INTEGRATED DRY NO, SO2 EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Low-NOx Combustion System Retrofit Test Period: August 3, 1992 through October 29, 1992

Baseline Air **Toxics** Test Period: November 17, 1992 through November 19, 1992

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ABBREVIATIONS

ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
Btu	British Thermal Unit
CARB	California Air Resources Board
CEM	Continuous Emissions Monitor
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CVĂA	Cold Vapor Atomic Absorptions
DSF	Dry Standard Cubic Feet, 68°F and 1 atm
DSCFM	Dry Standard Cubic Feet per Minute
EMP	Environmental Monitoring Plan
EPA	Environmental Protection Agency
F	Fahrenheit
FFDC	Fabric Filter Dust Collector
GC/MS	Gas Chromatography/Mass Spectroscopy
GFAA	Graphite Furnace Atomic Absorption
gr	Grains
ннv	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
1b	pound (mass)
kg	kilogram
m ³	cubic meter
mg	milligram
MMBtu	Million Btu
MS	Mass Spectrometry
MWe	Megawatt-electric
NO	Nitric Oxide
NO.	Oxides of Nitrogen
O ₂	Oxygen
PÁH	Polycyclic Aromatic Hydrocarbons
рСі	Pico-Curie
PID	Photoionization Detector
PM ₁₀	Particulate Matter less than 10 microns
DDM	parts per million
PSCC	Public Service Company of Colorado
PTC	Power Test Code
QA	Quality Assurance
sO ₂	Sulfur Dioxide
SO	Sulfur Trioxide
VOC	Volatile Organic Compounds

I. Project Status

A. Test Summary

The new low-NOx combustion system was tested from August 3, 1993 through October 29, 1993 at the Arapahoe 4 electric-generating steam station. This test had two phases: (1) Adjust the new burners and overfire air ports to maximize NOx reduction and minimize the emissions of unburned carbons. (2) Conduct a series of detailed tests with the optimized system to assess the performance as various boiler operating parameters are modified. Nearly 200 parametric tests were completed over this period.

The combustion system operated better than originally expected. Figure 1 shows a plot of the NOx emissions of the modified boiler compared to the original baseline emissions.



Depending on operating conditions, NOx emissions were reduced from 62 to 69%. In addition, the boiler retrofit caused no increase in carbon monoxide emissions or in the content of unburned carbon in the flyash.

No operating problems developed and the system required no maintenance during the test program. The new combustion system had one effect on operating conditions. It decreased the temperature of the flue-gas entering the convective pass of the boiler approximately 150°F. The lower flue-gas temperature increases the difficulty of maintaining design steam temperature at design levels at lower boiler loads.

A baseline test of certain air toxics was completed as part of the combustionsystem test program. This testing was conducted November 17, 1992 through November 19, 1992 after the combustion modifications were installed. The original purpose of this testing was to determine baseline emissions of at least twenty-three air toxics with the combustion retrofit in service. After finalizing this test plan, it was determined that 52 air toxics would be measured. Air toxics in six major groups were measured:

- Trace metals
- Acid-forming anions
- Volatile organic compounds
- Semi-volatile organic compounds
- Radionuclides
- Nitrogen compounds

An additional three phases of air toxics monitoring will be completed as part of this project. Results of the additional testing that will be conducted during urea injection, calcium-based injection, and sodium-based injection will be reported in future environmental monitor reports for these test series.

B. Summary of Environmental Monitoring

The purpose of this report is to document the environmental monitoring that was completed as part of the combustion test series. Monitoring was completed according the *Environmental Monitoring Plan for the Integrated Dry* $NO_{\underline{x}}/SO_{\underline{z}}$ Emissions Control System, dated February 1992 and the *Environmental Monitoring Plan Addendum for Air Toxics*, dated July 1993.

Generally, the testing went well and there were no significant environmental events during the test period. There were no excursions of any compliance monitoring except for opacity. Opacity was in compliance over 99.98% during the six-month period examined. The average opacity ranged from 3 to 4%.

A significant amount of supplemental monitoring was completed to define the emissions while operating and testing the combustion system retrofit. During this testing, it was found that the combustion retrofit produced a very positive environmental impact. Depending on operating conditions, NOx emissions were reduced by 62 to 69%. Also, this large reduction occurred without the negative impacts of high emissions of carbon monoxide or high content of unburned carbon in the flyash.

Particulate emissions were very low, on the order of 0.001 grains/dry standard cubic foot (gr/DSCF). While this emission is slightly higher than the baseline of the original combustion system, it is believed that this slight increase is due to normal variations in collection-efficiency and not due to a detrimental change of the combustion process.

 PM_{10} emissions were tested during the combustion optimization, but a problem with the sample caused the loss of all condensable particle emissions. The non-condensable PM_{10} emissions were in the range of 0.00003 gr/DSCF and were approximately an order of magnitude lower than the baseline emissions. It is believed that the sample time may not have been sufficient to determine

accurate PM_{10} emissions due to the very high collection-efficiency of the fabric-filter.

Data on 52 air toxics were collected during the baseline air toxics test. Although there were a few problems in the data collection and analysis which raise some questions, a significant amount of accurate data was collected on the unit. Results indicate that the fabric-filter is very effective at the removal of trace-metals emissions with an average removal rate of 97.1%. This large removal rate is possible as many of the trace-metals are associated with the particulate and fabric-filters are very effective at minimizing particulate emissions.

The emission of acid-forming anions was also low, due to the low content of these anions in the coal used on this unit. Emissions of polycyclic aromatic hydrocarbons (PAHs) and radionuclides were very low. None of the carcinogenic PAH compounds were measured above the detection limit.

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 is 1.2 lb/MMBtu. An Altech 180 continuous emission monitoring (CEM) system was installed at Arapahoe 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.

Sulfur dioxide emissions for compliance monitoring were calculated from the amount of sulfur in the fuel. Emissions calculated to be above the regulatory limit of 1.2 lb/MMBtu are provided to the state on a quarterly basis. The test period covered two quarters: the third and fourth quarter of 1992. During the third quarter of 1992, the average SO_2 content of the coal was 0.803 lb/MMBtu. There were no violations during this quarter. During the fourth quarter of 1992, the average SO_2 content was 0.840 lb/MMBtu. There were also no violations during this quarter. See Appendix A for copies of the reports documenting this information to the Colorado Department of Health.

B. Opacity Monitoring

According to Regulation 1, II.A.1., Arapahoe 4 may not exceed 20% opacity due to any air pollutant. The unit uses a Lear Siegler RM41 continuous opacity-monitor to measure and record opacity.

During the third quarter of 1992, Arapahoe 4 had 28 opacity excursions of six minutes that exceeded the 20% opacity limit. However, none of these excursions occurred during the combustion retrofit testing and all but two of these were related to startup and shutdown of the unit.

During the fourth quarter of 1992, Arapahoe 4 had 16 opacity excursions of six minutes that exceeded the 20% limit. All of these excursions were related to a single problem that caused the fabric-filter-bypass duct to open. See Appendix A for copies of the reports documenting this information to the Colorado Department of Health.

Arapahoe 4 was in compliance 99.98% of the test period. The monthly average opacity during the test period ranged 3.7 to 4.1%.

C. Aqueous Stream Monitoring

Colorado Wastewater Discharge Permit No. CO-0001091 requires that Arapahoe 4 must sample and report on various aqueous discharges. Appendix B contains reports provided to the regulatory agency during the combustion test period for August, September, and October 1992. Note that the unit was in compliance 100.0% of the test period since there were no violations during either of the test periods.

III. Summary of Supplemental Monitoring Results

A. Gaseous Species Monitoring

Significant gas monitoring was done to determine the environmental effects of the Integrated SO_2/NO_x Emissions Control System and specifically the combustion system retrofit.

Appendix C contains a summary of all test data obtained during the baseline testing conducted August through October 1992. The test summary contains average emissions by test for the following gases:

- Oxygen (O_2)
- Carbon monoxide (CO)
- Nitric oxide (NO)
- Carbon dioxide (CO_2)
- Sulfur dioxide (SO₂)

Four separate tests were conducted to determine SO_3 emissions during the test period. SO_3 emissions were measured at the economizer exit using the controlled-condensation technique. SO_3 emissions were very low with the majority of emissions having less than 1 ppm SO_3 . Triplicate samples were obtained. Table 1 summarizes the average results.

Table	1
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Test Number	SO ₃ ppm @ 3% O2
370	0.5
371	0.7
378	1.5
379	0.8

B. Particulate Monitoring

Three particulate tests were conducted during the combustion retrofit test period. These tests were conducted using EPA Method 5. Tests were conducted at both the inlet and the outlet of the fabric-filter dust-collector (FFDC). One test was conducted with the minimum amount of overfire air, approximately 15% of the total combustion air. The other two tests were conducted with the maximum amount of overfire air, approximately 25% of the total combustion air. All three tests were conducted at a nominal full load of 100 MWe. Table 2 summarizes the results of this testing.

Test Condition	Inlet Loading (grain/DSCF)	Outlet Loading (grain/DSCF)	Collection Efficiency
Minimum OFA	2.81	.0016	99.943%
Maximum OFA	2.49	.0006	99.976%
Air Toxics, max OFA	2.83	.001	99.965%

Table 2

The maximum overfire air data at the inlet and outlet and the air toxics tests are an average of three replicate tests. Three replicate tests were also attempted during the minimum overfire air testing. However, due to sample, load, and fuel-fired problems, the data for the minimum overfire air testing is a single sample point at both the inlet and outlet. As part of the particulate testing, the distribution of particulate size at the fabric-filter inlet was measured for both minimum and maximum overfire air operation. This particle-size analysis was not completed as part of the air toxics test.

A University of Washington Pilat Mark V cascade impactor was used to determine particulate size at the inlet. The impactor has a maximum aerodynamic cutpoint of 15.9 microns. To obtain the size distribution above the maximum cutpoint, the data was extrapolated with a cubic-spline-fit program. The computer program pcCIDRS (written by J. McCain of Southern Research Institute) was used to perform these extrapolations. This recently released program is widely accepted as one of the better cubic-spline-fit programs available. At the inlet, particulate sizing showed that the mass mean-diameter of the ash particle with minimum overfire air was 26 microns. With maximum overfire air, it was 18 microns. Appendix D contains a graph of the particulate diameter versus the cumulative weight percent.

To determine the PM_{10} emissions, EPA Method 201A was used to measure the distribution of particulate emissions at the outlet of the fabric-filter. This testing was conducted with the maximum-overfire air at approximately 25% of the total-secondary-combustion air. Three replicate-tests lasting three-hours each were completed.

This three-hour sample time was 50% longer than the sample time used to complete the baseline-testing for PM_{10} emissions. The sample time was increased with the hope of obtaining more accurate and repeatable data. Measuring PM_{10} emissions is difficult due to the high collection-efficiency of the fabric-filter and, thus, the very low particulate-loading.

A problem developed during the testing of particulate-emissions at Arapahoe 4. EPA Method 201A includes "condensable" particulate emissions from the impinger washes. Under this method, these condensable emissions are recovered from the washes by drying the collected water and weighing the residue. Then, these additional condensable-emissions are added to the sub-10 micron solid-emissions from the impactor.

Unfortunately, during the analysis of all three samples of condensableemissions at Arapahoe 4, the back-half (condensable) fraction could not be quantified due to the formation of a residual organic in the final wash. Thus, the final weights could not be achieved and the condensable-fraction could not be quantified. The average of the three replicate-tests at the fabric-filteroutlet for the non-condensable PM_{10} emissions was 0.0000341 grains/DSCF. This quantity consists of all the captured particles that were less than 10.541 microns in size.

Appendix D tabulates the PM_{10} test data and compares it to the baseline data. In general, the comparison shows that PM_{10} emissions are approximately an order of magnitude lower than the original baseline-emissions. It is NOT currently believed that the combustion modifications significantly reduced PM_{10} emissions but that sampling times may have been too short to obtain repeatable test data due to the very low PM_{10} emissions. It is believed that a sample time of eight hours would be required to increase the total particulate catch sufficient to obtain more meaningful data.

C. Aqueous Stream Monitoring

No supplemental monitoring of any aqueous streams was planned or conducted during the combustion system retrofit test program.

D. Solid-Stream Monitoring

Raw coal samples were obtained throughout the combustion system retrofit test program. Selected samples were submitted for proximate, ultimate and elemental ash analysis by an independent laboratory. Appendix E contains the results from these analyses. Generally, the individual coal samples were consistent, although some variance in sulfur content occurred. Two different sources of coal were used for the testing. The two coals were very similar in all respects except for sulfur content. The coal had an average higher-heating value (HHV) of 10,986 Btu/lb and an average carbon content of 61.86%. Three additional coal samples were analyzed during the air toxics test program. Appendix E also lists the results from this analysis.

