow	Ca/S•C	omp Ct	ic Ai	- Tg	20	M H2C	A W	Grid	ort O	IDin O	psis Ta	Tcalc	H208	
		MWe	*wet		. t	*	D/min			4 sch	n L	ب	шdб		ų.	ų	ų	ų.	ŗ	Ma:	
587	2060 66/81/5	108	3 60	Econ	0	0	00	800	0	-	İ						Ň	69			
587	6/18/93 1018	108	3 60	Econ	100	0	191	0 87	4	7	28	ŝ	•		275	263			201		
587	5/18/93 1039	108	3 60	Econ	100	0	19 1	0 87	ଞ	4											
587	5/18/93.1046	108	3 60	Econ	100	0	191	0 87	~	-											
587	5/18/93:1055	108	3 60	Econ	100	0	19 1	0 87	0-	1											
587	5/18/93-1105	108	3.60	Econ	00	0	19.1	0.87	ج .	2											
587	5/18/93:1115	108	3 60	Econ	<u>10</u>	0	19 1	0 87	-	Ś											
587	5/16/93 1123	108	3 60	Econ	00	0	191	0.87	.	5											
587	5/18/93 1135	108	3 60	Econ	100	0	191	0.87	4	6	28	52	•				Ň	19	285		
587	5/18/93-1150	108	3 60	Econ	100	0	161	0 87	-	6											
587	5/18/93 1214	108	3 60	Econ	0	0	00	80	N	6							Ñ	81			
587	5/18/93.1214	108	3 60	Econ	0	0	00	000	-	S											
588	5/19/93 0943	100	4 00	Econ	0	0	00	80	Ŧ	8	27.	- 64			269	256	Ñ	64	274		
588	5/19/93 1043	100	395 E	Econ	82	0	15.6	0 80	4	8	27:	ي تو			271	257	Ñ	66	275		
588	5/19/93 1053	100	3 95	Econ	82	0	15 6	0 80	a	8											
588	5/19/93 1100	100	3 95	Econ	82	0	15 6	0 80	₽E.	-											
588	8011 66/61/5	100	3 95	Econ	82	0	156	0 80	-	6											
589	1011 66/61/5	100	385	Econ	Ŧ	0	7.8	0 40	2)	7	27	20	,0		272	259			277		
583	5/19/93 1155	100	18 C	Econ	Ŧ	0	78	0 40	e								0	20			
589	5/19/93 1206	100	18 E	Econ	Ţ	0	78	040	N	9											
590	5/19/93 1239	100	4 04	Econ	25	0	4	0 24	5	7	28(ĕ			274	262			280		
591	5/19/93 1620	8	4 32	Econ	0	0	0 0	80	Ģ	N	27	3 -	•		268	259	Ñ	67	271		
591	5/19/93-1745	8	4 33	Econ	75	75	28 B	1 70	Ξ	0	27	ğ	~		270	258			274		
591	5/19/93.1756	8	4.33	Econ	75	75	28.8	1.70	96	1											
591	5/19/93-1805	6	4 33	Econ	22	75	28 8	1.70	4	9											
591	5/19/93 1814	8	4 33	Econ	75	75	28.8	1.70	0	60											
591	5/19/93.1826	8	4 33	Econ	75	75	288	1.70	36	7											
591	5/19/93 1837	06	4 33	Econ	75	75	288	1.70	0	0											
591	5/19/93:1845	8	4.33	Econ	75	75	28 8	1.70	ŝ	4											
591	5/19/93:1854	8	4.33	Econ	75	75	28 B	1.70	1	6											
591	5/19/93 1905	8	4 33	Econ	75	75	28 8	1.70	Q .	•											
591	5/19/93 2001	8	4 33	Бсод	0	0	00	000		-		1			ľ				600		
592	5/20/93.0905	110	3 60	L CO L	0	0	00	00.0	0 '		R C				274	202	ſ	92	202		
592	5/20/93.1056	110	3 60	Econ	0	0	0 0 ¹	00.0	÷ (- 44C		5 				602	N	2			
592	5/20/93 1212		3 60		3	.	2		- 5			ö									
592	5/20/93 1221	10	3 60		8 8	0	22		ň	0,0											
592	5/20/93 1230	2	3 60		3	5 (2 2 2		.												
592	5/20/93 1247	110	3 60	Econ	5	0	2 / 1	200	7	_											
592	5/20/93.1255	110	3 60	Econ	8	0	17 2	0 81	2	0	1	i							• 00		
592	5/20/93:1303	<u>5</u>	3.60	Econ	8	0	17.2	0 81	Ŧ_	•	52	-	5								
592	5/20/93:1320	110	3.60	Econ	8	0	17 2	0.81	<u>a</u> _	80											
592	5/20/93:1329	110	3.60	Econ	8	0	17.2	0.81	Ţ	•											
592	5/20/93:1337	110	3.60	Econ	8	0	17 2	0.61		_											
592	5/20/93:1412	110	3 60	Econ	0	0	00	80		1.6							•				
593	5/21/93.0047	70	5 30	Econ	0	0	00	80	0	S,	22	<u>ہ</u>			252	243	N	ç			
6 65	5/21/93.0118	20	5 30	Econ	73	73	28.1	1 66	~	Ś	â	Ś									

