STACK EMISSIONS SURVEY
PETROTOMICS COMPANY
URANIUM MILL
SHIRLEY BASIN, WYOMING

MAY 1985

FILE NUMBER 8510-117

Prepared By:

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INTRODUCTION

Western Environmental Services and Testing, Inc. (WEST, Inc.) of Casper, Wyoming, conducted a Stack Emissions Survey at the Petrotomics Company's Uranium Mill located near Shirley Basin, Wyoming, on May 5, 1985. The purpose of this survey was to determine emissions of particulates, Uranium-natural (U), Radium-226, Thorium-230, Lead-210, and Radon-222 from the Yellow Cake Dryer Stack and the Packaging Room Exhaust Stack.

The sampling followed the procedures set forth in the "Wyoming Air Quality Standards and Regulations," Wyoming Department of Environmental Quality, 1982; the Appendix to the Code of Federal Regulations, Title 40, Chapter I, Part 60; and the United States Nuclear Regulatory Commission Code of Federal Regulations, Title 10, Chapter I, Part 20.

SUMMARY OF RESULTS

The principal conclusions are:

Yellow Cake Dryer Stack

1. The emissions of particulate matter from the Yellow Cake Dryer Stack were 0.893 pounds per hour (0.0656 grains per dry standard cubic foot), based on the test using the 'front-half' collections of the EPA-type sampling train.
2. The concentration of Uranium-natural (U) was 4.09×10^{-10} µCi/ml, based on the test using the 'front-half' collections of the EPA-type sampling train.
3. The U_3O_8 emission rate is 0.0423 pounds per hour, based on the test using the 'front-half' collections of the EPA-type sampling train.

Packaging Room Exhaust Stack

1. The emissions of particulate matter from the Packaging Room Exhaust Stack were 0.024 pounds per hour (0.0057 grains per dry standard cubic foot), based on the test using the 'front-half' collections of the EPA-type sampling train.

2. The concentration of Uranium-natural (U) was 1.27×10^{-9} µCi/ml, based on the test using the 'front-half' collections of the EPA-type sampling train.

3. The U_3O_8 emission rate is 0.0041 pounds per hour, based on the test using the 'front-half' collections of the EPA-type sampling train.

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SUMMARY OF RESULTS

	Yellow Cake	Packaging Room	
Run Number	1	1	
Stack Flow Rate - ACFM	2991	815	
Stack Flow Rate - DSCFM*	1588	499	
% Water Vapor - % Volume	18.46	12.34	
% CO_2 - % Volume	2.2	0.0	
% O_2 - % Volume	17.1	21.0	
% Excess Air At Sampling Point	402	---	
Particulates Probe,Cyclone & Filter Catch (C_{an}) grains/dscf*	0.0656	0.0057	
grains/cf at Stack Conditions (C_{at})	0.0347	0.0035	
lbs/hr (C_{aw})	0.893	0.024	
Total Catch (C_{ao}) grains/dscf*	---	---	
grains/cf at Stack Conditions (C_{au})	---	---	
lbs/hr (C_{ax})	---	---	
Uranium-natural µCi/ml	4.09×10^{-9}	1.27×10^{-9}	
U_3O_8 Emissions lbs/hr	0.0423	0.0041	

* 68°F., 29.92 "Hg (20°C., 760 mm Hg)

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RADIOCHEMISTRY LABORATORY RESULTS
AS REPORTED BY ALPHA ENERGY LABORATORIES, INC.
ON JULY 8, 1985

YELLOW CAKE DRYER STACK

Sample Date: May 2, 1985

Radon-222*	pCi/l	6.4 ± 0.7
	LLD - pCi/l	0.4
Uranium-natural (U)	µg/sample	5969
	µgCi/ml	$4.09 \times 10^{-9} \pm 0.06 \times 10^{-9}$
	LLD - µCi/ml	3×10^{-12}
Radium-226		
	µCi/ml	$1.06 \times 10^{-12} \pm 1.03 \times 10^{-12}$
	LLD - µCi/ml	2×10^{-12}
Thorium-230		
	µCi/ml	$3.09 \times 10^{-12} \pm 1.66 \times 10^{-12}$
	LLD - µCi/ml	6×10^{-13}
Lead-210		
	µCi/ml	$7.1 \times 10^{-12} \pm 4.3 \times 10^{-12}$
	LLD - µCi/ml	7×10^{-12}