A carbon analysis of the flyash was also completed during the baseline-testing. Since flyash carbon-content is a major variable that reflects combustion system operation, flyash carbon samples were completed on nearly every test. Three methods were used to analyze these samples: (1) on-site loss-on-ignition analysis, (2) PSCC laboratory loss-on-ignition analysis, and (3) independent laboratory carbon analysis. On-site analysis allowed the data to be turned around rapidly, within 20 minutes.

To ensure the accuracy of the on-site analysis, the PSCC laboratory analyzed many duplicate samples. There was very good agreement between the data from the two loss-on-ignition test methods. However, while loss-on-ignition analysis is fast, it measures more than the carbon content of a sample. Therefore, a group of samples was also sent to an independent laboratory to determine their elemental-carbon content. As expected, the carbon content was slightly less than that predicted by loss-on-ignition analysis. In general, loss-on-ignition analysis over predicted the absolute carbon content of the flyash by an absolute 1.3 to 1.7%. The carbon content of the flyash measured by loss-on-ignition analysis ranged from 1.6 to 13.7%, with an average value of 3 to 5%. Appendix C lists the on-site loss-on-ignition data. Also included in this appendix are two figures which compare the laboratory and on-site analysis and the elemental carbon verses loss-on-ignition data.

IV. Summary of Air Toxics Monitoring Results

A total of 52 potential air toxics were measured at Arapahoe 4 after the combustion modifications were installed and optimized. Table 3 lists the air toxics that were sampled during this baseline air toxics test program. Sampling of the air toxics occurred from November 17, 1992 through November 19, 1992. The unit was operated at a base load of a nominal 100 MWe during the testing. No sampling occurred during sootblowing operations.

Table 4 lists the average operating conditions of the unit during the sampling period. The recently optimized combustion modifications were operated at approximately 25% overfire air during the sampling period. Figure 2 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 were obtain of unpulverized coal, bottom ash, and flyash. This report 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 (EMP) Addendum for Air Toxics Monitoring*, dated July 1993.

Average Operatin Continuous E	g Conditions and missions Data
Unit load	103.5 MW Gross
Steam flow	847 Mlb/hr
Stack oxygen	5.49% (wet)
Stack carbon monoxide	49 ppm (dry)
Stack nitrogen oxide	292 ppm (dry, 3% O ₂)
Stack sulfur dioxide	393 ppm (dry, 3% O ₂)

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Public Service Company of Colorado contracted with Carnot, Inc of Tustin, California to complete the air toxics work at the Arapahoe 4 station. Fossil

TABLE 3 PSCC ARAPAHOE UNIT 4 TARGET COMPOUND LIST

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	•.	TRACE METALS	· · · · · · · · · · · · · · · · · · ·
Arsenic		Barium	Beryllium
Cadmium		Chromium	Cobalt
Copper		Lead	Manganese
Mercury		Molybdenum	Nickel
Selenium		Phosphorus	Vanadium
AC	D-FORM	NG ANIONS OR PRECUR	SORS
Chloride		Fluoride	Phosphate
		Sulfate	•
<u></u>	VOLATIL	E ORGANIC COMPOUN	DS
Benzene		Toluene	Formaldehyde
. SI	MI-VOLAT	TILE ORGANIC COMPO	UNDS
, , , , , , , , , , , , , , , , , , ,	Polycyc	lic Aromatic Hydrocarbon	
Acenaphthene		Acenaphthylene	Anthracene
Benzo(a)anthracene		Benzo(a)pyrene	Benzo(b)fluoranthene
Benzo(g,h,i)perylene	.]	Benzo(k)fluoranthene	_ Chrysene
Dibenzo(a,h)anthracene		Fluoranthene	Fluorene
Indeno(1,2,3-cd)pyrene		Naphthalene	Phenanthrene
Рутеле	:	2-Methylnaphthalene	3-Methylcholanthrene
	7,12-1	Dimethylbenz(a)anthracene	•
· · · · · · · · · · · · · · · · · · ·		RADIONUCLIDES	
.Ra ²²⁶	Th ²³²	Ŭ ²³¹	Po ²³⁰
Ra ²²⁸	Th ²⁹⁰	U ²³⁵	Pbzo
•	Th ²²⁸	U ²⁴ _	• •
<u></u>	NIT	ROGEN COMPOUNDS	-
•	· · ·	Cvanide	

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



Figure 2. Sample Locations at PSCC Arapahoe Unit 4

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Energy Research Corp of Laguna Hills, California provided some assistance at the site and with data collection. Table 5 lists the laboratories used to analyze the collected samples.

Laborat	ories for Air Toxics Analyses	
Analysis	Laboratory	Location
Solid particulate	Carnot, Inc	Tustin, Ca.
Chloride (supplemental)	Carnot, Inc	Tustin, Ca.
Acid-forming anions	Curtis and Tompkins	Berkeley, Ca.
Trace metals	Curtis and Tompkins	Berkeley, Ca.
Volatile organic compounds	Atmosphere Assessment Associates	Chatsworth, Ca.
Semi-volatile organic compounds	Zenon Environmental Laboratories	Burlington, Ontario
Radionuclides	Accu-lab Research	Golden, Co.
Fuel analysis	Commercial Testing and Engineering	Denver, Co.
Neutron activation analysis	Massachusetts Institute of Technology	Cambridge, Ma.

Table	5
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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 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. Bias that were estimated as listed below:

- For all non-detect data, a bias of one-half of the detection limit was used. No bias was assumed for analytical results reported above the detection limit.
- 2) A bias of 10% was assumed for the flue gas flow rate on both the inlet and outlet fabric filter ducts. Bias was estimated by comparing the calculated and measured flue gas flow rate.
- 3) A bias of 19% was assumed for the inlet particulate collection rate and 10% was assumed for the outlet particulate collection rate. The bias was estimated by examining the isokinetic sample rate for different flue gas flow rates.
- 4) A bias of 5% was assumed for the coal flow based on the difference of the calculated and measured coal flow rate.
- 5) A bias of 21% was calculated for the fly ash mass flow rate based upon the assumed biases for particulate collection and inlet flue gas flow rate.
- 6) A bias of 22% was calculated for the bottom ash mass flow based upon the assumed biases for particulate collection, inlet flue gas flow rate, and coal flow rate.
- 7) It was assumed that all other measurements were accurate and had a bias of 0%. While this scenario is not likely, insufficient data was available to make any reasonable assumptions.
- 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 was not possible, 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:

1) 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.

2) 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.

C. Treatment of Blank Values

Three different types of blanks were used as part of the air toxics test program 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 the 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 to 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 = <u>SUM(blank value/sample value*100)</u> number of samples

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 (2/10+2/5+2/4)*100/3 or 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

Table 6 lists the results of the gaseous air toxics monitoring at the inlet and outlet of the fabric-filter. Three replicate tests were completed for each air toxic species. Individual tests were averaged to determine the estimated air toxics emission. The uncertainty of the average as explained in section IV.A is also reported.

In general, trace metal emissions were very low at the FFDC outlet as the FFDC is very efficient for metals removal. The overall average removal rate of the trace metals for the fabric-filter measured during this test was 97.1%. Mercury and chromium are the metals of most interest due to their potential health impact. Mercury is the most difficult of the trace metals to remove as it may be present as a vapor rather than a solid particulate. The calculated removal rate for mercury of 78.2% assumes that the outlet mercury emissions existed at the detection limit. Additional methods are available to determine the speciation of these metals. The species of mercury are very important in the removal process as it is currently believed that ionic-mercury is much easier to remove than the other species. Chromium, especially hexavalent-chromium, is also gaining interest due to its potential toxicity. Additional baseline-testing is planned at a later date to determine speciation of these two important trace-metal emissions.

Outlet emissions of the semi-volatile organic compounds (polycyclic aromatic hydrocarbons, or PAH) were very low or non-existent. Of the 19 compounds measured, only naphthalene and 2-Methylnaphthalene were measured at average values above the detection limit at the outlet. For both of the PAH compounds, the field blank levels are actually higher than the reported outlet

Emissions
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Table

			Fabri	c Filter In	let					Fabric	Filter Ou	tlet		
	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank ¹ Correct	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank ¹ Correct
Trace Metals	Hg/Nm ³	Jev.Nm ³	µg/Nm ³	ug/Nm ³	%	µg/Nm ³	%	д/Nm ³	Hg/Nm ³	µg/Nm ³	µg/Nm ³	×	нg/Nm ³	8
Arsenic	33.5	19.4	37.0	30.0	81	1.28	0.0	0.47	1.8	0.65	0.97	183	0.82	0.0
Barium	237	88.4	588	305	210	3.39	2.5R	2.2	0.56	1.6	1.5	145	607	70.8R
Beryllium	6.7	14.4	14.1	11.7	95	< 0.04	0.0	<0:03	<0.03	< 0.03	< 0.03	33	<0.03	0.0
Cadmium	2.5	2.7	3.7	3.0	8	0.15	0.0	0.28	0.14	<0.08	0.15	197	<0.08	0:0
Chromium	36.7	84.8	73.6	65.0	8	0.53	0.9R	0.72	0.70	1.1	0.85	2	0.19	31.8R
Cobalt	21.6	\$0.4	44.4	38.8	100	< 0.38	0.0	< 0.28	<0.28	<0.26	<0.27	33	<0.27	0.0
Copper	249	197	214	220	37	2.41	0.3R	1.6	1.6	1.0	1.4	8	<0.98	25.2R
Lead	147	36.3	65.0	82.9	174	0.15	2.7R	0.61	0.56	0.52	0.56	77	0.05	58.9R
Manganese	149	310	300	253	8	0.53	0.1R	1.3	1.9	0.65	1.3	119	0.22	16.4R
Mercury	2.4	1.5	1.3	1.7	91	0.32	9.4R	<0.28	<0.45	<0.39	<0.37	67	<0.38	0.0
Molybdenum	7.8	15.5	18.5	14.0	101	0.30	30.7R	0.22	0.22	0.21	0.22	17	0.22	94.0R
Nickel	19.4	5 0.4	48.1	39.3	112	1.13	0.0	19.5	2.5	13	1.9	400	<0.55	0.0
Setenium	23.5	34.1	29.6	29.1	51	< 0.08	0.0	0.42	0.73	0.26	0.47	127	<0.05	0.0
Phosphorus	006/1	19000	18900	18600	ณ	<1.88	0.0	8.1	8.7	9.2	8.6	20	<1.36	0.0
Vanadium	100	213	215	176	35	0.23	0.1 R	0.36	0.17	0.39	0.31	8	0.16	36.7R

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

¹ R (Reagent Blank Correction) or L (Laboratory Blank Correction) indicate the type of blank correction.