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		GAS AN	IAL E	CON-D	RY (1-12	2	GAS AI	VALY	SIS IN	LET-WI	it		GAS AN	IALY	SIS OI	JTLET-V	VET	•	
Test	Date & Time	0N N	8	S02	C02	02	0 N	8	S02	C02	H2O	8	02 V	8	S02	C02	H2O	ő	Comments
		mdd	mdd	ppm	; *	Ydry	ррт	Edd	E d	*	*	*	Edd	E	E E	*	*	*	
587	2/18/93.0907	278	138	420	14 26	4.90	278	138	420	14 26	000	4 90	242	152	365	12.32	8.99	5 10	No Sorbent
587	5/18/93 1018	278	138	420	14 26	8	278	138	420	14 26	00 0	4 90	288	155	388	13 84	80	5 40	EE 1-12
587	5/18/93 1039	278	138	420	14 26	4 90	278	138	420	14 26	00 0	4 90	248	200	247	11 81	800	7 40	EE 1,2
587	5/18/93 1046	278	138	420	14 26	4 90	278	138	420	14 26	000	4 90	318	69	411	14 34	000	4 90	EE 3.4
587	5/18/93 1055	278	138	420	14 26	4 90	278	138	420	14 26	00 0	4 90	298	75	430	14 89	0.0	4 40	EE 5,6
587	2/18/93 1105	278	138	420	14 26	4 90	278	138	420	14 26	00 0	4 90	290	310	475	16 17	800	3 00	EE 7.8
587	5/18/93 1115	278	138	420	14 26	4 90	278	138	420	14 26	000	4 90	313	66	410	14 34	000	5 05	EE 9,10
587	5/18/93 1123	278	138	420	14 26	4 90	278	138	420	14 26	000	4 90	270	1	330	11 50	80	810	EE 11,12
587	5/18/93 1135	278	138	420	14 26	4 90	278	138	420	14 26	000	4 90	293	125	380	13 93	80	5 35	EE 1-12
587	5/18/93 1150	278	961	420	14 26	490	278	138	420	14 26	000	4 90	246	125	345	12 16	8 80	5 25	Aftech Out
587	5/18/93 1214	278	138	420	14 26	4 90	278	138	420	14 26	00 0	4 90	298	142	395	13 86	000	5 40	Base Drift
587	5/18/93 1214	288	142	395	13 86	5 40	268	142	395	13 86	000	5 40	249	120	355	12 01	8 54	5 40	No Sorbent
588	5/19/93 0943	261	69	392	13 14	5 30	261	69	392	13 14	800	5 30	223	65	360	11 65	B 75	5 00	No Sorbent
588	5/19/93 1043	261	69	392	13.14	5 30	261	69	392	13 14	000	5 30	255	43	378	13 34	800	5 10	EE 1-12
588	5/19/93 1053	261	69	392	13 14	5 30	261	69	392	13.14	000	5 30	210	48	342	11 73	881	4.91	Allech Out
588	5/19/93-1100	261	69	392	13 14	5 30	261	69	392	13 14	0000	5 30	219	50	214	10 76	800	800	EE 1.2
588	5/19/93 1108	261	69	392	10 14	5 30	261	69	392	13 14	000	5 30	288	24	415	14 22	000	4 05	EE 3,4
583	2/19/93 1137	261	69	392	13 14	5 30	261	69	392	13 14	000	5 30	228	34	240	10.99	000	7 70	EE 1.2
	5/19/93 1155	261	69	392	13 14	5 30	261	69	392	13.14	00 0	5 30	246	57	390	13 50	800	4 85	EE 1-12
283	5/10/01 120P	261	5	CDE	13 14	5 30	261	69	392	13 14	0000	5 30	205	53	341	11 66	873	5.15	Altech Out
200	5/19/01 1239	261	59	266	13 14	5 30	261	69	392	13 14	000	5 30	235	35	283	11 15	00 0	7 55	EE 1,2
102	5/19/91 16/0	222	26	385	13 42	96 4	222	56	385	13 42	00 0	4 95	187	49	341	67 11	884	4 95	No Sorbent
5	5/19/93 1745	222	26	385	13 42	4 95	222	56	385	13.42	00 0	4 95	217	8	06E	12 87	000	5 55	EE 1-12
5	5/19/93-1756	222	56	385	13 42	4.95	222	56	385	13 42	00 0	4 95	206	15	205	10 84	0.0	7 70	EE 1,2
501	5/19/93-1805	222	99	385	13 42	4.95	222	56	385	13 42	0000	4 95	246	<u>1</u>	381	13 92	000	4 35	EE 3.4
5	5/19/91 1814	200	99	385	13 42	4 95	222	56	385	13 42	0000	4 95	225	38	402	14 05	000	4 10	EE 9, 10
	SUIDIO 1826	222	3	385	13 42	1 95	222	292	385	13 42	000	4 95	170	25	196	10 30	00 0	8 10	EE 11,12
	5/10/03-1897	222	3 4	385	11.42	4 95	222	26	385	13.42	800	4 95	224	30	422	14 84	0.00	3 40	EE 7.8
5	5/10/03-1845		3 4	385	13.42	195	222	95	385	13.42	0000	4 95	229	5 8	378	13 45	000	4 85	EE 5,6
201	5/19/93-1854	222	26	385	13 42	4.95	222	56	385	13 42	00.0	4.95	215	35	330	13 20	000	5 20	EE 1-12
165	5/19/93 1905	222	26	385	13 42	4.95	222	56	385	13 42	800	4.95	188	25	303	11 45	8 85	5 05	Altech Out
591	5/19/93.2001	222	56	385	13.42	4.95	222	9 2	385	13.42	800	4.95	221	27	370	13 08	000	5.40	Base Drift
592	5/20/93.0905	249	38	392	14 02	4.55	249	38	392	14.02	000	4 55	214	38	348	12.04	9.30	4.45	No Sorbent
592	5/20/93:1056	243	28	405	13 85	4 55	243	28	405	13 85	000	4.55	208	21	359	11 93	9 23	4 70	No Sorbent
592	5/20/93:1212	243	28	405	13 85	4.55	243	28	405	13 85	000	4 55	244	54	400	13 80	000	4 65	EE 1-12
592	5/20/93 1221	243	28	405	13 85	4 55	243	28	405	13 85	0.0	4.55	233	3	214	10.78	000	7.90	EE 1,2
592	5/20/93-1230	243	28	405	13 85	4 55	243	28	405	13 85	000	4 55	272	79	435	14 19	000	4 05	EE 3,4
592	5/20/93 1247	243	28	405	13 85	4 55	243	28	405	13 85	000	4 55	275	59	430	14 47	000	4 15	3,4,HiPres
592	5/20/93 1255	243	28	405	13 85	4 55	243	28	405	13 85	00 0	4 55	220	83	240	10 89	800	7 65	1,2,11iPres
592	5/20/93 1303	243	28	405	13 85	4 55	243	28	405	13 85	000	4 55	237	97	428	13 99	000	4 35	1-12,Hi P
592	5/20/93 1320	243	28	405	13.85	4 55	243	28	405	13.85	800	4 55	229	120	240	1 80 11	80	7 50	EE 1.2
592	5/20/93 1329	243	28	405	13 85	4.55	243	28	405	13 85	80	4.55	273	144	442	14.45	800	3 80	EE 3,4
592	5/20/93.1337	243	28	405	13 85	4.55	243	28	405	13.85	80	4.55	249	11	427	13.66	800	4.80	EE 1-12
65	5/20/93-1412	243	58	405	13 85	4.55	243	28	405	13 85	000	4 55	256	57	445	13.53	000	4 80	BaseDrift
593	5/21/93:0047	217	13	430	11 96	6.75	217	13	430	11.96	0.00	6.75	184	8	380	10.41	8.32	6 60	No Sorbent
593	5/21/93 0118	217	. 61	430	11 96	6.75	217	13	430	11 96	000	6.75	217	2	392	11.74	000	6 95	EE 1-12

PSCC Arapahue Unit

PSCC Arapahoe Unit 4 Catchum/Humidification-Duct Injection, Ca(OH)2 calculations pased upon 68% CaO