* Radon-222 analyzed by CORE Laboratories

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RADIOCHEMISTRY LABORATORY RESULTS
AS REPORTED BY ALPHA ENERGY LABORATORIES, INC.
ON JULY 8, 1985

PACKAGING ROOM EXHAUST STACK

Sample Date: May 2, 1985

Radon-222*	pCi/l	3.1 ± 0.5
	LLD - pCi/l	0.4
Uranium-natural (U)	µg/sample	1566
	µgCi/ml	$1.27 \times 10^{-9} \pm 0.02 \times 10^{-9}$
	LLD - µCi/ml	4×10^{-12}
Radium-226		
	µCi/ml	$1.02 \times 10^{-12} \pm 1.26 \times 10^{-12}$
	LLD - µCi/ml	2×10^{-12}
Thorium-230		
	µCi/ml	$2.53 \times 10^{-12} \pm 1.03 \times 10^{-12}$
	LLD - µCi/ml	5×10^{-13}
Lead-210		
	µCi/ml	$1.3 \times 10^{-13} \pm 63 \times 10^{-13}$
	LLD - µCi/ml	4×10^{-12}

* Radon-222 analyzed by CORE Laboratories.

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RADON-222 RESULTS

Sample Date: May 2, 1985

Yellow Cake Dryer Stack	pCi/l	6.4 ± 0.7
	LLD - pCi/l	0.4
Packaging Room Exhaust Stack	pCi/l	3.1 ± 0.5
	LLD - pCi/l	0.4

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DISCUSSION OF RESULTS

The one test for particulates taken on each stack appeared to be valid representations of the actual emissions. The indicative parameters calculated from the field data were in close agreement to previous tests. The rate of sampling for the test on the Yellow Cake Dryer was well within the specified limits of the isokinetic rate. The rate of sampling for the test on the Packaging Room Scrubber Stack was higher than the specified limits, the deviation being 10.93 percent. However, based on previous experience, WEST, Inc. feels that the particulate values were not biased greatly and do represent the actual emissions.

DESCRIPTION OF PROCESS OPERATION

In a uranium milling operation, uranium is extracted from ore, purified, and converted to U_3O_8. The raw ore is crushed and mixed with sulfuric acid to leach out the uranium. The mixture goes through a sand-slime separation to remove and wash the sand. The de-sanded pulp is collected and transferred to the resin-in-pulp circuit where ion-exchange resin is removed counter-current to the solution flow.

This mixture goes to the clarifier where a filter removes solids and routes the pregnant solution to the solvent extraction circuit. The uranium-sulfuric acid mixture is removed from the organic phase by ammonium sulfate. The solution then goes to a precipitation tank where yellow cake is precipitated upon addition of ammonia. The yellow cake is dried, converted to U_3O_8, and conveyed to a storage hopper where it is loaded into 55-gallon drums for shipment.

DESCRIPTION OF SAMPLING LOCATIONS

Yellow Cake Dryer Stack

The sampling ports on the Yellow Cake Dryer Stack are located approximately 35 feet above the ground. The sampling was performed from two ports on the circular stack located approximately 10 feet (10.0 stack diameters) downstream from the stack inlet and approximately 2 feet (2.0 stack diameters) upstream from the stack outlet.

Packaging Room Exhaust Stack

The sampling ports on the Packaging Room Exhaust Stack are located approximately 35 feet above the ground. The sampling was performed from two ports on the circular stack located approximately 8 feet 11 inches (10.44 stack diameters) downstream from the stack inlet and approximately 4 feet 1 inch (4.78 stack diameters) upstream from the stack outlet.

SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical procedures used followed the procedures set forth in the "Wyoming Air Quality Standards and Regulations", Wyoming Department of Environmental Quality, 1982; the Appendix to the Code of Federal Regulations, Title 40, Chapter I, Part 60; and the United States Nuclear Regulatory Commission, Code of Federal Regulations, Title 10, Chapter I, Part 20.

A preliminary velocity traverse was made at each port in order to determine the uniformity of flow in the Yellow Cake Dryer Stack. Particulate samples of 5-minute duration at each of the six traverse points were taken from each port using an EPA-type, heated, glass-lined probe. The first and sixth points were not sampled because they were less than 1 inch from the stack wall. Instead, points 2 and 5 were sampled twice.