Continued
Emissions
Air Toxics
- Gaseous
Table 6 -

			Fabrie	c Filter I	nlet					Fabric	: Filter Ou	ıtlet		
	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank ¹ Correct	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank ¹ Correct
Semi-Volatile Organic Compounds	J. Mar J.	Hg/Nm ³	e ^{mN/34}	rg/Nm ³	%	JE/Nm ³	%	Je/Nm ³	µg/Nm ³	AB/Nm ³	Jeg/Nm ³	*	JR/Nm ³	%
Naphthatene	16.0	0.24	0.40	0.31	æ	<0.36	SAL	0.42	0.25	0.34	0.34	8	Ŋ	48L
Acenaphthylene	< 0.012	<0.011	< 0.033	< 0.019	170	< 0.012	0	< 0.011	<0.009	< 0.008	< 0.009	47	<.027	0
Acenaphthene	< 0.014	< 0.012	< 0.012	< 0.013	42	< 0.016	0	< 0.014	<00.0>	< 0.015	< 0.013	3	<.02	0
Fluorenc	0.015	0.013	0.015	0.014	R	0.009	0	0.014	0.011	< 0.013	< 0.013	4	<.013	0
Phenanthrene	<0.142	< 0.140	< 0.183	<0.155	53	< 0.140	0	< 0.134	<0.111	< 0.141	<0.129	4	<.116	0
Anthracene	< 0.019	< 0.010	< 0.019	<0.016	8	< 0.007	0	0.012	< 0.014	< 0.006	< 0.014	74	<.013	0
Fluoranthene	<0:030	< 0.033	0:030	<0.031	8	<0.029	0	< 0.029	< 0.024	< 0.023	< 0.025	43	< .025	0
Pyrene	< 0.031	< 0.034	0£0:0>	<0.032	66	<0:030	0	<0.029	<0.024	< 0.023	< 0.025	43	<.025	0
Benz(a)anthracene ²	<0.019	< 0.021	< 0.040	< 0.026	118	<0.019	0	< 0.018	<0.016	< 0.014	< 0.016	\$	< .016	0
Chrysene ²	<0.019	< 0.020	< 0.037	<0.025	105	< 0.019	0	< 0.018	<0.015	< 0.014	< 0.016	47	<.016	0
Benzo(b)fluoranthene ²	<0.011	< 0.024	<0:030	<0.022	119	<0.009	0	< 0.007	<0.008	< 0.014	< 0.010	105	<.013	0
Benzo(k)fluoranthene ²	<0.021	<0.096	< 0.069	< 0.062	\$ 51	< 0.012	•	< 0.013	<0.011	< 0.018	< 0.014	F	<.010	0
Benzo(a)pyrene ²	<0.056	< 0.077	< 0.011	<0.048	£1	< 0.011	0	< 0.011	< 0.026	< 0.008	< 0.015	162	<.010	0
Indeno(1,2,3-cd)pyrene ²	<0.030	< 0.029	< 0.029	<0.029	સ્ટ	<0.033	0	< 0.033	<0.047	< 0.039	<0.040	S	<.028	0
Dibenzo(a,h)anthracene ²	<0.037	< 0.037	< 0.037	< 0.037	R	< 0.037	0	< 0.039	<0.056	< 0.045	< 0.047	x	<.034	0
Benzo(g,h,i)perytene ²	<0.037	< 0.029	< 0.029	<0.032	51	< 0.032	0	< 0.030	<0.038	< 0.034	< 0.034	45	<.027	0
2-Methytnaphthalcne	0.041	0.026	0.015	0.027	119	0.016	0	0.063	0:020	0.022	0.035	<u>к</u> і	7	0
7,12-Dimethylbenz(a)anthracene	<0.025	< 0.004	< 0.047	<0.025	218	<0.007	0	<0.007	<0:006	< 0.003	<0.005	90	<.007	0
3-Methylcholanthrene	<0.149	<0.007	<0.146	<0.101	1 27	< 0.007	0	<0.007	<0.006	< 0.006	< 0.006	8	<.006	0

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

 1 R (Reagent Blank Correction) or L (Laboratory Blank Correction) indicate the type of blank correction.

² Carcinogenic PAH compounds

Continued
Emissions
Air Toxics
Gaseous /
e 6 -
Tabl

			Ë	abric Filto	er Inlet					Fab	ric Filter (Dutlet		
	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Biank Correct	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank Correct
Acid-Forming Anions	wdd	шdd	mqq	wdd	8	bbu	%	шdd	udd	udd	wdd	%	uudid	æ
Chlorine (Total)	0.64	0.69	0.62	0.65	R	N/A	0	0.67	0.60	0.27	0.51	121	N/A	0
(Gaseous)	0.61	0.49	0.60	0.57				0.65	0-57	0.26	0.49			
(Solid)	0.03	0.20	< 0.04	0.08				< 0.03	0.03	< 0.03	0.02			
Fluorine (Total)	8.5	6.7	6.7	7.3	42	N/A	0	9.5	7.6	2.6	6.6	137	N/A	0
(Gaseous)	7.7	5.8	6.3	6.6				9.5	7.5	25	6.5			
(Solid)	0.77	0.87	0.44	0.70				0.06	0.06	0.06	0.06			
Phosphate (Total)	0.35	0.64	0.18	0.39	149	N/A	0	<0.58	< 0.47	<0.15	<0.40	142	N/A	0
(Gaseous)	< 0.62	0.58	0.13	0.34				<0.54	< 0.43	<0.11	<0.36			
(Solid)	0.04	0.06	0.06	0.05				<0.04	<0.04	×0.04	<0.04			
Sulfate (Total)	350	320	300	320	R	N/A	29.02	290	300	300	300	15	N/A	84.01
(Gaseous)	340	310	290	320				290	300	30	300			
(Solid)	5.3	4.2	3.4	4.3				0.03	0.03	0.02	0.02			
Radionuclides (solids)				Inter Not Me	asured			pCi/Nm ³	pCi/Nm ³	pCi/Nm ³	pCi/Nm ³	%	pCi/Nm ³	r
Uranium-233,•234								< 0.06	<0:06	0.05	<0.06	8	N/A	0
Uranium-235								<0.06	<0.06	0.05	<0.06	83	N/A	0
Uranium-238								<0.0 6	<0.06	<0.05	<0.06	33	N/A	0
Radium-226								0.11	0.11	0.11	0.11	15	N/A	0
Radium-228			_					0.80	0.96	0.76	0.84	3	N/A	0
Lead-210				_				<0.75	<0.73	0.22	<0.75	104	N/A	0
Polonium-210								0.06	<0:05	<0.05	<0.06	87	N/A	0
Thorium-228								< 0.23	<0.34	<0.16	<0.24	8	N/A	0
Thorium-230								<0.17	< 0.06	<0.16	<0.13	128	N/A	0
Thorium-232								< 0.06	<0.11	<0.11	<0.09	88	N/A	o
].											

NOTE < indicates that the quantity measured was less than the detection limit thus the detection limit is shown ¹ Majority of blank correction is due to sulfate in filter

Table 6 - Gaseous Air Toxics Emissions Continued

			Fab	ric Filter	Inlet					Fabric	c Filter Ou	tlet		
	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank Correct	Test 1	Test 2	Test 3	Average	Uncert	Field Blank	Blank Correct
Volatile Organic Compounds	qdd	qdd	qdd	qdd	%	qdd	8	qdd	qdd	qdd	qdd	%	qdd	%
Benzene	0.60	< 0.26	0.46	0.40	152	0.04	0	0.69	0.88	1.34	0.97	85	10.	0
Toluene	3.8	1.4	1.4	2.2	154	0.29	0	43.8	23.1	30.7	32.5	80	\$ <u>7</u>	0
Formaldehyde	13.0	13.9	17.0	14.6	ĸ	35.2	0	10.8	24.9	12.6	16.1	119	15.7	0
Nitrogen Compounds	qdd	qdd	qdd	qdd	%	qdd	%	qdd	qdd	qdd	ppb	%	qdd	8
Cyanide (as HCN)	8	\$	6	8 >	90	N/A	0	7	<4	8	<8	76	N/A	0

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

emissions. It is believed that both these compounds may be an artifact of resin degradation and are not source related. This would explain similar emission levels in both the sample and the field blank. None of the carcinogenic PAH compounds were detected at either the inlet or the outlet of the FFDC. As all of the PAH compounds were measured near or below the detection limit or are not believed to be source related, it is impossible to determine if the FFDC removes any of the compounds.

An EPA Method 5 sampling train was used to sample anions. The sample train collected a solid sample in a particulate filter and a gaseous sample within a series of impinger baths. Table 6 shows three values for each anion: (1) total, (2) solid fraction, and (3) gaseous fraction. The results show that the majority of all anions exists in the gas phase. The fabric filter was effective in removal of the solid phase anions but removed only a small fraction of the gas phase anions. Gaseous phosphate at the inlet was only 0.34 ppm which represent only 3% of the total phosphorus measured with the multi-metals train. It would be expected that the two values would agree for both measurements, so the difference is likely caused by the two measurement methods. It is believed that the multi-metals train accurately measures phosphorus and that the data presented in the anion tables obtained with ion chromatography are not accurate. Gaseous sulfur emissions were approximately 320 ppm. This represents 90% of the sulfur present in the fuel. The total sulfate level at the outlet represents 83% of the coal sulfur. While the data indicates that some gaseous sulfur is removed across the fabric-filter, no removal is expected and the small difference is within the uncertainty of the data. The continuous emissions monitor averaged 334 ppm over the test period and thus agrees with the outlet sulfate emissions within the range of uncertainty of the data.

From the solids sample collected at the fabric-filter outlet by the EPA Method 5 sampling train, 11 types of radionuclide emissions were measured. Of the 11 potential radionuclides, only Radium-226 and Radium-228 had average values

above the detection limit. No reagent blank corrections were made for the data as correcting in some cases would have reduced the data to below zero. The reagent blank for Radium-226 was 0.1 versus a reported value of 0.11 pCi/Nm^3 and for Radium-228 was 1.5 versus a reported value of 0.84 pCi/Nm^3 . Thus, although values are reported for these two radionuclides, they are not believed to be source related and the reported values are likely due to the fiberglass filter used for particulate collection.

Three volatile-organic compounds (VOC) were measured during the testing: benzene, toluene, and formaldehyde. The data indicate that both benzene and toluene actually increased across the fabric-filter. It is suspected that the both VOCs at the inlet were actually higher than shown, but as VOC's such as toluene and benzene may be absorbed directly on particulates, a representative sample may have not obtained in the high-particulate/highcarbon inlet test location. An additional test is planned to determine VOC emissions and confirm these data. While the formaldehyde emissions are very low, the field blanks contained 35 ppb of formaldehyde at the inlet and 16 ppb of formaldehyde at the outlet. The field blank measurements were at or even higher than the gaseous sample. The sample viles for both the field blank and measurement samples were NOT stored in an air-tight nitrogen-purged desiccator. It is possible that the samples may have been contaminated with formaldehyde in the air that may have penetrated the sample seal. Future testing will use the air-tight sealing system with a nitrogen purge to eliminate this possible contamination point.

Finally, the emissions of nitrogen-based cyanide at both the inlet and outlet were below the detection limit.

Analysis
Toxics
ıl Air
. Co
Table 7

			Base Tex	st Method				Neui	tron Activ	ation Anal	lysis	
	Test 1	Test 2	Test 3	Average	Uncert	Blank ⁴ Correct	Tcst 1	Test 2	Test 3	Average	Uncert	Blank Correct
Trace Metals	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	%	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	mg/Kg
Arsenic ²	<05	<05	×٥5	2. 0>	53	0:0	0.55	0.40	0.49	0.48	64	0
Barium ²	0.61	28	21	z	182	6.9L	350	525	383	419	<u>55</u>	0
Beryllium	0.21	0.24	0.23	0.22	18	13L						
Cadmium	60'0	<0.05	<0.05	<0:05	117	0.0	0.13	60.0	0.11	0.11	8	0
Chromium	0.8	1.3	1.1	1.1	85	711'L	3.00	3.50	2.05	2.85	2	0
Cobalt	0.8	1.0	1.0	0.9	IE	0.0	0.74	0.75	0.70	0.73	11	0
Copper	2.7	2.8	2.7	2.7	7	15L						
Icad	2.1	2.5	1.6	2.1	S	12.0L						
Manganese	3.4	5.9	3.4	4.2	8	13.0L						
Mercury ²	<0.1	0.1	<0.1	<0.1	74	0:0	0.025	0.026	0.013	0.021	25	0
Molybdenum	<0.1	<0.1	0.2	0.1	217	0:0	0.89	1.20	0.95	10.1	41	0
Nickel	0.4	0.8	2.0	9:0	87	10.11						
Selenium ²	<0.05	< 0.05	<0.05	<0.05	53	0.0	0.75	0.77	0.93	0.82	31	0
Phosphorus	510	330	370	410	23	0.0						
Vanadium	2.6	3.5	2.8	3.0	40	3.3L						
Acid-Forming Anions	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	%	mg/Kg	mg/Kg	mg/Kg	mg/Kg	8	8
Chloride as CI ⁻⁽²⁾	0 9	< 100 ¹	600	009	80	0	19	22	26	ង	60	0
Fluorine as F ⁻	R	83	8	25	16	0						
Phosphate ³	1564	1073	SE11	1300	ß	0						
Sulfate	14100	13200	12300	13200	99	0						
II NOTE / indicates th	bet the quantit	tv measured u	vac less than t	he detection b	mut thus the c	detection limit	is shown.					

All values are reported on an as-received basis for the coal. All values are reported on an as-received basis for the coal. ¹ Results from this sample inconsistent with other data and was not included in the average. ² Neutron activation analysis results was used for these trace species rather than the base method. ³ Phosphate values are reported but are not believed accurate. Ion-chromatography many not be appropriate technique for measurment. ⁴ R (Reagent Blank Correction) or L (Laboratory Blank Correction) indicate the type of blank correction.