5		Boile	_	Sorber	I Fee	; •	Injecto	or cal	AS02	Red	Humidifi	cation)) 1	lodga	ise Te	mps		Tutt	id calc	
Test	Date & Time	Load	02cr	Loc.	A.W	B.e	Flow	Cars.	Comp	Calc	Air	Igo	Twl	H2O	A.W.	Srid (Dut II)in Op	sis Tâ	L Tcal	: H20e	
		MWe	"wel			*	b/min		*	24	sdm	ų.	Ļ	mag	•	÷	ų	÷	ų.	بد	₩%	
593	5/21/93 0126	2	5 30	Econ	73	73	28.1	1.66		251	Ì											
593	5/21/93 0138	20	5 30	Econ	23	23	28 1	1 66		- 0												
665	5/21/93 0144	2	5 30	Econ	23	23	28 1	1 66		30.7												
593	5/21/93.0157	20	5 30	Econ	23	73	28 1	1 66		0.2												
593	5/21/93 0210	20	5 30	Econ	73	23	28.1	1 66		06								2	80			
2 63	5/21/93 0221	2	5 30	Econ	2	5	28 1	1.66		40												
593	5/21/93 0301	20	5 30	Econ	23	23	28 1	1 66		113								24	61			
593	5/21/93 0308	70	5 30	Econ	23	73	28 1	1 66		10 0												
593	5/21/93 0316	70	5 30	Econ	23	73	28 1	1 66	•••	38 6												
593	5/21/93 0324	20	5 30	Econ	73	73	281	1 66		112												
593	5/21/93 0430	70	5 30	Econ	73	73	281	1 66		13.5		59								259		
£63	5/21/93 0436	20	5 30	Econ	73	23	281	1 66	•	112												
593	5/21/93 0535	70	5 30	Econ	0	0	00	00 0		35								25	0			
594	6/8/93:1000	113	4 00	Econ	0	0	00	00 0		-15		63						21	с	283		
594	6/8/93:1056	113	4 00	Econ	80	80	308	174		63	~	85			N	79 2	63			285		
594	6011 66/8/9	113	4 00	Econ	80	8	30 8	1.74		285								27	8			
594	6/8/93.1119	E11	4 00	Econ	80	80	30 B	174		00								27	8			
594	6/8/93.1130	113	4 00	Econ	80	80	30 B	1 74	·	27												
594	6/8/93.1138	113	4 00	Econ	90	8	308	1 74	••	24 0												
594	6/8/93 1147	113	4 00	Econ	80	80	308	174		63								27	6			
594	6/8/93 1157	113	4 00	Econ	80	80	30.8	1.74		64								27	6			
594	6/8/93.1456	113	4 00	Econ	80	80	30 B	1.74		54	3719 2	94	52	80 0	55 1	60 1	70	17	8 43	163		
594	6/8/93.1536	113	4 8	Econ	80	80	30 B	1 74		05								ส	6			
594	6/8/93:1551	113	4 00	Econ	80	80	30.8	1 74	•	¥ 6.								25	0			
594	6/8/93:1551	113	4 00	Econ	0	0	00	80	·	12												
595	6/9/93 0731	80	5 12	Econ	0	0	00	80		07	~	60			~	57 2	6 6	25	0	260		
595	6/9/93 08 18	80	5 12	Econ	60	60	23 1	1 67	.,	906	0	64								264		
595	6/9/93 0827	80	5 12	Econ	60	60	23 1	1 67		16												
595	6/9/93 0835	80	5 12	Econ	80	60	231	1 67	•	9 9												
595	6/9/93 0848	60	5 12	Econ	60	60	23 1	1 67		ŝ												
595	6/9/93 0900	80	5 12	Econ	20	60	23.1	1 67	-	505								52	S			
595	6/9/93.0917	80	5 12	Econ	80	60	23 1	167		83								52	S			
596	6/9/93:1350	80	5 11	Econ	0	0	0.0	80	•	90	CN4	11	93		~	73 2	56	56	2	277		
596	6/9/93-1437	80	5 11	Econ	60	8	23.1	1.70		7.5	N	78	57					26	8	278		
596	6/9/93.1455	80	5 11	Econ	80	8	23 1	1.70		62								26	8			
596	6/9/93:1542	80	5 11	Econ	80	80	23 1	1.70	-	103	3657 2	81	5	600	1 69	46 2	5	8	30	139		
596	6/9/93:1625	80	5 11	Econ	60	80	23.1	1 70	-	03	3857		40	600	69	46 1	69	17	30			
596	6/9/93:1656	60	5 11	Econ	60	80	23.1	1.70		57								20	6			
596	6/9/93.1715	80	5.11	Econ	0	0	0.0	800		06												
597	5/10/93:1053	80	4 58 1	con.	0	0	00	80			~	68	2		N	65 2	55			268		
597	6/10/93-1247	80	4 58 1	con.	8	8	23.1	1.67		<u>[</u>]	~	2	35		2	67 2	23			271		
597	6/10/93:1259	80	4 58 1	con•	80	60	23.1	1.67		12 6												
597	6/10/93:1306	80	4 58 1	con•	3	8	23.1	167		13												
597	5/10/93 1315	80	4581	con*	60	80	23.1	1.67		07												
597	610163 1316	80	4581	con'	60	60	231	167		34												
597	6/10/93 1328	80	458	con.	60	60	23 1	1 67	()	19												