			Base Te:	st Method				Neut	ron Activa	tion Anal	vsis	
	Test 1	Test 2	Tcst 3	Average	Uncert	Blank Correct	Test 1	Test 2	Test 3	Average	Uncert	Blank Correct
Radionuclides	pCi/g	pCi/g	pCi/g	pCi/g	r K	%			Not App	icatble		
Uranium-233,-234	0.16	0.13	0.11	0.13	47	0				Γ		
Uranium-235	<0.01	<0.01	0.02	0.01	217	0			_			
Uranium-238	0.12	0.05	0,11	0.0	101	_						

0 Q 0 0 0 0 0

101

0.09 0.28 0.24

0,11 0.24 0.16 0,7 0.20 0.12 0.30 0.15

0.05

11.0

0.29

Radium-226 Radium-228 Lead-210¹

0.20 <0.69 <0.10 0.08 0.17 0.04

0.35 0.37 0.10

Polonium-210

Thorium-230

Thorium-232

Thorium-228

0.09 0.12 0.12

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0.50 0.12 0.10

163

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0.20 0.10

137

Table 7 - Coal Air Toxics Analysis Continued

NOTE < indicates that the quantity measured was less than the detection limit thus the detection limit is shown All values are reported on a dry basis for the coal. ¹ The highest non-detect was not used for the **average**, dection limits varied by sample.

emissions were very low. Radionuclides were also near the detection limit in the testing of the inlet fuel. Small variations can cause a large variation in the mass balance. No known sampling or analytical problems were reported that would account for the varying closure. All duplicates, blanks, spikes, and other quality assurance checks were within acceptable ranges.

Table 9 also shows the percent removal for the metal and anions measured. The FFDC was very effective for metals removal with an overall 97.1% removal. The FFDC does appear to provide slight removal of the anions, however, the removals are within the uncertainty of the data and may not be significant.

Generally, the test program used the analytical methods specified in the EMP. However, some of the methods were changed in order to improve detection limits or confirm data that was measured using the analytical methods specified in the EMP. Table 10 lists the air toxics that were analyzed with a different method than specified in the EMP.

The 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 concentration of the toxic in the sample, mass flows of the solid and gas are required. Table 11 lists the mass flow rates of the flue gas and solids used to determine the mass flow of the toxics. Note that there are three different flue gas flow rates listed for metals, particulate matter and anions, and PAHs. The actual flue gas flow rate was used for each test as they were conducted at different times. The flue gas flow rate used for the VOC, formaldehyde and cyanide tests were from the concurrent major test that was being conducted. Coal flow was measured using the existing plant equipment. Flyash and stack ash flow was calculated using the measured particulate loading and flue gas flow.

	EMP Specified Method	Method Used
FFDC Inlet Benzene Toluene Cadmium Chromium	EPA TO-14 w/GC-PID EPA TO-14 w/GC-PID EPA SW 846-7421 (GFAA) EPA SW 846-7421 (GFAA)	EPA TO-14 w/GC-MS EPA TO-14 w/GC-MS EPA SW 846-6010 (ICP) EPA SW 846-6010 (ICP)
FFDC Outlet Benzene Toluene Cadmium Chromium	EPA TO-14 w/GC-PID EPA TO-14 w/GC-PID EPA SW 846-7421 (GFAA) EPA SW 846-7421 (GFAA)	EPA TO-14 w/GC-MS EPA TO-14 w/GC-MS EPA SW 846-6010 (ICP) EPA SW 846-6010 (ICP)
Fuel Arsenic Barium Chlorine Mercury Selenium Cadmium Chromium Lead Manganese	EPA SW 846-7060(GFAA) EPA SW 846-6010(ICP) ASTM D-4208(ISE) EPA SW 846-7470(CVAA) EPA SW 846-7740(GFAA) EPA SW 846-7131(ICP) EPA SW 846-7191(GFAA) EPA SW 846-7421(GFAA) EPA SW 846-6010(ICP)	INAA INAA INAA INAA EPA SW846-6010(ICP-AES) EPA SW846-6010(ICP-AES) EPA SW846-7420(GFAA) EPA SW846-6010(ICP-AES)
Bottom Ash Fluoride Lead Cadmium Chromium	EPA 300.0(IC) EPA SW 846-7421 (GFAA) EPA SW 846-7131(ICP) EPA SW 846-7191(GFAA)	EPA 340.2(ISE) EPA SW 846-6010 (ICP) EPA SW846-6010(ICP-AES) EPA SW846-6010(ICP-AES)
Flyash Fluoride Lead Cadmium Chromium	EPA 300.0(IC) EPA SW 846-7421 (GFAA) EPA SW 846-7131(ICP) EPA SW 846-7191(GFAA)	EPA 340.2(ISE) EPA SW 846-6010 (ICP) EPA SW846-6010(ICP-AES) EPA SW846-6010(ICP-AES)

Table 10

STREAM MASS	S FLOW DATA		
	Test 1	Test 2	Test 3
Flue gas flow, metais inlet (DSCFM)	247,200	252,100	261,800
Flue gas flow, metals outlet (DSCFM)	245,700	253,100	264,900
Flue gas flow, PM/Anions inlet (DSCFM)	245,800	250,200	255,900
Flue gas flow, PM/Anions outlet (DSCFM)	244,300	251,200	258,900
Flue gas flow, PAH inlet (DSCFM)	245,000	245,300	243,500
Flue gas flow, PAH outlet (DSCFM)	248,200	247,100	244,800
Coal flow (lb/hr)	86,800	88,900	88,800
Total ash flow (lb/hr) ¹	7,670	7,850	7,840
Bottom ash flow (lb/hr)	1,450	1,490	1,480
Flyash flow (lb/hr) ²	6,610	6,840	6,790
Stack ash flow (lb/hr) ²	0.56	4.1	1.9

Table 11

¹Total carbon-free ash flow calculated using coal flow and average ash content of fuel over the test period.

²Mass flow of ash calculated from measurement of ash concentration multiplied by calculated flow of flue gas.

INTEGRATED DRY NO₂/SO₂ EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Low-NOx Combustion System Retrofit Test Period: August 3, 1992 through October 29, 1992

Baseline Air Toxics Test Period: November 17, 1992 through November 19, 1992

Appendix A

State Emission Reports



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

October 19, 1992

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

RE: Third Quarter, 1992 Excess Emissions Report, Arapahoe Units #1-4

Dear Roy:

Attached is the excess emissions report for the third quarter, 1992, 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 - 694.5 hours, Unit #2 - 659.5 hours, Unit #3 - 770.9 hours and Unit #4 - 2,119.7 hours.

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

Sincerely,

the J. Cehlonia

Peter J. Cohlmia Chief Environmental Scientist

PJC:tc

Attachments

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>1992</u>
- c. Reporting date: <u>10/9/92</u>
- d. Person completing report: <u>Mark Spomer</u>
- e. Station name: <u>Arabahoe 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.

а.	Opacity Monitor:	Unit 1	Unit 2	Unit 3	Unit 4
b.	Manufacture:	Lear Siegler	L.S.	L.S.	L.S.
c.	Model No:	RM 41	RM41	RM4 1	RM 41
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

a. Zero and Cal values used, by instruments:

Zero	Unit 1	Unit 2	Unit 3	Unit 4
	0.0	0.0	<u>0.0</u>	0,0
Cal	52.5	<u>51.7</u>	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. Cohimia SIGNATURE Ret Collinia Title ____ Chief Environmental Scientist Date 10/20/92

* Suggested Format for Subpart D sources in:

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

TABLE I

Excess Emissions

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

_<u>SO²</u>

No violations

Coal sampling and analysis during the quarter indicated an average SO2 content of 0.803 lbs/MMBtu.

Opacity

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.

Page 4 of 4

TABLE II

Continuous Monitoring System Operation Failures

Date	Time* From - To	Instrument	Effect on Instrument Output
7/01/92	0000 to 7/07 1315	#1,2,3,4 RM41	Connecting wiring to WDPF
7/13/92	1045 to 7/13 1550	#1 RM41	Calibration and Audit
7/14/92	0640 to 7/14 1410	#2 RM41	Calibration and Audit

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**************** OPACITY MONTHLY DATA REPORT

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POWER PLANT: ARAPAHOE SOURCE - CURRENT UNIT: 🛉 👘 1.11.1 REPORT START TIME: QUARTER = 3 7/1992

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DAY		VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
· • ·	A	В	Ċ	D *	E	FACTOR	OPACITY
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7/06	0	ġ	R	3	7	2+	4.0
7/07	0	0	0	0	D	24	3.8
7/00	0	0	0	0	0	24	<i>n</i> .0
7/09	0	0	0	0	0	24	3.6
7/10	0	0	Ō	0	0	24	4.1
7/11	0	0	0	0	0	24	4.1
7/12	0	0	0	0	0	24	4.3
7/13	0	0	0	0	0	24	3.8
7/14	0	D	D	D	0	24	4.3
7/15	0	0	D	0	e	24	4.4
7/16	0	0	0	0	0	24	3.9
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7/15	0	0	0	• • • •	C	24	4.0
7/19	0	0	0	0	0	24	
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********* OPACITY MONTHLY DATA REPORT

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POWER PLANT: ARAN	ΡΑΗΟΕ		
UNIT: 4	SOURCE = CURRENT		
REPORT START TIME:	: OUARTER = 3 8/1992	•	ि वि

DAY		VIOL	ATION CATE	GORY		WEIGHT	AVERAGE
•••••	A	B	С	D	Ε.	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%		7.
8/01	0	0	0	D	0	24	3.9
8/02	0	0	0	0	0	24	4.0
8/03	0	0	0	D	0	24	3.9
8/04	0	. 0	0	0	0	24	3.9
8/05	0	0	0	0	. 0	24	4.4
B/06	0	0	0	0	0	24	3.9
€/07	0	0	0	0	0	24	4.4
8/08	0	0	0	0	0	24	4.5
8/09	0	0	D	0	0	24	4.3
8/10	0	0	0	0	0	24	4.4
8/11	0	0	0	Q	0	24	3.8
8/12	0	0	0	0	0	24	4.1
8/13	0	0	0	0	0	24	3.6
8/14	0	0	0	0	0	24	4.0
8/15	0	D	D	0	0	24	3.9
8/16	0	0 ·	0	0	0	24	4.5
8/17	D	0	D	0,	0	24	4.1
8/18	0	0	0	0	0	24	3.15
8/19	0	0	0	0	0	24	4.0
8/20	0	0	0	0	0	24	4.5
8/21	D	D	0	D	0	24	4.2
8/22	0	0	. 0	0	C	24	4.3
8/23	0	0	0	0	0	24	4.1
8/24	0	0	0	0	Ο.	24	4.2
8/25	0	D	0	0	0	24	3.7
8/26	0	0	0	0	0	24	3.3
8/27	0	0	0	0	0	24	4.5
8/28	0	0	0	0	0	24	4.6
8/29	0	0	0	O .	0	24	4.5
8/30	0	0	D	0	. · D	24	4.0
8/31	0	0	0	0	0	24	3.7
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****** OPACITY MONTHLY DATA REPORT

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POWER FLANT:	ARAPA	HOE		
UNIT: 4		SOURCE = CURI	RENT	
REPORT START	TIME:	QUARTER = 3	9/1992	

DAY	VIOLATION CATEGORY WEIGHT AVERA						AVERAGE
-	A	ъ В	С	D	E	FACTOR	OPACITY
	20-25%	25-30%	30-35%	35-45%	OVER 45%	•••	X
9/01	0	0	0	0	0	24	3.9
9/02	0	0	0	0	0	24	4.0
9/03	0	0	0	0	0	24	4.1
9/04	0	. 0	0	0	0	24	4.6
9/05	0	0	0	0	. 0	24	4.2
9/06	0	0	0	0	0	24	4.4
9/07	0	0	0	0	0	24	4.1
9/08	0	0	0	0	0	24	4.3
9/09	0	0	0	0	0	24	4.3
9/10	O	0	0	0	0	24	4.5
9/11	0	0	0	0	D	24	4.5
9/12	0	0	0	0	0	24	4.4
9/13	0	0	0	0	D	24	4.1
9/14	0	0	0	0	0	24	4.5
9/15	O	0	0	0	0	24	4.3
9/16	0	0	0	0	0	24	4.4
9/17	0	0	0	0.	0	24	3.9
9/18	0	0	0	···· 0	0	24	3.4
9/19	0	D	0	0	D	24	3.4
9/20	0	0	0	0	0	24	3.2
9/21	0	0	0	0	0	24	3.7
9/22	0	0	0	0	0	24	3.7
9/23	0	0	0	0	· D	24	3.4
9/24	Ō	0	0	0	0	24	5.5
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********	********** OPAC	ITY Violat	**************************************	******
POWER PL Unit: 4 Report P	ANT: ARA Period:	(PAHOE Source : Quarter	= CURRENT = 3 1992	
REASON CODE Hourly Exc Upset Excl	S FOR: LUSIONS = USIONS =	none none		
START DATE-	TIME EN	D DATE-TIM	E MIN-Z MAX-Z AVG X TYPE	VIOLATION REAS
7/2/92	13 E×	LESSES	UNIT STRETUPS ! SHUTDOWNS	
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TOTAL VIOLATIONS = 28

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

January 29, 1993

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

RE: Fourth Quarter, 1992 Excess Emissions Report, Arapahoe Units #1-4

Dear Roy:

T

Attached is the excess emissions report for the fourth quarter, 1992, 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 - 1,661.9 hours, Unit #2 - 1,163.6 hours, Unit #3 - 1,731.4 hours and Unit #4 - 2,205.3 hours.