PSCC Arapahoe Unit

	-	GAS AN	ALE		RY (1-12	2	GAS A	HALY:	NI SIS	LET-WI	····· 1:		GAS A	AALY	SIS O	JTLET-	NET	:		
Tesl	Date & Time	QN	8	S02	C02	02	2	8	S02	C02	H2O	8	Ŷ	8	S02	C02	H2O	8	Comments	
		mdd	ppm	ppm	3 4	Xdry	рра	Edd	bou	, t	1	*	Шdd	ШQ	툂	з я	×	×		
593	5/21/93.0126	217	2	430	11 96	6.75	217	13	430	96 t t	00 0	6.75	185	32	296	10.98	0.0	7.90	EE 1.2	
593	5/21/93.0138	217	2	430	11 96	6.75	217	13	430	11 96	800	6 75	228	14	458	12 72	80	5.80	EE 3,4	
593	5/21/93 0144	217	13	430	11.96	6 75	217	2	430	11 96	800	6 75	170	6	209	8.37	00.0	108	EE 11,12	
593	5/21/93.0157	217	13	430	11.96	6.75	217	2	130	11 96	80	6.75	227	თ	438	12.24	0.0	6.45	EE 9, 10	
593	5/21/93.0210	217	13	430	11.96	6.75	217	2	64	11.96	800	6.75	214	16	307	11.73	<u>8</u> 0	6 90	EE 1-12	
593	5/21/93:0221	217	13	430	11.96	6.75	217	13	130	11 96	0.00	6 75	185	5	350	10.38	8.26	6.60	Altech Out	
593	5/21/93.0301	217	13	430	11 96	6 75	217	3	430	11 96	800	6.75	213	-	380	11.84	0.0	6 80	EE 1-12	
593	5/21/93.0308	217	13	430	11.96	6 75	217	13	130	11 96	000	6 75	182	Ξ	346	10 42	8 33	6 51	Altech Out	
593	5/21/93 0316	217	13	430	11 96	6 75	217	8	430	11 96	00 0	6 75	186	25	250	11 11	800	7 50	EE 1.2	
593	5/21/93 0324	217	13	430	11 96	6 75	217	2	430	11 96	00 0	6 75	165	6	181	841	800	10 80	EE 11,12	
663	5/21/93 0430	217	13	430	11 96	6 75	217	61	430	11 96	00 0	6 75	207	26	380	11 97	80	6 45	EE 1-12	
593	5/21/93 0436	217	13	430	11 96	6 75	217	13	430	11 96	000	6 75	177	21	347	10 62	8 36	6 30	Altech Out	
593	5/21/93 0535	217	13	430	11 96	6 75	217	5	430	11 96	000	6 75	207	42	415	11 74	00 0	6 75	BaseDull	
594	6/8/93:1000	272	200	315	12 93	5 30	272	200	315	12 93	00 0	\$ 30	253	130	285	11 26	8 14	5 30	No Solbent	
594	6/8/93 1056	272	200	315	12 93	5 30	272	200	315	12 93	00 0	5 30	263	160	298	13 29	80	5 15	EE 1-12	
594	6/8/93.1109	272	200	315	12 93	5 30	272	200	315	12 93	0 00	5.30	238	375	190	10 30	80	7.75	EE 1,2	
594	6/8/93.1119	272	200	315	12 93	5 30	272	200	31S	12 93	00 0	5 30	309	150	335	13 61	800	4 30	EE 3.4	
594	6/8/93:1130	272	200	315	12 93	5 30	272	200	315	12 93	00 0	5.30	273	19	345	13 83	000	4 25	EE 9, 10	
594	6/8/93 1138	272	200	315	12 93	5 30	272	200	315	12 93	000	5 30	210	20	225	11 72	80	6 25	EE 11,12	
594	6/8/93 1147	272	200	315	12 93	S 30	272	200	315	12 93	00 0	5 30	261	100	299	13 09	800	5 10	EE 1-12	
EQ.	6/8/93-1157	010		315	12 93	5 30	272	200	315	12 93	00 0	5 30	229	100	280	11 82	B 44	4 65	Allech Out	
	6.0.00 1468	573		315	19 69	5 30	270	000	315	12 93	000	5 30	212	69	260	11 27	12 40	4 70	Altech Out	
	0/0/33-1400	272			15 03 15 03		010		22	12 63	88		2.15	3 5		11 87	8 42	02.7	Attach Out	
594	0/8/93:1530	212		212	52.21	2	212		2	16.35	3 8	200					2 8	2 9	Data Prit	
594	6/8/93:1551	272	200	315	12.93	5.30	272	2002	315	12 93	000	8	967	ŝ	055	13.14	8 i	2.6		
594	6/8/93:1551	258	85	330	13.14	5 10	258	85	330	13 14	80	5 10	231	74	305	12.03	8.47	2	No Sorbent	
595	6/9/93 0731	213	23	325	12 24	6.10	213	23	325	12 24	80	6.10	189	18	289	10 92	8.16	5.95	No Solbent	
595	6/9/93 0818	213	23	325	12 24	6.10	213	23	325	12 24	000	6 10	199	25	193	10 07	8	8.25	EE 1.2	
595	6/9/93 0827	213	23	325	12 24	6.10	213	23	325	12 24	000	6 10	240	17	339	13 12	80	5 20	EE 3,4	
595	6/9/93 0835	213	23	325	12 24	6 10	213	23	325	12 24	0000	5.10	212	52	344	13,17	0.0	5 30	EE 9, 10	
595	6/9/93.0848	213	23	325	12 24	6.10	213	23	325	12 24	0000	6.10	146	59	210	11 05	80	7 35	EE 11,12	
595	0060.66/6/9	213	23	325	12 24	6.10	213	23	325	12 24	800	6 10	209	27	290	12 21	80	6.15	EE 1-12	
595	6/9/93 0917	213	23	325	12 24	6 10	213	23	325	12 24	00 0	6 10	185	23	270	11 09	8 11	5 80	Altech Out	
596	6/9/93.1350	217	25	320	12.16	6.10	217	25	320	12.16	00 00	6.10	195	19	290	10 95	7.98	5 90	No Sorbent	
596	6/9/93:1437	217	25	320	12 16	6 10	217	25	320	12.16	000	6.10	214	52	209	12 00	0.0	6 45	EE 1-12	
596	6/9/93.1455	217	25	320	12.16	6 10	217	25	320	12 16	80	6 10	195	20	270	10 98	8 07	2 90	Attech Out	
596	6/9/93 1542	217	25	320	12 16	6.10	217	25	320	12.16	800	6.10	181	15	240	10 25	12 37	5 95	Altech Out	
596	6/9/93.1625	217	25	320	12.16	6.10	217	25	320	12 16	0000	6.10	181	16	240	10 28	12 44	5 93	Altech Out	
596	6/9/93.1656	217	25	320	12.16	6 10	217	25	320	12.16	800	6.10	161	18	273	11 11	8.19	5 80	Allech Out	
596	6/9/93:1715	217	25	320	12.16	6.10	217	25	320	12.16	800	6.10	194	19	290	11 19	8.17	5.70	Base Drift	
597	6/10/93:1053	230	175	328	12.62	8.00	230	175	328	12 62	80	8.9	211	110	290	11.14	7.89	5 90	No Sorbent	
597	6/10/93:1247	230	175	328	12.62	89	230	175	326	12.62	800	<u>8</u> .9	191	593	240	12.35	80	6.15	EE 1.2	
597	6/10/93:1259	230	175	328	12.62	8 .00	230	175	328	12.62	8.0	8 .8	241	300	321	14.49	800	4.20	EE 3.4	
597	6/10/93:1306	230	175	328	12.62	6 .00	230	175	328	12.62	0.0	6.00	246	8	342	13.48	8.0	5.15	EE 5,6	
597	6/10/93:1315	230	175	328	12.62	8 .00	230	175	328	12.62	8.0	6.00	253	E	360	14.04	0.00	4.65	EE 7.8	
597	6/10/93:1319	230	175	328	12.62	6.00	230	175	328	12.62	00.0	6.00	247	20	320	12.71	0.0	5.85	EE 9.10	
597	6/10/93:1328	230	175	328	12 62	<u>6</u> .00	230	175	328	12 62	800	6.0	190	16	165	9 24	800	9 20	EE 11,12	

PSCC Arapahoe Unit 4 Calcium/Humidification-Duct Injection, Ca(OH)2 calculations based upon 68%. CaO

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		Buile	ĩ	Sarbe	ant F	bed	Inject	or cal	ASO2	Red	Humidi	ficatio	~			Jaghor	iise Té	sdme		Ŧ	umid c	alc
lest	ปลเม & Time	Load	1 02cr	Loc	A.V	v B.e	Flow	Cars.	Comp	Calc	Aır	1go	Twl	1120	Ŵ	Grid (= Inc	Din O	psis	Ta To	alc H	20e
		MWe	".wel			*	hm/d		•••		schin	ш	ų.	шuб		-	J.	ų	ų	Ŀ	بدا	M
597	6/10/93 1335	8	4 58	Econ.	99	60	23.1	1 67		216												
597	6/10/93 1343	80	4 58	Econ.	8	60	23 1	1 67		31.3												
597	6/10/93 1349	80	4 58	Econ•	<u>0</u> 9	60	231	1 67		2 61								~	64			
597	6/10/93 1355	80	4 58	Econ	60	80	231	1 67		13 5								N	64			
597	6/10/93 1403	80	4 58	Econ*	80	60	23 1	1 67		11 3		275	17							5	75	
597	6/10/93 1412	80	4 58	Econ.	60	60	231	1 67		12 6												
597	6/10/93 1533	80	4 58	Econ.	60	60	23 1	1 67		16.2	3825	281	62	58.0 0	99	142 1	06	-	91	90	14	
597	6/10/93 1625	80	4 58	Econ	60	60	231	1 67		177	3838	282	63	5700	20	142 1	66	-	64	6 13	17	
597	6/10/93 1720	80	4 58	Econ•	60	60	231	1 67		18.0	3838	282	63	5700	02.0	142 1	56	-	56 2	6 13	17	
597	6/10/93 1751	80	4 58	Econ.	0	0	00	0000		52												
597	6/10/93 1751	80	4 58	Econ.	0	0	00	000		5 F												
598	6/11/93 0741	80	5 14	Econ*	0	0	00	000		17		262	67		. •	58 2	115	2	48	26	52	
598	6/11/93 0838	80	514	Econ.	8	60	23 1	1 70		92		264	68					2	52	26	4	
598	6/11/93 0849	80	5 14	Econ.	60	60	231	1 70		33 S								N	52			
598	6/11/93 0857	80	5 14	Econ	9	60	231	1 70		17.4								N	54			
598	9060 66/11/9	80	5 14	Econ.	60	60	23 1	1 70		06								2	54			
598	511/93 0912	00	5 14	Econ*	99	60	231	1 70		0 5								N	55			
598	6111/93 0919	80	5 14	Econ*	60	60	231	1 70		05								2	55			
598	6/11/93 0929	90	5 14	Econ.	09	99	231	02 1		30.7												
598	6/11/93 0934	80	514	Econ.	99	60	231	1 70		10.7												
598	6/11/93 0942	80	5 14	Econ*	80	60	23 1	1 70		11.7		269	ß					2	56	26	60	
598	6/11/93 0957	90	5 14	Econ'	D	0	00	00 0		46								2	57			

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PSCC Arapatioe Unit

	GAS AI	NAL E	CON-DI	RY (1-12	с С	BAS ANA	יראצו	S INL	ET-WE	1	Ŭ	GAS AN	ALY	SIS OL	JTLET-V	VET		
Date & Time	01	3	S 02	C 02	02	0N ON	8	502	C02	H20	02	QV	8	SU2	C02	H2O	05	Comments
	աժմ	шdd	Шdd	÷6	۰, dry	ртр	Ē	шdd	•°	je.	*	mqq	шdd	шdd	j.º	¥,	*	
6/10/93 1335	230	175	328	12 62	8	230 1	75	328	12 62	0 00	6 00	190	225	240	11 22	00 0	7 00	EE 1
6/10/93 1343	230	175	328	12 62	6 00	230 1	75	328	12 62	80	6 00	179	860	239	12 81	000	5 10	EE 2
6/10/93 1349	230	175	328	12 62	6 00 6	230 1	75	328	12 62	00 0	6 00	248	190	303	14 24	00 0	3 85	EE 3
6/10/93 1355	230	175	328	12 62	6 00	230 1	75	328	12 62	00 0	6 00	249	35	299	13 10	800	5 20	EE 4
6/10/93 1403	230	175	328	12 62	6 00	230 1	75	328	12 62	000	6 00	222	250	294	12 61	000	5 85	EE 1-12
6/10/93 1412	230	175	328	12 62	6 00	230 1	75	328	12 62	000	6 00	196	225	265	11 44	8 27	5.40	Altech Out
6/10/93 1533	230	175	328	12 62	6 00	230 1	75	328	12 62	00 0	6 00	180	200	230	10 38	12 36	5 85	Altech Out
6/10/93 1625	230	175	328	12 62	6 00	230 1	75	328	12 62	00 0	6 00	174	200	228	10 49	12 73	5 65	Altech Out
6/10/93 1720	230	175	328	12 62	6 00	230 1	75	328	12 62	00 00	6 00	175	150	228	10 55	12 77	5 60	Altech Out
6/10/93 1751	230	175	328	12 62	6 00	230 1	75	328	12 62	00 00	6 00	211	265	310	12 25	00 0	6 05	Base Drift
6/10/93 1751	211	265	310	12 25	6 05	211 2	65	310	12 25	00 0	6 05	190	210	284	11 13	8 37	5 75	Altech Out
 6/11/93 0741	240	62	325	12 66	5 80	240	22	325	12 66	00 0	5 80	211	53	290	11 29	861	5 40	No Sorbent
 6/11/93 0838	240	62	325	12 66	5 80	240	22	325	12 66	00 0	5 80	230	75	295	12 70	00 0	5 80	EE 1-12
6/11/93 0849	240	62	325	12 66	5 80	240	2	325	12 66	000	5 80	217	8	155	8 25	000	10 10	EE 1,2
 6/11/93 0857	240	62	325	12 66	5 80	240	3	325	12 66	800	5.80	261	23	248	11 45	000	6.95	EE 3.4
 6/11/93 0906	240	62	325	12 66	5 80	240	22	325	12 66	00 0	5 80	270	21	339	13 40	00.0	5 05	EE 5.6
 6/11/93 0912	240	62	325	12 66	5 80	240	8	325	12 66	00 0	5 80	254	ee	360	14 36	000	4 25	EE 7,8
 6/11/93 0919	240	62	325	12 66	5 80	240	23	325	12 66	000	5 80	207	154	383	15 38	00 0	3 00	EE 9, 10
 6/11/93 0929	240	62	325	12 66	5 80	240	22	325	12 66	00 0	5 80	172	56	220	12 26	00 0	6 15	EE 11,12
6/11/93 0934	240	62	325	12 66	5 80	240	с С	325	12 66	00 0	5 80	200	57	262	11 25	8 50	5 50	Altech Out
6/11/93 0942	240	62	325	12 66	5 80	240	ŝ	325	12 66	00 0	5 80	225	120	287	12 49	00 0	5 80	EE 1-12
2560 66/11/9	240	62	325	12 66	5 80	240	2	325	12 66	00 0	5 80	241	36	304	12 26	00 0	6 10	Base Drift