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

Sincerely,

-1_ Cohlonin

Peter J. Cohlmia Chief Environmental Scientist

PJC:tc

Attachments

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: 01/12/93
- 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: <u>294-2810</u>

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.
с.	Model No:	RM4 1	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.

Part 4 - Conversion factors

8.	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	<u> 51.7 </u>	_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_Pitz J. Cohlmin SIGNATURE_Rate J. Cohlmin Title_Chief Snvium mental Scientist Date 1/29/93

* Suggested Format for Subpart D sources in:

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

TABLE I

Excess Emissions

Date	Time* From - To	Pollutant	Magnitude* Lb/106 BTU
		_ <u>\$0</u> ²_	

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No violations

Aug SC2 EXIC INTAMIATIN (14th included in report, data Chitained from Marilyn Thompson 9116193)

Opacity Funth Attached is additional information for excesses occurring during the Total Quarter

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

Continuous Monitoring System Operation Failures

Date Time* From -- To Instrument Effect on Instrument Output

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INTEGRATED DRY NO₂/SO₂ EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Low-NOx Combustion System Retrofit Test Period: August 3, 1992 through October 29, 1992

Baseline Air Toxics Test Period: November 17, 1992 through November 19, 1992

Appendix B

Aqueous Stream Compliance Data



Public Service Company of Colorado P.O. Box 840 Denver, CO 80201-0840 (303) 294 - 8500 FAX (303) 294 - 8815

James R. McCotter Senior Vice President General Counsel and Corporate Secretary

September 24, 1992

Colorado Department of Health Colorado Water Quality Control Division Monitoring & Enforcement Section 4210 East 11th Avenue Denver, CO 80220

RE: Discharge Permits: CO-0000027 Cameo CO-0000612 Comanche CO-0001139 Zuni CO-0001104 Cherokee CO-0001091 Arapahoe CO-0001112 Valmont CO-0001121 Fort St. Vrain

Dear Sir:

Pursuant to the discharge permits issued on the above Public Service Company of Colorado plants, the attached NPDES Discharge Monitoring Reports for the month of August, 1992 are hereby transmitted.

Sincerely,

mobile

James R. McCotter Senior Vice President General Counsel and Corporate Secretary

Attachments

cc: U.S. E.P.A. Region VIII ATTN: Enforcement-Permit Program Denver Place - Suite 500 999 - 18th Street 8WM-C Denver, CO 80202-2405

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(NEPLACES EPA FORM T-48 WHICH MAY NOT BE USED.) Form 3320-1 (Rev. 10-79) PREVIOUS EDITION TO BE USED

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Public Service Company of Colorado P.O. Box 840 Denver, CO 80201-0840 (303) 294 - 8500 FAX (303) 294 - 8815

James R. McCotter Senior Vice President General Counsel and Corporate Secretary

Colorado Department of Health Water Quality Control Division Monitoring & Enforcement Section 4300 Cherry Creek Drive South Denver, CO 80222-1530

RE: Discharge Permits: CO-0000027 Cameo CO-0000612 Comanche CO-0001139 Zuni CO-0001104 Cherokee CO-0001091 Arapahoe CO-0001112 Valmont CO-0001121 Fort St. Vrain CO-0000523 Hayden

Dear Sir:

Pursuant to the discharge permits issued on the above Public Service Company of Colorado plants, the attached NPDES Discharge Monitoring Reports for the month of September, 1992 are hereby transmitted.

Sincerely,

October 24, 1992

ames R. McCotter

Attachments

cc: U.S. E.P.A. Region VIII ATTN: Enforcement-Permit Program Denver Place - Suite 500 999 - 18th Street 8WM-C Denver, CO 80202-2405

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Public Service Company of Colorado P.O. Box 840 Denver, CO 80201-0840 (303) 294 - 8500 FAX (303) 294 - 8815

November 24, 1992

James R. McCotter Senior Vice President General Counsel and Corporate Secretary

Colorado Department of Health Water Quality Control Division Monitoring & Enforcement Section 4300 Cherry Creek Drive South Denver, CO 80222-1530

EE: Discharge Permits: CO-0000027 Cameo CO-0000612 Comanche CO-0001139 Zuni CO-0001104 Cherokee CO-0001091 Arapahoe CO-0001112 Valmont CO-0001121 Fort St. Vrain

Dear Sir:

Pursuant to the discharge permits issued on the above Public Service Company of Colorado plants, the attached NPDES Discharge Monitoring Reports for the month of October, 1992 are hereby transmitted.

Sincerely,

James R. McCotter

Attachments

cc: U.S. E.P.A. Region VIII ATTN: Enforcement-Permit Program Denver Place - Suite 500 995 - 18th Street 8WM-C Derver, CO 80202-2405

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ю диу 092 1 0 0 Егнент селсе Vol не	PERMIT REQUIREMENT										
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COTTER. JAMES R. . VICE PRESIDENT	× 200 € 2	Y INCUMEY OF THOSE NING THE NAFORMATICH DE ACCURATE AND CO NY PENALTIES FOR S	MUCIVICIJALS HAMEENAT I BELEVE THE SI MPLETE I ANA AWARE UBMITTING FALSE MI	ELY RESPONSIBL JBMITTED INFOH THAT THERE AF CORMATION INTI	E FOR MATHON ME SIG MINIC						
	2 11	OSSIBILITY OF FINE AN C. 9.1319 (Prodition and maximum imprimented)	D IMPHISONMENT SEE or three platates may in heliaers h munitivend 3	relate force as to select force as to search	Elanu SIGNA	TURE OF PRINCIN	AL EXECUTIVE		AUDUO NUMBER	YEAR W	DAY DAY
MENT AND EXPLANATION OF ANY	VIOLATIONS IR	clerence all attachment	s here)								

		VILANOT .		10010	ARGE MUN (2.16)	LOWING REP	JRT (DMR) (12.19)				OMB No. 2	040-0004
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Water Water <th< th=""><th>HITY ARAPAHDE</th><th></th><th></th><th>FROM QT</th><th>MO 01</th><th>TO VEAR</th><th>MG DAV</th><th></th><th></th><th></th><th></th><th></th></th<>	HITY ARAPAHDE			FROM QT	MO 01	TO VEAR	MG DAV					
				(20.21)	122 231 (24.2	112.92) 15	(18 - 291 (30 31)	NOTE: Read ins	tructions be	fore con	pleting thi	t form.
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AND GREASE Leaverage NO BLSCHIAREE OAL ENDIAL OAL CANAL	(32-37)		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MUMIXUM		(62-63)	(64-68)	(69-70)
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OTTER. JAMES R. ON MY MOUNT OF THOSE MOUNDAIRS INTERVALUES TO REMOVEMENT FOR MOMATION TO A MANAGEMENT OF MANAGEMEN	E/TITLE PRINCIPAL EXECUTIVE	OFFICER I CER	THY UNDER PENALTY O	F LAW THAT I HAVE MFORMATION SUBMITT	PERSONALLY EN	BASED	2		TELEPHO	ΥE	× _	u + E
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INTEGRATED DRY NO,/SO2 EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Low-NOx Combustion System Retrofit Test Period: August 3, 1992 through October 29, 1992

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Baseline Air Toxics Test Period: November 17, 1992 through November 19, 1992

Appendix C

Combustion Retrofit Data Summary

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fest	Date &	Time	Description	Load Mil		irner (<			3	2000				
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000	00/20/01	10.00	BO DO NAV Americk An Exceed			101011	100/100	5 00 F	100	2	10 121	E O E	13	367	2	2	2	
	26/00/92	00.01								r u				272				
	76//0/00		100-115 MM dispatch, As round					ימ		יית י					5			
203	08/10/92	08:28	As Found	100	4	.145	100/100	4.05 B	162 2	ni En	35 57	286		0/6	07.9	5.4C	, , ,	
201	38/10/92	14:38	OFA Dampers to 40%	100	45	-145	40140	3 99 B	1 98 1	υΩ΄ ++	60 42	310	12.9	375	Q .9	5.60	5.7	
205 (38/11/92	08:23	As Found	100	45	-145-	100/100	3.96 8	115 2	iú ∾	10 48	277	13.2	374				
506 (20/11/9C	10:00	Secondaries to light-off	100	45	.145.	100/100	3.96 B	192 2	7 5.	20 27	290	13.1	976				
07 (38/11/92	14:40	Secondaries @ light-off, Reduced OFA	66	45	-145-	50/53	3.97 B	90 2	1 5	15 40	285	13.0	372				
903	38/12/92	14:00	Repeat 207 Next Day	100	45	.145.	52/52	3.89 9	28 2	0 2	30 100	3 288	13.1	372				
603	20/12/92	15:05	B Group Secondaries to Normal	100	45	-145-	52/52	4.12 9	111 2	- 2	00 325	269	13.2	371				
210 (78/12/92	16:12	C Group Secondaries to Normal	100	19 14 12	-145-	52/52	3.95 9	116 2	0	30 62	291	13.0	376				
211 (28/13/92	09:58	104 MW As Found. Aborted due to Dispatch	104	5 ¥	-145-	100/100	Ð	199 2	2.5	30 64	288	13.1	116				
212	38/13/92	10:38	110 MW. As Found	110	45	-145*	100/100	4.03 9	10 2	2 2	20 39	302	13.2	368				
213 (78/13/92	14:15	110 MW. Balanced Secondary Air Flows	110	45	-145-	100/100	3.95 9	165 2	с С	00 19	298	13.2	369				
214	28/11/92	09:13	A Mit OOS. AS Found	101	45	-145-	100/100	3.93 B	188 2	ب در	80 152	270	12.9	377			10.8	
215 (78/14/92	12:06	A Mill OOS. OFA Flow Biased to East	101	45	-145-	55/100	3.99 9	28 2	ы С	60 112	296	12.2	283			10.5	
216	14/92	14:10	A Mill OOS, OFA Dampers @ 40%	101	45	-145-	40/40	396 8	1 161	່ມ ເມ	70 271	1 298	12.1	382				
17	JB/14/92	16:30	A Mill COS. OFA @ 100%, immers @ 45*-2	101	00	.145.	100/100	4.10 8	20 2	9	30 342	268	12.	378				
91	18/14/92	16:30	All Mills, OFA @ 100%, inners @ 452	101	30	-145-	100/100	3.97 8	159 2	•	90 54	238	12.9	378				
	117/92	10:36	PSCC VWO Heat Rate Test	113	30	.145*	100/100	4.00 9	80 2	. .	15 60	287	13.6	377	5.90	5.40		1881
200	10/10/02	0.000	DEA D INTE Intern@16.2 Diam D46		UE UE	.115	100/100	104	111 2	4	85 74	246	13.4	368	4.85	5.25	9.1	1834
			An The route Balance Burner Constants							- -		043	13.7	300	4 65	6 00	77	
	ZANDLING	15:51	AS 220 WITH DAMINOUS DUMAN SOCOMMERCES		20			2 6		r •								
222	08/18/92	15:38	As 221 with outers to 45*-2	100		-0£/-	100/100	4.02 1	169 3		10 36	112	0.51			9.10	-	
223 (08/18/92	17:25	As 222 with Secondaries at normal position	100	30	.06/.	100/100	4.00 B	86 2	si ►	15 38	279	9.64	406				
224	<u>00/19/92</u>	08:59	Repeat 223 next day	100	30	.0E/.	100/100	1.06	156 2	₩.	83 56	256	13.3	410	9.4	5.90	7.3	1829
225	76/18/92	11:04	Repart 220	100	30	-145	100/100	4.02 B	145 2	÷ e	53 47	248	13.7	417	4.60	6.65	7.9	1874
26 (26/18/80	14:33	OFA @ 100%, imens@45*-3, Outens@45*	100	22	-145-	100/100	4.02 B	140 2	₹ 4	10 88	244	13.6	418	4 .60	6.65	7.7	1832
27 (18/20/92	08:48	Repeat 226 next day	100	22	-145-	100/100	4.03 8	153 2	4 4	63 81	235	13.4	11	4.80	5.65	9 .4	1797
28	78/20/92	11:02	inners to 45°	100	45	-145-	100/100	1.01 8	148 2	- -	58 140	0 238	13.2	11	4.65	6.65	7.1	1908
28 (78/21/92	08:43	C Mill OOS, Innr @ 45-2, otra @ 45, JowO2	100	C 30	-145-	100/100	3.24	123 2	4	35 21	5 261	11.6	420			10.3	1789
30	18/21/92	10:36	As 229 with normal O2	100	0000	-145-	100/100	4.02 8	162 2	+ ~	90 38	283	14.2	190			6.9	1834
16	18/24/92	10:23	OFA @ 100%, inners@45*-2, Outens@45*	100	30	-145-	100/100	3.99 8	141 2	9 10	75 253	9 235	13.0	538	4,80	6.65	8 .2	9891
32	18/24/92	15:21	Repeat 231 (LOI Problems)	100	30	-145-	100/100	4.00 8	168 2	*	85 226	9 242	1.0	548			0 .0	
33 (18/25/92	07:55	100 MW, 100% OFA, 4.0% CR O2	100	30	-145-	100/100	3.96 8	165 2		97 121	1 240	Ξ	550	¥.05	6.95	4.7	1845
34 0	18/25/92	10:23	As 233 with W/E OFA Dampers @ 45/42%	100	30	-145-	45/42	3.85 8	196 1	ю́ Ю	43 122	276	13.8	532	5.25	7.20	3.4 . C	1838
35 (18/25/92	12:46	As 233 with W/E OFA Dempers @ 35/32%	100	30	-145*	35/32	4.14 8		s. S	50 58	298	13.4	190	5.45	7.35	3.8	1880
36 0	18/25/92	15:01	As 233 with W/E OFA Dampers @ 55/58%	100	30	.145*	55/58	4.15 8	198 2	0 0	18 76	263	13.7	611	8.9	7.60	6.0	1882
37 (18/26/92	09:00	B0 MW, 100% OFA, 4.9% CH O2	80	30	-145*	100/100	4.91 6	:86 2	න් ස	70 65	219	13.2	423	5.55	7.45	5.5	1710
38 0	18/26/92	11:46	As 237 with W/E OFA Dampers @ 30/34%	00	90	•145*	90/34	4.86 7	24 1	9 0	38 22	276	12.7	415	6.20	7.75	2.8	1732
39 6	18/2 6/92	13:58	As 237 with W/E OFA Dampers @ 45/44%	80	30	-145-	45/44	4.91 6	1 161	ف و	02 84	247	12.8	115	6.65	7.65	4.5	1748
10 0	18/2 8/92	08:33	BO MW, 100% OFA, 5.7% CR OZ	80	30	-145-	100/100	5.69 7	69 2	ю е	70 19	247	12.1	108	6.65	7.70	3.6	1669
1.1	38/2 8/92	10:40	As 240 with W/E OFA Dampers @ 40/42%	80	30	-145-	40/42	5.76 3	176 1	*	02 9	285	12.1	405	8.80	7.70	2.1	1716
12	18/28/92	14:27	As 240 with W/E OFA Dampers @ 25/29%	80	30	.145	25/29	5.70 7	191	~	13 6	314	11.8	403	6.95	7.15	1.7	1760
	18/26/92	16:36	As 242 with avg 02 reduced to same as 240	80	30	-145-	25/29	5.13 7	131	Ś	18 8	287	12.3	1 406	6.50	6.65	2.4	1755
	NA/29/92	08:09	60 MW. 100% OFA 7.0% CR OZ	60	C 30	-145	100/100	6.94 6	329 2	- 10	98 11	304	Ξ	412	7.90	B.20	2.1	1538
	NA/20/02	10:13	As 244 with W/E OFA Dampers @ 42/39%	60	30	-145-	42/38	6.99 6	1 1 1 1	6 6	11 66	310	11.2	423	0.25	0.40	3.0	1570
1.840	XA129/92	12:05	As 244 with W/E OFA Dampers @ 25/20%	60	C 30	-145-	25/20	6.94 6	579 1	6	50 9	337	11.2	476	8.45	8 .60	2.2	1580
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Arapahoe 4 Retrolit Burn. Jata Summary