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Test	Date & Time	Load	02cr	Loc	۸	, B.e	Elo.	w Ca/S	-Cor	Ip Calc	Aır	Tgo	Ιwί	HZC	A'N	Grid	0 M	Ω	Opsis	Ţa	Tcalc	H2Oe
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599	6/15/93 0750	80	5 70	Duct	0	•	0					266							256	ļ	266	
599	6/15/93 0915	80	5 70	Duct	35	0	6	•	თ	36	3854	271	63	540	0 73	150	196		196	8	148	8 80
565	6/15/93 1100	80	6 20	Duct	35	0	9	04	=	17	3797	280	64	59 0	0 66	147	160		160	õ	145	8 11
665 5	6/15/93 1300	80	6 10	Duct	35	0 ;	6	0 0 0	₽;	23	3795	284	5	000	0 65	148	154		155	88	150	7 63
600	6/16/93 0840	5	88		5 :	2 8	8 7		N 8	9/1 9/1	3666	202	4 4 4		180	14(192 921		961		152	8 4 2 9 4 6
600	0011 66/91/9		8 8		25	14	5 6	199	2 2	215	3845	E75	6 9	200	6/ 0	147	157		155	2	155	8 83
600	6/16/93 1500	3 8	2005	Duct	2 2	59	592	9 1 82	3 8	22 6	3855	272	33	510	62 0	147	156		155	; 8	156	956 956
600	6/16/93 1800	80	5 00	Duct	67	66	52	5 1 82	8	26.8	3840	272	65	510	62 0	147	154			8	156	8 75
601	6/17/93 0800	80	5 30	Duct	60	0	=	1 0 87	7	10.2	3976	252	63	410	1 03	154	211		201	8	161	9 03
601	6/17/93 0900	81	5 20	Duct	60	0	Ē	0 85	16	12 4	3954	253	63	430	0 97	147	170		167	8	158	105
601	6/17/93 1100	81	5 20	Duct	60	0	-	0 86	20	136	3946	256	63	43 0	0 96	147	159		156	8	161	8.81
601	6/17/93 1300	81	5 20	Duct	60	0	11 4	0.84	17	12 0	3958	257	64	43 0	0 97	147	158		156	8	162	888
601	6/17/93 1500	81	5 10	Duct	8	0	1	1 0 84	17	13 1	3635	257	63	44 0	0 94	148	157		156	90	160	8.93
601	6/17/93 1550	81	5 20	Duct	80	0	1	1 0 85	17	12 9	3951	257	63	430	0 96	146	157		156	80	162	8 97
602	6/21/93 0900	80	5 10	Duct	36	0	69	0 38	₽	4	3880	262	63	45 0	0 88	1-19	203		198	õ	163	8 60
602	6/21/93 1100	8	5 20	Duct	38	0	7 2	0 38	2	4 2	3871	264	64	480	084	147	166		162	ĝ	160	8 57
602	6/21/93 1300	8 0	5 20	Duct	40	0	76	040	2	36	3872	269	62	49 0	0 84	147	161		158	90	161	831
603	6/22/93 0925	96	4 10	Duct	85	85	32	159	21	6 ZZ	3827	274	63	56 0	0 70	149	203		196	8	162	8 98
603	6/22/93 1114	95	4 20	Duct	92	92	35 .	1 1 97	24	187	3781	280	63	0 65	0 66	150	161		162	8	160	842
603	6/22/93 1300	95	4 20	Duct	80	8	ŝ	161 6	27	182	3760	283	64	60 0	0 64	147	156		157	ß	161	B 08
603	6/22/93 1500	95	4 20	Duct	72	73	27	9 1 64	26	202	3791	282	65	57 0	0 68	147	160		161	90	16a	67 B
603	6/22/93 1650	95	4 10	Ducl	72	73	27	9 1 69	90	24 0	3785	284	64	59 0	0 67	147	162		163	8	164	8 92
604	6/22/93 1850	81	5 50	Duct	63	63	24	12 - 2	ង	16 8	3843	275	64	53 0	0 77	143	158		157	8	151	861
604	6/22/93 2100	80	5 65	Duct	62	62	23	9 1 79	25	18.8	3866	268	64	49 0	0 85	147	157		157	8	153	9 26
604	6/22/93 2320	50	7 50	Duct	42	42	10	1 75	26	22 2	4070	248	64	34 0	1 35	145	153		152	8	156	6 98
604	6/23/93 0100	59	6 90	Duct	42	42	9	1 1 53	25	23 B	4024	248	64	36 0	1 27	146	151		150	8	159	7 32
605	6/28/93 1110	106	4 90	Duct	70	2	27 (2.00	ส	12.8	3681	286	65	65 0	0 58	146	193	187		8	172	6 6 3
605	6/28/93 1240	106	4 80	Duct	61	62	23	2 2	t	12.7	3738	290	65	62 0	0 62	158	184	179	183	ð	181	9 9 8
605	6/28/93 1350	107	4.80	Duct	5	2	33	1.63	16	115	3740	293	66	61.0	0 63	168	187	182	196	So	187	9 82
605	6/28/93.1500	109	4 60	Duc	65	66	25	1 1.66	Ξ	82	3755	295	66	580	0 65	171	190	187	190	8	195	6 7 9
605	6/28/93.1705	108	3 60	Duct	68	ទី	8	2	5	18.2	3680	294	65	66.0	0 56	148	173 175	172	175	8	8	978
503	6/28/93 1905	non UR	4 10		8	88					2005		8 5			641	23	22	2 :	38		, , , , , ,
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	0010 55/52/9	5			3 5	2 2	2 6		2 6	201	3756	272	5 6		60 0 0 9 9	146	153	154	155	2	155	777
505	6/29/93 0430	6	5 20		12	: 2	5	73	5	214	5775	270	65	580	0 66	147	152	154	155	8	156	8 11
605	6/29/93.0700	6	5 20	Duct	22	22	27	1.72	28	22 9	3757	270	65	59 0	0 64	147	151	153	155	ß	154	8.12
605	6/29/93.0905	94	5 10	Duct	72	72	27	1.68	8	24.4	3722	276	65	610	0 61	147	152	154	156	8	159	8.14
605	6/29/93.1100	96	5.10	Duct	74	74	28.	1.68	25	179	3722	279	65	610	0 61	147	154	156	156	8	164	7 82
605	6/29/93.1220	109	4 20	Duct	84	85	Ř	1 2 03	36	27.7	3545	288	66	75 0	046	147	155	156	159	8	157	971
605	6/29/93:1550	107	4 20	Duct	84	85	35	1 2.11	38	33 B	3551	292	65	74 0	0 46	149	162	162	166	8	160	9 93
605	6/29/93.1700	106	4 40	Duct	69	69	59 59	1.87	27	205	3562	293	65	13 0	047	150	155	154	158	8	162	10 31
605	6/29/93 2120	86	5 30	Duct	65	65	25 (163	53	23 4	3702	272	65	60 0	0 63	147	152	153	155	8	158	7 30
606	6/29/93 2300	60	6.80	Duct	48	48	16	5 164	28	22 5	3901	256	65	410	1 02	144	149	150	149	õ	151	7 60

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psd	C Arapahoe Unit																		
	`	GAS AN	IALE	CON-D	RY (1-1)	2)	GAS AN	IALY	SIS IN	LET-WE			GAS AN	1 AL Y	SIS U	JTLET	WET	:	
Test	Dale & Time	Q X	0 S	S02	C02	02	Q	8	S 02	C02	H20	6	01	3	S 02	C02	H2O	05	Comments
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599	6/15/93 0750	207	õ	378	11 82	6 45													Base
599	6/15/93 0915	207	8	378	11 82	6.45	196	თ	339	10 75	8 71	6 02	177	22	298	9 97	12 32	6 42	
6 65	6/15/93 1100	207	8	378	11 82	6 45	200	~	329	10 42	7 82	6 42	183	2	292	9 64	11 77	6 85	
599	6/15/93 1300	213	5	379	11 51	6 95	196	9	351	10 83	787	6 00	179	12	310	9.97	11 82	6 45	ΔLoad
600	6/16/93 0840	226	257	440	12 67	6 45	213	26	396	11 56	8 70	5 45	182	297	290	10 48	12 31	6.22	
600	6/16/93 1100	226	257	440	12 67	6 45	212	27	352	11 41	8 66	561	186	126	241	10 25	12 13	6 52	
600	6/16/93.1300	226	257	440	12 67	6 45	221	16	325	11 20	8 98	5 65	191	85	224	10 20	12 79	6 50	
600	6/16/93-1500	226	257	440	12 67	6 45	213	61	318	11 31	8 92	5 48	181	176	220	10 42	12 66	6.15	
600	6/16/93 1800	226	257	440	12 67	6 45	219	21	298	11 19	8 85	573	184	53	196	10 36	12 58	6 30	
601	6/17/93 0800	218	77	304	12 22	6 80	205	23	273	11 08	9 15	6 00	175	79	224	10 33	11 99	6 53	
601	0060 26/21/9	218	27	304	12 22	6 80	208	21	268	10 78	8 87	6 40	180	52	210	36 6	11 67	7 15	
601	6/17/93 1100	218	77	304	12 22	6 80	209	21	272	10 92	16 8	6 05	179	64	207	69 6	11 43	7 0 8	
601	6/17/93 1300	218	11	304	12 22	6 80	211	25	260	10 98	9 04	5 95	182	62	224	10 24	12 13	6 50	
601	6/17/93 1500	218	11	304	12 22	6 80	207	26	280	11 07	9 12	5 90	187	43	216	10 03	11 99	678	
601	6/17/93 1550	218	11	304	12 22	6 80	203	27	280	11 14	9 26	575	183	48	217	10 10	12 10	6 62	
602	6/21/93 0900	208	49	410	11 79	7 10	208	20	388	11 18	919	5 58	182	34	327	10 18	12 10	6 58	
602	6/21/93 1100	208	49	410	11 79	7.10	214	19	392	10 99	68 8	6 00	187	õ	334	10 03	12 02	6 80	
602	6/21/93 1300	208	49	410	11 79	7.10	210	24	3 94	11 08	8 66	5 95	188	27	340	10 19	11 93	6 65	
603	6/22/93 0925	247	69	415	12 87	5 90	217	51	360	10 83	8 52	6 10	189	33	258	10 71	12 43	6 20	
603	6/22/93.1114	247	69	415	12 87	5 90	224	29	345	11 80	8 72	4 90	187	45	245	10 57	12 11	6 00	
603	6/22/93 1300	247	69	415	12 87	5 90	224	31	325	11 77	8 72	4 30	195	63	220	10 46	12 10	6 15	
603	6/22/93 1500	247	69	415	12 87	5 90	221	33	323	11 69	6 03	5 00	189	109	230	10 64	12 18	5 85	
603	6/22/93 1650	247	69	415	12 87	5 90	223	31	311	11 68	9 12	5 05	196	56	208	10 38	12 11	6 10	
604	6/22/93 1850	247	69	415	12.87	5 90	213	27	281	10 92	8 16	6 15	192	21	198	9 45	11 08	7 55	load follow
604	6/22/93 2100	247	69	415	12 87	5 90	214	26	273	10 78	8 71	6 20	188	22	193	9 62	11 68	7 25	
504	6/22/93 2320	165	111	249	944	9 80	161	78	258	9 72	7 88	7 70	142	83	163	8 03	9 97	9.45	
604	6/23/93 0100	161	130	266	10 08	9 15	168	74	262	66 6	8 07	7.30	149	107	167	851	10 25	8 80	
605	6/28/93 1110	274	8	262	11 61	6 38	216	5	227	10 41	10.54	4 90	221	15	175	9 65	13 47	5 90	w/Nat Gas
605	6/28/93 1240	274	8	262	11 61	638	229	13	233	10 54	10 59	4 90	220	14	183	9.81	13.44	570	
605	6/28/93 1350	274	18	262	11 61	6 38	251	16	235	10 48	10 14	5 30	235	17	190	9 85	13 06	5 85	
605	6/28/93.1500	274	₽	262	11.61	6 38	251	16	243	10 54	10 17	5.22	234	16	203	10.01	13.06	5.70	
605	6/28/93.1705	274	8	262	11.61	6 38	237	8	255	10 73	10.50	4 75	215	8	190	10 08	13 87	5 30	
605	6/28/93.1905	274	9	262	11 61	6.38	253	17	241	10.48	10.43	5 05	208	32	183	10 34	14.40	4 90	
605	6/28/93.2100	250	Se :	330	12.05	6.80	នី	<u>6</u> :	287	10 93	8 23	6 20	204	52	230	10.32	12 20	6 25	NGas off
605	6/28/93.2300	250	8	330	12.05	6 80	2	58	238	10 80	8 30	6.30	208	Ê	210	10 04	11.93	9.9	
605	6/29/93 0100	250	R	330	12 05	6 80	83	8	236	10 88	8 26	6.20	209	N	217	10.05	11.80	6.72	
605	6/29/93-0300	250	26	326	11.86	6 95	27	53	292	10.60	8 01	6 00	207	18	205	9.92	11.67	6 85	
605	6/29/93.0430	250	26	326	11 86	6 95	228	9	290	10 68	8 10	6 40	213	16	206	996	11 62	6.90	
605	6/29/93 0700	250	56	326	11 86	6 95	22B	8	288	10 71	7 99	6 60	214	6	203	9 83	11.50	6 95	
605	6/29/93.0905	250	8	326	11.86	6 95	239	6	282	10 57	7 92	6 75	215	40	202	10 20	12 01	6 55	
605	6/29/93:1100	250	5 6	326	11.86	6 95	232	24	230	10.79	7 74	6 55	214	5B	215	9.74	11.51	7 00	NGas on
605	6/29/93.1220	264	31	298	12.01	5 90	238	21	260	10 86	06 6	5 05	211	4	170	10 06	13 83	5.55	NGas on
605	6/29/93.1550	264	31	298	12 01	5 90	238	1	258	10 92	10 29	4 80	216	18	152	9 83	13.72	5.62	
605	6/29/93:1700	264	31	298	12 01	5 90	218	17	242	10 76	10 89	4 50	198	1 0	148	8 54	12 24	7 50	NGas off
605	6/29/93 2120	212	55	295	10.84	8 25	221	23	302	11 10	8 31	5 95	196	72	210	10 27	12 04	6 40	TCshield
606	6/29/93 2300	193	ର	280	10.45	8.50	218	26	270	9 91	777	7 58	193	28	188	9.02	10 76	8 15	