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Arapathoe 4 Retrofit Bu. . Data Summary

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Test	Date &	Time	Description	Load N	Aills	Burner	OFA Dmprs	CR 02	Total	OFA	õ	8	ğ	S	O2c Air	htr Sta	Ц К	DI Acol	ustic
	l			MWe	80	Spin Vanes	% Open	% wel	Air	Flow	*	E mdo	Ðu	ほえ	0 8	0 8	2 FEF	E S	đ
						nner/outer	West/East		kpph	×		ň	20,	8	8				╻
247	08/29/92	14:08	As 246 with avg O2 reduced to same as 244	60	ပ	30°/45°	25/20	6.42	646	0	B. 05	9	108	1.1	112 7.	90 8.2	25 S.	2 15	68
946	00/06/00	DR 32	60 MW 100% OFA 62% CB 02	60	B	30°/45°	100/100	6.23	591	26	7.70	:	56 1	1.5 5	29 7.	10 7.7	70 2.	0 16	20
	20/06/00	10.16	As 248 with W/E DEA Demonster @ 42/30%	09	: a	30.45	66/24	6.24	596	9	A 07		68	5	19 7	65 7.9	5 2.	9 15	95
	00100100		As 240 Will FVIC OFA Dempora © 10/16V				16/15	6 27	613	2			10			S B OB	5	15	98
250	26/06/80	CU.21								.		 					i e ju	16	5
251	26/06/90	13.51								7 4				, . , .					4
252	08/30/92	15:28	As 250 with avg 02 reduced to same as 248	60	Ð	30-/45	61791	0. 0	5/5	n	20.7		60				5 (5 (
253	08/31/92	08:22	80 MW, 100% OFA, 4.7% CR O2, Rpt 237	80		30-/45-	100/100	4.71	114	23	5.75	51	20 1	3 2	52 5.	22 E.1	0	<u> </u>	D S
254	08/31/92	10:49	As 248 with Drupes @ 31/29%, Rpl 238	80		30-/45"	31129	4.82	732	2	6.2 0	23	1	2.7 5	55 6.	05 6.7	-	6 17	5
255	08/31/92	12:41	As 254 with 02 Bias at -0.25%	90		30-/45-	31/29	4.50	712	9	6.00	30	1 95	3.1.5	54 5.	70 6.4	1.	B 17	76
256	00/31/92	15.23	As 254 with 02 Bias at -0.70%	80		30-/45-	31/29	4.03	709	₽	5.82	75	121	3.1 5	57 5.	60 6.2	20.2	0 17	4 6
257	09/01/92	08:21	100 MW, 100% OFA, 4.5% CR O2	100		30-/45-	100/100	64.4	663	24	5,47	20	191	3.4.5	57 5.	25 5.6	0 2	6 19	12
258	09/01/92	10:16	As 257 with OFA Dampers @ 50/50%	100		30-/45-	50/50	4.51	905	18	5.63	23	182 1	3.3 5	53 5.	65 6.2	25	6 19	17
259	09/01/92	12:18	As 257 with OFA Dampers @ 35/35%	100		30-/45-	35/35	4,49	106	12	5,90	12	-	3.0 5	57 5.	BO 5.3	2	+ 18	1
260	09/02/92	08:42	100 MW, 100% OFA, 3.5% CR O2	100		30-/45-	100/100	3.52	822	23	4.27	212	21	4.4	25 4.	20 4.7	75 8.	0 19	5
261	09/02/92	11.14	As 260 with OFA Dampers @ 50/50%	100		30-/45-	50/50	3.55	865	18	1.95	251	57 1	3.7 4	196 4.	20 4.9	5.	ē - 6	5
262	09/02/92	13:18	As 260 with Drupps @ 43/44%, Aborted	105		30-/45-	49/64	3.28	906	16	1.90	285	181	4.2.4	153		~	6 18	97
263	09/02/92	14:49	As 260 with OFA Dempers @ 43/44%	100		30-/45-	43/44	3.36	854	15	0.0	918	122	3.7 A	1 36 4.	50 4 .t	.9 0	-	
264	09/03/92	08:55	100 MW. 100% OFA. 5.0% CR O2	100		30-/45-	100/100	4.88	878	54	5,60	27	115 1	9 S C	16 5.	60 6.0	0 5	8	28
365	00/03/92	10-49	As 264 with OFA Dampers @ 49/50%	100		30-/45-	49/50	5.05	924	8	5,93	21	112 1	2.9	11 5.	85 6. 1	ي 5	2 18	EE
366	00/03/02	15-25	As 264 with CFA Dampers @ 32/35%	100		30-/45-	33/35	4.88	957	12	6.50	12	164 1	2.5 4	11 6.	15 6.6	4	3 1 8	02
296	09/03/92	08.08	BO MW. TOD'S OFA. 5.7% CR OZ	80		30-/45-	100/100	5.71	757	23	5.48	20	57 1	2.4 4	07		e,	6 16	95
	00/07/00	10-18	As 267 with OEA Dampers @ 42/40%	80		30-145-	42140	5.80	792	4	7.10	ø	106 1	1.9 4	10 8.	85 7.2	0.2	5 17	18
969	09/03/02	12-01	As 267 with OFA Dampers @ 26/28%	80		30-/45-	26/28	5.76	604	æ	7,15		133 1	1.7	107 6.	90 7.3	-	8 17	38
070	09/17/92	0.02	100MW, Drivers & 50/50%, 4.0% CR 02	100		30-/45-	50/50	4,13	881	18	5.55	139	1 683	3.2	1 09 5.	20 5.3	15 6.	7 18:	25
271	09/17/02	11-22	As 270 w/ Nox Port Spin Venes Wide Open	100		30-/45-	48/50	4.39	897	8	5.55	5		4 4 E	07 5.	45 5.4	÷	è T	8
61.6	00/17/92	11.39	As 270 w/ Norr Port Soin Vanes Chosed	100		30-/45-	55/61	4.10	606	8	5.58	16	123 1	3.4	105 5.	35 5.4	0.6	2 10	5
67.0	00/1 8/92	08-49	TOTANY, IBY, OFA. 40% CR 02, Pol 270	100		30-/45-	49/46	4.00	868	18	5.35	170 2	82 1	3.6	16 4.	80 5.4	0 2	18	26
	00/11/00	11:03	As 273 w/ Norr Port Soin Vanes Closed	100		30-/45-	58/56	4,18	071	18	5.35	27 2	1 10	3.7 4	15 5.	15 5.6	0	8 18	12
110	09/18/92	14:10	As 274 w/ NOx Port Centers Balanced	001		30-/45-	59/57	3.96	895	18	5.50		101	4.6	07 5.	10 5.7	0.5.	7 17	-
276	09/16/92	16:25	Quick Repeat of 274	100		30-/45-	57/57	4.18	869	18	5.35	20	1 66	3.6	90				
277	09/19/92	08:19	100MW, Port Varies Closed ,Centers Open,	100		45/45	98/100	4.10	885	8	5.45	80 2	60	9.0 9.0	60		فت ا	2	36
			Max OFA (19%), 4.0% CR O2, 45/45																
278	09/18/92	10:01	As 277 with inners/outers @ 45-2n/45	100		30-/45-	02/02	4.20	888	20	5.3 8	20	87 1	3.6	10		n		4
279	09/19/92	11:57	As 277 with inners/outers @ 45-3n/45	100		30-/45-	60/65	4.19	885	8	5.43	-	182 1		105		4 1		
280	09/19/92	14:57	As 277 with inners & outers • 45-2n	100		.0E/.0E	48/48	101	908	8	2.60		80	9.0	02		uù v		= ;
281	09/20/92	08:12	Repeat 277	100		45-145-	100/100	0.4	896	8	2 • 8	20	201	8	Ē		e ·	9 9 9	
282	09/20/92	09:39	As 281 with inners/outers @ 45-1n/45	100		37-/45*	100/100	4.27	698	20	5.38	37	1 161	9.0 9.0	60		•		57
283	09/20/92	11:00	As 281 with inners/outers @ 45-2n/45	100		30-/45-	65/00	4.18	895	19	5.50	9	108	3.6	107		•	8	09
284	09/20/92	14:19	A 283 with NOx Port Centers Balanced	001		30-/45-	80/100	3.57	901	18	5.53	19	105	3.6	103		4		08
285	09/21/92	06:30	110MW, Max OFA, 3.0% CR OZ	110		30-/45-	100/100	3.01	920	8	. 85 1	200	181	• •	120 4.	45 4.7	. 9	÷	8
286	09/21/92	10:35	110MW, Max OFA, 4.0% CR O2	110		30-/45-	100/100	3.97	970	21	5,65	36	136	9.9	119 5.	65 5.6	4	2	2
287	09/21/92	13:42	110MW, Max OFA, 4.8% CR O2	110		30-/45-	100/100	4.78	086	21	5,97	50		• •	113 5.	95 G.1	÷ (
286	09/21/92	15:14	Rpt 285, Abort Hall-Way Through	110		30-/45-	100/100	3.03	927	21	. 69.4	000	107	3.3	86		en i I		
289	09/22/92	08:34	110MW, Min OFA, 3.7% CR O2	110		30-/45-	26/17	3.69	1011	æ	2.90	123	177	90	12 6.	62 2'E	20 20	7 18(
280	09/22/92	10:34	110MW, Min OFA, 4.0% CR O2	110		30-/45-	21/19	3.96	1015	•	5,95	128	177	3.6	08 6.	82 5.8	S G		
201	09/22/92	14:17	As 200 w/ Mills Blased to Balance CR 02	110		30-/45-	21/19	3.91	875	8	5.70	520	153	3.6	05 <u>5</u> .	Q			

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Taat	Oala E Tin	-	 	N head	iit.	Rurner	OFA During	CB CB	[olal	V	8	2	ů Č	ര 8	02c Ai	rhtr St	ack L	OI Ac	oustic
		2		MWe C		bin Vanes	X Open	low %	Air	No.			0 E	- E - X	Ð	22	2 2 2	22	EGI
					-	ner/outer	Wesl/East		horry	*		: 6	8	ĥ	03	*	*	*	÷
292 0	1 20/23/02	10:50	110MW, 15% OFA, 4.0% CR O2	110		30-/45-	39/42	3.82	1018	15 6	12 7	3	75 1	1.1 3	93 5	90 6.	10 6	7	108
293 C	19/23/92 1	13:34	As 292 w/ Mills Biased to Balance CH 02	110		30-/45-	39/42	3.85	1002	Ξ	.85 1	82 3	64 13	0.2 3	92 5	60 5.	60	~	843
294 0	19/24/92 0	18.22	110MW, 21% OFA, 3.8% CR O2	110		30°/45°	100/100	3.81	981	2	.43 B	0	38 1	÷.	07 5	.05 5.	45	8	998
295 0	19/24/92 1	12:05	As 294 w/ Mills Biased to Balance CR 02	110		30°/45°	100/100	3.71	931	21	.33	6	36 14	1 .6 4	04		~	·2	876
296 0	9/25/92 0	00:13	110MW, 21% OFA, 3.8% CR O2, Rpt 294	110		30-/45*	100/100	3.73	975	21	.30 3	E 2	39 14	•	23		9	-	840
297 0	19/25/92 0	19:42	As 296 w/ 10% OFA Bias to East, 20% OFA	110		30-/45-	100/60	3.81	961	20	.33 2	E ~	38 10	÷ 6.1	17				840
298 0	1 25/92 1	11:17	As 296 w/ 20% OFA Blass to East, 19% OFA	110		30*/45*	100/50	3.73	974	19	.40 2	•	52 13		60		-0	9	853
299 0	19/25/92 1	13:04	As 298 (19% OFA) w E&W OFA Balanced	110		30-/45-	58/62	3.80	166	19 5	.38 3	2	37 13	• 6'1	15		9	0	844
300 0	19/28/92 1	10:58	100MW, 20% OFA, 3.85% CR 02	100		30-/45-	100/100	3.77	862	20	.23 1	10 2	63 14	Ŧ 0:	17 5	.05 5.	20 5	5	759
301 0	19/28/92 1	12:48	100MW, 20% OFA, 4.4% CR 02	100		30-/45-	100/100	4.37	882	2	.78 2	ŝ	00 10	*	14 5	35 5.	75 3	-	785
302 6	19/28/92 1	14:24	100MW, 20% OFA, 4.9% CR 02	100		30-/45-	100/100	4.90	934	21 6	.35 1	•	33 12	4	07 6	10 6.	25 2	.7	661
303 0	19/29/92	0:03	HVT Tests, 1111MW, 21% OFA, 4.0% CR 02	111		30-/45-	100/100	3.94	958	21	.45 7	5	22 14		19			-	838
304 0	0 26/06/60	08:43	100MW, 10% OFA, 3.8% CR O2	100		30-/45-	30/24	3.81	888	5	.65	9 9	20 13	8.	19 5	45 5.	75 6	s.	804
305 0	19/30/92 1	10:21	100MW, 10% OFA, 4.4% CR O2	100		30-/45-	30/30	4,41	897	5	.25	e.	49 13	- 	16 6 .	00 6	15 4	0	831
306 6	1 26/06/60	11:38	100MW, 10% OFA, 5.0% CR O2	100		30-/45-	30/30	4.89	946	2	.70	2	76 12	•	#1 0	35 6.	80	6	829
307 0	19/30/92 1	13:34	100MW, 15% OFA, 5.0% CR O2	100		30-/45*	44/47	4.93	911	15 6	.58	6	52 15	•	13 6	35 6.	4 B	0	808
308 6	1 28/30/82	15:00	100M/W, 15% OFA, 4.4% CR O2	100		30-/45-	44147	4.39	888	15	.13 3	2	01 EE	¥ 9.	14	00	15	ۍ ۲	813
309 C	19/30/92	16:18	TODAWY, 15% OFA, 3.8% CR O2	100		30*/45*	44/47	3.84	853	15	181	5	10 13	₹ 8,	05 6	4 0	70 5	2	834
310 1	0/01/92 0	19:3B	100MW, 24% OFA, 4.9% CR O2, OM Ports	100		30-/45*	100/100	4.95	683	2	.50 3	3	66 13	.7 4	00 5	45 5.	60 6		807
311	0/01/92 1	11:31	100MMV, 24% OFA, 4.4% CR O2, OM Ports	100		30-/46	100/100	4,45	856	24	90.3	0	68 11	•	10	10 5	25	5	840
312 1	0/01/92 1	13:37	100MW, 24% OFA, 4.0% CR 02, OM Ports	100		30-/45-	100/100	1.01	831	23	.38 2	20	1 9 9	*	1	45 4.	75 6	- 0	858
313 1	0/01/92 1	15:25	100MW, 20% OFA, 4.0% CR O2, New Ports	100		30-/45-	100/100	4.02	830	21	.85 6	20	100	÷	80				
314	10/01/92 1	15:51	100MW, 20% OFA, 4.4% CR O2, New Ports	100		30-/45-	100/100	4.40	846	20	.20 3	5	88	•	07				
315 1	0/02/92 0	10:0 (100MW, 15% OFA, 1.8% CR O2, OM Ports	100		30-/45*	42/37	4.84	935	15 6	1.13 1.	35 3	21 15	•	03 5	65 5.	85 8	O,	
316 1	10/02/92 1	11:03	100MW, 15% OFA, 5.6% CR O2, Old Ports	100		30-/45*	41/41	5.55	968	15	.63	2	36 12	•	0	30 6.	65 4	-	
317 1	0/02/92 1	12:33	100MW, 20% OFA, 6.0% CR O2, Old Ports	100		30-/45-	52/50	6.01	958	20	19	~	23	•	0 9	9 9	60 3	e j (
318 1	0/02/92 1	13:58	100MW, 20% OFA, 4.8% CR 02, ON Ports	100		30-/45-	52/58	4.99	883	5 5	÷ 80°.	3	10	• ·	00		40 1 1 1 1	e, ·	
319 1	0/02/92 1	15:17	100MW, 20% OFA, 5.2% CR 02, OH Ports	100		30-/45*	52/58	5.21	923	20	00.3		5		00	85 6.	•	₹.	
320 1	1 26/20/0	16:37	Recheck Test # 316	100		30-/45-	52/58	4.98	813	0	80		02		88 98	1		I	
321 1	0/03/92 0	19:24	100MW,24%0FA,4.9%CR02,0M,RpH310	100		30-/45-	100/100	4.90	054	5 7 7	. 95 195	0	2	• ·	90 90 90	902 102	20	ب ب	
322 1	10/03/92 1	10:49	100MW, 24% OFA, 4.9% CRO2, Wide Open	100		30-/45-	100/100	4.98	968	5 22 5 22	0.1		92		9 4 0 1 0	. 10 110		~ (
323 1	10/03/92 1	12:17	100MW, 24% OFA, 4.4% CRO2, Wide Open	100		30-/45-	100/100	64.4	848					•				Ņ	
324 1	0/03/92 1	13:28	100MW, 24% OFA, 3.8% CRO2, Wide Open	001	(30•/45•	1001/001	3./9			50.							- P	664
325 1	0/04/92 0	8 :33	60MW, B MII 00S, 28% OFA, 7.6% CH02	60		30-145	001/001	00.7	550		2.5	, c						- - e	
326 1	0/04/92 0	9:48	SOMW, BIMILLOOS, 26% OFA, 7.0% CHUZ			-01/-00		00.1 6.47		0 C 0 C) ()) ()			08	50 7.	60 2	. 60	
1 126	1 28/10/0	5	COMMY, D MMI UUS, 20% UPA, 6:3% UHUS			30+/45+	100/100	7.57	613) =	102	6.6.1	2 28	95 8	15 2	~	
	1 28/40/0	2.54	RUMMY, CIMMI CUCK, 28% CITA, 7:0% CINCK RUMMI, CIMMI COS, 28% CIFA, 7 (CK CRO2	909	, u	30-/45-	100/100	6.98	587	. 9 . 9	89	6	92 +	. 8.	105 7	50 7	75 3	-	
		2.05	ENAMIC MAIL COST 20% OF A 55% CBO	909) C	30*/45*	100/100	6.49	557	26	.20 2		17 1	E 0.4	84 8	.95 7.	25 3	Ņ	
		20.8	AMAN 25% OFA 62% CRO2	00	,	30-/45*	100/100	6.14	767	25	80	6	103 1	e	92 6	.80 6.	95 2	₹.	
1 225	0/02/82 0	10-16	ROMAN, 25% OFA, 5.5% CRO2	80		30-/45-	100/100	5.52	731	25	.45	5	67 13	.7 3	96				
333 1	0/05/92 0	18:50	BOMW, 25% OFA, 5.0% CRO2	80		30-/45-	100/100	6.14	696	24	10	2	72 1		88			,	
334 1	0/05/92 1	0:25	BOMW, 25% OFA, 4.5% CHO2	60		30-/45-	100/100	4.40	648	2	2 .43	-	10	9	92 92	. 15 . 5	90 00	ej -	
335 1	0/05/92 1	12:08	BOMW, 15% OFA, 4.5% CHO2	08		30-/45-	42/38	4.43	672	5	.70 1	00	62		90 2	45		N, I	
336	0/05/92 1	13:32	BOMW, 15% OFA, 5.0% CHO2	60		30-/46-	42/38	5.06	692	15	5.15 6.15		82	0.0	87 6	9 9 9			
337 1	0/06/92 0	18:S1	100MW, 20% OFA, 3.6% CHO2	100		30-/45-	69/55	3.79	940	20	1.75 Z	37 2	202	* D:	* 80	÷ R		ņ	