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PSCC Arapatroe Unit 4 Calcium/Humidification Duct Injection, Ca(OH)2 calculations based upon 68% CaO

l calc	H20a	Wa,	7 49	7 29	7 26	7 31	7.37	7 53	9 06	9 57	8 57	8 66	8 57	<u> 9</u> 05	8 95	7 74	7 60	7 69	9 32	9 59	9.26	9 52	9 56	808	7 83	7 81	744	7 83	7 55	8 56	874
Humic	Tcalc	ų	153	152	150	152	151	149	155	142	156	149	150	147	143	147	147	142	153	155	141	145	141	158	149	148	148	146	159	155	156
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	SisqC	Ļ	147	147	147	147	147	148	154	152	152	152	154	152	151	145	144	141	152	156	158	163	162	155	147	145	149	144	154	158	157
emps	Din	۶,	148	148	149	148	149	149	152	153	151	151	152	151	150	146	45	142	152	152	55		159	54	148	146	149	46	154	156	157
use J	out	F.	148	147	147	147	47	48	51	50	20	20	64	48	48	44	44	4	46	49	5	57	21	Ċ,	40	64	46	42	47	20	50
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	₹ Ω	e	101	101	- 0	0	- 0	-	0 0	0	0 0	0 0	0 0	5 0	0 0	0 0	- 0	5 0	0 0	0 0	0 0	0 0	0 0	0 0	5 0	5 0	5 0	0 0	0	0 0	0
	H	. 96	38	38	38	1 37	38	33	65	66	61	59	65	54	51	42	4	42	66	22	5	75	23	57	44	44	43	40	55	11	75
lõn	0 Tv		6	ü 9	è B	2 6	99 6	1 65	0.0	6	- 6	5	5	5	65	2	7 64	7 64	65	2	6 2	7 65	- 62	2 65	2 65	59	4 64	9	65	1 64	3 65
difica	ţ		1 25	24	24	24	24	24	28(28(27	27	271	<u>56</u>	26(249	5	24	279	28	28	28	28	27:	25	251	25	25:	26	53	8
Hum	Au	schm	3951	3966	3965	3972	3948	4022	3636	3631	3683	3700	3639	3756	3794	3675	3889	3874	3626	3547	3475	3515	3525	3521	2917	2921	2910	2890	2906	3318	3348
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PSCC Arapahoe Unit

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PSCC Arapahue Unit 4 Calcinim Injection Surrmary Duct Injection Fests cont Ca(OH)2 Calculations based on 68% CaO

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PSCC Arapahoe Unit / Ca(Ofi)2 Calculations

	CO NO COMPANY	2 SU2 NU COMments	mpg mpg	30 252 195 Toxics 22	0 247 197	15 252 200	0 239 196	NG 240 195	0 235 192	0 250 190 Toxics 23	5 240 190	5 250 200	0 243 192	0 250 194	5 264 200 Toxics 24	0 222 200	5 230 194	5 207 191	5 219 193	5 355 165 50 deg approach	3 277 170	2 260 165	0 245 178 30 deg approach	0 212 177	7 200 170	0 380 225 Base	0 220 205	0 195 205	0 217 195 B leeder only	0 223 205	
•				2.90 4	82 4	2.73 4.	86 4	1 62.3	11 4	94 5	98 51	54 5	95 5	70 5	62 5	30 5	98 5	92 5	83 5	13 4	92 4 1	12 4	22 1	4 4	50 1	89	1 82	75 4.	86 4	38 4	
	alysis, v 2023 L	20	÷،	1 47 12	1 53 12	1 45 12	147 12	1.37 12	157 12	115 12	1 14 12	0.84 12	95 12	1 04 12	0.84 12	0.82 13	0.89 12	0.00 12	0 83 12	1 52 12	131 11	154 12	1 28 12	1 06 12	1 04 12	2408	147 12	1 57 12	1 78 12	1 70 12	
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		3	bpm	83	99	45	8 8	48	55	266	264	109	176	191	200	188	215	179	142	177	1	184	225	224	355	228	147	144	167	201	
	ģ	Ş	Edd	221	219	222	221	235	215	210	215	221	213	215	219	221	218	228	221	188	<u>19</u> 0	188	198	198	195	230	233	220	221	225	,
1	53	202	ррш	438	457	431	4 37	426	435	440	430	417	425	101	422	412	418	392	392	430	423	413	315	325	330	385	355	348	340	337	
	SIS, W	č	*	4 25	3 58	80	3 70	4.10	3 35	400	4 20	4 62	4 30	4 22	4 50	4 70	4 50	4 85	4 50	3 80	3 82	3 90	3 85	4 10	4 30	4.05	4 10	390	4 05	8	
4	VIENA	D2H		817	9.25	8 99	9 15	66 8	9.32	8 S3	9 42	8 11	9 27	9 2 8	9 11	9 04	910	8 89	9 20	916	9 17	9 07	60 6	8 62	854	9 O 6	8 .00	9.02	108	8 .83	
		202	*	12.62	13 08	12 72	12 95	12.69	13.30	12 50	12 24	12 02	12 18	12 24	11 98	11 79	11 56	11 71	12 07	12 60	12 56	12.45	12.40	11.94	11 87	12.56	12.58	12.74	12.67	12 83	
-	ŝ	No.	mdg	Ŧ	ċ	7	7	7	7	ņ	ņ	ç	ņ	ņ	4	7	Ŧ	'n	7	7	Ŷ	ņ	ņ	7	7	ņ	7	7	7	ņ	
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	Ş	Ş	Edd	240	245	246	247	248	245	230	229	235	234	230	238	242	240	237	240	205	208	205	215	210	210	245	260	250	255	250	
:		Š,	Edd	6	475	472	5	8	8	460	457	460	461	450	151	438	449	432	207	468	4 50	450	338	365	378	614	380	397	365	360	
		3	ζıb.:	4.85	4 70	8	5.05	1.90	4.70	28	5 10	5 05	S 05	4 80	5 30	5 68	5 60	5 50	5 35	4 30	4.70	4 43	9 7	4 50	4 60	9	4 90	4.45	4.70	4 80	
		202	•	13 92	13 92	13 77	13 53	13 72	13 84	13 24	13 29	13 30	13 38	12 82	01 01	12 83	12 92	12 85	12 07	13 84	I3 53	13 BO	13 40	11 01	13 21	13 66	13 70	14 60	14.05	14 04	
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		3	шdd	<u>≋</u>	97	59	49	56	62	408	66	225	308	138	204	192	198	121	169	259	184	237	312	370	424	256	119	215	166	220	
Prijz Carculations		Uale & Lime		00 11 06/61/01	10/19/93 12 30	00 01 00/19/01	10/19/93 14 30	10/19/93 15 30	10/19/93 16:30	00-8 66/02/01	10/20/93 9 30	10/20/93 10 30	10/20/93 11 40	10/20/93 12 50	10/20/93 14 30	10/20/93 15 30	10/20/93 16 40	10/20/93 17 30	10/20/93 18 40	10/26/93 14 30	10/26/93 15 50	10/26/93 17 10	10/27/93 9 40	10/27/93 14:30	10/27/93 15 10	01:6 26/1/11	11/1/93 13.40	11/1/93 16 50	11/1/93 17.50	11/2/93 11:30	
Calc	1.1.1	lest		205	705	705	705	205	202	206	206	706	706	206	101	101	101	101	707	807	209	710	Ш	712	713	Ξ	715	716	717	719	