Arapahoe 4 Retrofil B. Jr Data Stimmary

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Test	Date &	Time	Description	Load	Vills	Burner	OFA Dmprs	CH OS	fotal	OFA	8	8	ů N	ğ	302c A	trhtr \$	Stack	<u>5</u>	coustic
				MWe	800	Spin Vanes	% Open	lew %	Air	Flow	×	Edd	OLLI	*	OE	8	05	EHCo	HEGT
						Inner/outer	West/East		k ph	*		e	× 02	8	× 02	×	×	*	ц.
338	10/06/92	10:12	100MW, 20% OFA, 4.4% CRO2	100		30-/45-	59/55	4.32	862	20	5.25	109	268 1	3.8		1.90	5.10	4 2	
9139	0/06/92	11:32	100MW, 20% OFA, 5.0% CRO2	100		30-/45-	59/55	4.89	865	22	5.78	0	306 1	0.0 5	108	5.80	5.90	1 .0	
340	0/06/92	13.18	100MW, 15% OFA, 5.0% CHO2	100		30-/45.	39/35	4 99	898	15	6.35	21	351 1	2.7	108	6.15	6.50	3.0	
341	0/06/92	14.44	100MW 15% OFA, 4.4% CHO2	100		30-/45-	39/35	4.45	852	5	5.75	69	324 1	3.3	102	5.35	5.65	5.5	
342	0/06/92	16:02	100MW, 15% OFA, 3.8% CRO2	100		30-/45-	36/35	3.79	832	15	5.20	132	303 1	3.5	105	5,10	5.45	6.4	
343	0/07/92	09:10	100MW, C Mill OOS, 28% OFA, 5.0% CRO2	100	с	30-/45-	100/100	4.95	923	28	6.23	128	308 1	2.8	108	00.6	6.25	11.4	
344 1	26/20/0	10:48	100MW, C MM OOS, 28% OFA, 4.5% CRO2	100	с	30-/45-	100/100	4.46	868	27	5.45	2 9 3	201 1	4.0	05	2.60	5.90	13.7	
345	0/01/92	13:09	100MW, C Mil OOS, 28% OFA, 6.1% CRO2	100	U	30-/45-	100/100	6.19	066	27	7.18	8.	340 1	2.2	103	7.05	7.45	9.5	
346	10/13/92	07:55	110MW, 24% OFA, 4.2% CHO2	110		30-/45-	100/100	4.17	970	24	5.25	22	304 1	0	537	1.85	5.25	10	
347	10/13/92	09:53	110MW, 24% OFA, 3.5% CHO2	110		30-/45-	100/100	3.46	924	25	4.58	99	278 1	4.5 1	536	542	4.65	5.2	
348	10/13/92	11:23	110MW, 24% OFA, 2.8% CHO2	110		30-/45	100/100	2.86	893	54	3.9B	111	249 1	8.4	530	9.85	1.05	7.8	
349	10/13/92	13:53	110MW, 15% OFA, 3.5% CHO2	110		30-/45-	40/40	3.48	1001	15	5.30	66	332 1	3.7	501 2	7.00		6.2	
350	10/13/92	15:08	110MW, 15% OFA, 4.2% CHO2	110		30-/45-	40/40	4.17	1008	15	6.03	94	357 1	3.1	505	9.65	5.90	4.7	
351	10/14/92	07:58	BOMW, C Mill OOS, 27%, OFA, 5.9%, CH O2	80	ပ	30-/45	100/100	5.93	779	27	7.38	17	332 1	2.0	121	/.30	7.60	4.5	
352	10/14/92	00.00	BOMW, C Mill OOS, 27% OFA, 4.9% CR O2	80	с	-145	100/100	4.99	707	27	6.23	39	287 1	2.8	116	3.05	6.30	7.3	
353	10/14/92	10:33	80MW, C Mill OOS, 27%, OFA, 4.4%, CH O2	00	υ	30-/45-	100/100	4.47	688	27	5.80		266 1	3.3	117	6.55	5.85	9.4	
354	10/14/92	12:04	80MW, B Mill OOS, 27% OFA, 4.4% CR O2	00	8	30-/45-	100/100	4.40	702	27	6.00	62	259 1	3.2	10		6.10	9.0	
355	0/14/92	13:12	BOMMY, B MII OOS, 27% OFA, 4,9% CR O2	08	8	30*/45*	100/100	4.90	731	28	6.40	0	274 1	2.0	116 6	02.1	9.40	6.2	
356 1	0/14/92	15:03	BOMMY, B MILLOOS, 27% OFA, 5.7% CR 02	80	8	30-/45-	100/100	5.73	778	27	7.05		298 1	2.1	109 7	00.	7.15	5.5	
357 1	0/15/92	00 D3	ROAM DI MAR COS, 27% OFA, 5 8% CR OZ	80	C	30-/45	100/100	5.77	791	27	7.30	54	325 1:	2.3	111 2	25	7.35	5.8	
	0/15/02	00.33	ROWN D MA DOS 27% OFA 4.7% CR OZ	80	0	30-/45	100/100	4.64	732	27	6.30	84	274 1:	3.2	110	1.15	6.25	8.2	
056	0/15/92	10:48	ROMAN D MELOOS. 27% OF A 6.3% CR O2	80	0	30-/45-	100/100	6.26	013	27	7.60	27	333 1:	2.1	111 7	.45	7.60	6.2	
360 1	0/15/92	12:23	BOMW, A Mill OOS, 27% OFA, 6.3% CH O2	00	<	30-/45-	100/100	6.26	778	27	7.08	6	335 1:	2.5	Ξ		7.25	4.5	
361	0/15/92	13:32	BOWW, A MHI OOS, 27% OFA, 5.8% CR O2	08	<	30-/45-	100/100	5.79	762	26	6.75	16	317 1	2.7	801	9.60	8.80	6.0	
362	0/15/02	14:46	BOMW, A Mill OOS, 27% OFA, 5.2% CH O2	08	<	30-/45	100/100	5.18	723	26	6.35	28	300 1	0.0	105 6	3.15	6.50	6.2	
363 1	0/16/92	07.48	100MW, B Mil OOS, 28%OFA, 5.0% CRO2	100	8	30-/45-	100/100	4.98	924	28	6.43	C T	350 1	3.3	9 001	0	9.60	8.6	
364	0/16/92	09:13	100MW, B Mill OOS, 28%OFA, 4.4% CRO2	100	8	30-/45.	100/100	46.4	885	28	5.90	6.	332 1	3.5	901	5.75	5.00	9.7	
365	0/16/92	10:59	ROMAN, B MIR DOS, 28% OFA, 3.6% CRO2	100	8	30-/45-	100/100	3.61	851	27	6.03	212	289 1	Ţ	198	50.5	5,15	12.4	
366	0/20/92	11:26	100MW, GAS FIRE, 26% OFA, 2.1% CHO2	100		30-/45-	100/100	2.13	111	5 6	5.00	166	187 1	T	0				
367 1	0/20/92	12:18	100MW, GAS FIRE, 26% OFA, 3.4% CRO2	100		30-/45-	100/100	3.46	854	26	4.90	95	336 8	5	•				
368	0/20/92	13:06	100MW, GAS FIRE, 26% OFA, 2.6% CRO2	100		30-/45-	100/100	2.52	793	28	3.80	53	231 1	0.1	0				
369	0/20/92	13:33	100MW, GAS FIRE, 6% OFA, 2.6% CHO2	100		30-/45-	30/30	2.50	821	80	9	2	582	•	0				
370	10/21/92	00:11	TRC Tests, 100MW, 24% OFA, 3.7% CRO2	100		30-/45-	100/100	3.70	830	54	4.07	5	253	- 	102				1986
116	0/22/92	06:12	THC Tests, 100MW, 24% OFA, 3.7% CHO2	100		30-/45-	100/100	3.73	838	5			251 1		117		9.10		2901
372	0/22/92	13:47	TRC Tests, 100MW, 24% OFA, 4.2% CR02	100		30-/45-	100/100	4.18	855	4	5.30		260	N			0 I N 1		1054
373 I	0/23/92	07:56	TRC Tests, 100MW, 24% OFA, 4.3% CRO2	100		30-/45-	100/100	4.29	852	2	5.34	88	270 1	- 	102		5.80	1	
1 1/10	0/24/92	08:04	50MW, ALDMIISOOS, 32%OFA, B.4%CRO2	50	2	30-/45-	100/100	8.33	592	32	9.75	25	355 1	9.0		08.0	9.60	9. 1 9. 1	1430
376	0/24/92	09:56	60MW, AADMilisOOS, 31%OFA,7.6%CHO2	60	99	30-/45-	100/100	7.67	658	31	8.60	26	360 1		405 1	800	B.70	5.4	1500
376	0/25/92	07:17	HVT Testa, GOMW, 26% OFA, 7.3% CHO2	60	υ	30-/45-	100/100	7.37	646	26	0 .70	•	312 1	=	527				
377	0/25/92	12:04	HVT Tests, BOMW, 24% OFA, 5.2% CRO2	08		30-/45-	100/100	5.10	728	5	6.55	12	262	_	542		1		
376	0/26/92	09:18	TRC Tests, 100MW, 15% OFA, 4.5% CRO2	100		30-/46-	40/40	4.54	017	15	6.88	9	310 1	3.8	573	_	5.75		948
379	0/27/92	08:40	TRC Tests, 100MW, 15% OFA, 4.6% CRO2	00 t		30-/45-	40/40	4.55	900	15	6.89	2	303 1	- 	188		5.85		1822
380	0/28/82	08:22	100MW GAS FIRE, 6% OFA, 3.0% CRO2	100		30-/45-	25/15	2.02	795	æ	4.35	ທີ	663	<u>6</u>	6 ·	09	7.10		
361	10/29/92	09:36	100MW GAS FIRE, B% OFA, 2.2% CRO2	100		30+/45*	25/15	2.19	174	æ	3.70	35	565	9	•••	80.	9.60		
382	0/29/92	10:03	100MW GAS FIRE, 8% OFA, 3.5% CRO2	100		30-/46-	26/15	3.54	808	0	6.20	2	743 8		n '				
363	10/29/92	11:01	100MW GAS FIRE, 20% OFA, 3.0% CRO2	100		30-/42-	117	3.82	=	20	4.70	27	436	-	4				

Arapahoe 4 Retrofit B / Data Summary

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Crossplot of PSCC and FERCo LOI Analysis Results



Crossplot of LOI and Elemental Carbon Analysis Results

INTEGRATED DRY NO_x/SO₂ EMISSIONS CONTROL SYSTEM

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ENVIRONMENTAL MONITORING REPORT

Low-NOx Combustion System Retrofit Test Period: August 3, 1992 through October 29, 1992

Baseline Air Toxics Test Period: November 17, 1992 through November 19, 1992

Appendix D

Particulate Data Analysis



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Figure 5-35. Pre- and Post-Retrofit Baghouse Inlet Cumulative Particle Size Distributions at 100 MWe



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Figure 5-34. Pre- and Post-Retrofit Baghouse Inlet Differential Particle Size Distributions at 100 MWe

Table 5-7

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Summary of Pre- and Post-Retrofit Baghouse Outlet PM₁₀ Results at 100 MWe

DASELINE D	URNERS				XCL BUR	NERS W251	k OFA		
	Text 1	Test 2	Average			Teel	Test 2	Text 3	Average
	0 BAC	253.0	260.5	Temperature	(L)	C0/2	255.1	258.0	0.672
		62.09	60.55	Sample Volu	me (DSCP)	75.883	79.124	24.72	77203
	12.07	104	44.42	Gas Velocity	(h/sec)	11.37	10.41	42.44	44.42
Under Versioning Auf-Second	173.576	461,168	167,372	Volumetric F	low Rale (ACFM)	456,681	446,087	468,522	454,705
Volumetric Flow (DSCFM)	254,180	255,547	254,864	Volematric F	law (DSCFM)	258,465	260,872	271,867	251,248
Slage Cutpoint	Mass (Collected (mill	igrams)	Stage	Cutpoint	-	Mass Collecte	d (milligrams)	
	22	20	21	_	16.617 micron	<u>66</u> 1	0.42	NO.1	056:0
		015	10	~~~	10.541 micron	0.13	0.07	0.14	0.113
	0.17	0.14	910		3.949 micron	00.0	20:0	0.12	0.047
	10.0	0,12	80.0	-	2 106 micron	000	80	<u>8</u> 0	10.0
1 017 micros	0.0	010	0.05	Ś	1.199 micron	800	000	000	0-00-
	0.0	80	90.0	49	0.577 micron	000	<u>8</u> .0	000	80
	0.62	0.60	0.75	-	0.201 micton	000	000	000	000
Non-Condensible (NC) Frection (In-stack)				Non-condens	ible (NC) Fraction (In-stack	-			
Mare Calledad (me)	3.68	2.20	2.94	Mass Collect	ed (mg)	1.52	0.51	133	1.12
New Collected (me) < 10 mbros	80	1.0	122	Mass Collect	ed (mg) < 10 micron	0.13	<u>60</u> 0	670	0.17
Percent < or = 10 micron	26.09%	66.82%	46.45%	Percent < or	= 10 micron	8.55%	12.65	21.00%	15.80%
Total Impactor (< 15.977 microw)				Total Impact	or (< 16.617 micron)				····
	6.05E-05	3,516-05	4.79E-05	NC PM. Co	me (g/DSCF)	2.00E-05	6.458-06	1.738-06	1.46E-05
	9.34E-06	5.45E-05	4.94E-04	NC PM, Co	me. (gr/1)9CF)	3.09E-04	9958-06	2.25E-04	2.25E-04
NC PMa Embaion Rate (Ba/hr)	2.0339	12186	1.6263	NC PM # Em	ission Rate (ibs/hr)	0.6584	0.2225	0.6245	0.5108
From Impector Stage 2 (< 9.438 micron)				From Impad	or Stage 2 (< 10.541 micror				
	1.50E-05	234E-05	1.96E-05	NC PM. Co	Mc. (g/DSCF)	1.172-06	1.148-06	3.78E-06	221E-06
	2.4E-04	3,616-04	3.03E-04	NC PM CO	Mc (gr/DSCF)	2.65E-05	1.748-05	5.83E-05	3.416-05
NC PMa Embasion Rate (Ibs/hr)	9023'0	0.7906	0/09/0	NC PM, Em	ission Rate (Ibs/hr)	0.0586	66000	0,1360	0.0779

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INTEGRATED DRY NO₂/SO₂ EMISSIONS CONTROL SYSTEM

ENVIRONMENTAL MONITORING REPORT

Low-NOx Combustion System Retrofit Test Period: August 3, 1992 through October 29, 1992

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Appendix E

Coal/Ash Analysis