A preliminary velocity traverse was made at each port in the Packaging Room Exhaust Stack. Particulate samples of 5-minute duration at each of the six traverse points were taken from each port utilizing an EPA-type, heated, glass-lined probe.

Before the test, the sampling train was leak-checked at 15 inches of mercury. After the test, the train was again leak-checked at the highest recorded vacuum reading during the test. Final leak-checking was performed in order to predetermine the possibility of a diluted sample.

Before and after each test, the pitot tube lines were checked for leaks under both a vacuum and pressure; the lines were checked for clearance; and the zero manometer reading verified.

The emissions were calculated from gravimetric analysis using the 'front-half' collections of the EPA-type sampling train. The 'front-half' particulate and filters were analyzed by Alpha Energy Laboratories, Inc., Dallas Texas.

DESCRIPTION OF TESTS

Personnel from WEST, Inc. arrived at the Petrotomics Company Uranium Mill near Shirley Basin, Wyoming, at 1100 hours on Thursday, May 2, 1985. The sampling equipment was moved onto the Yellow Cake Dryer Stack and prepared for testing by 1215 hours. Testing began at 1218 hours and was completed by 1320 hours.

The equipment was moved onto the Packaging Room Exhaust Stack. Testing began at 1337 hours and continued until completion at 1439 hours.

The equipment was moved off the stack and loaded into the mobile laboratory. The samples were recovered and taken to WEST, Inc.'s laboratory in Casper, Wyoming for further analyses and evaluation.

Testing at Petrotomics Company's Uranium Mill was completed at 1530 hours on Thursday, May 2, 1985.

Bruce A. Hinchey
President

Alan D. Reylance
Laboratory Supervisor

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APPENDICES

A. Location of Sampling Points

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APPENDIX A

Location of Sampling Points

APPENDIX A

Location of Sampling Points

Yellow Cake Dryer Stack

The sampling ports are located approximately 10 feet (10.0 stack diameters) downstream from the stack inlet and approximately 2 feet (2.0 stack diameters) upstream of the stack outlet. The first and sixth sample points were not sampled because they were less than one inch from the stack wall; instead, points two and five were double sampled. The locations of the sampling points were calculated as follows:

Inside Stack Diameter = 12 inches

Port and Wall Thickness = 4 inches

Point No.	Percent of Diameter From Wall	Distance From Wall
1	4.4	-----
2	14.7	1-3/4"
3	29.5	3-1/2"
4	70.5	8-1/2"
5	85.3	10-1/4"
6	95.6	-----

Packaging Room Exhaust Stack

The sampling ports are located approximately 8 feet 11 inches (10.44 stack diameters) downstream from the stack inlet and approximately 4 feet 1 inch (4.78 stack diameters) upstream from the stack outlet. The locations of the sampling points were calculated as follows:

Inside Stack Diameter = 10-1/4 inches

Port and Wall Thickness = 4-1/2 inches

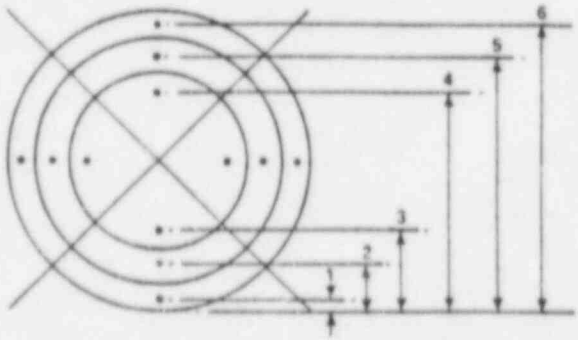
Point No.	Percent of Diameter From Wall	Distance From Wall
1*	4.4	1/2"
2	14.7	1-1/2"
3	29.5	3"
4	70.5	7-1/4"
5	85.3	8-3/4"
6*	95.6	9-3/4"

* Points 1 and 6 were adjusted to within 1/2" due to their proximity to the stack wall.

APPENDIX A

Location of Sampling Points

TRAVERSE POINT	DISTANCE, % of diameter
1	4.4
2	14.7
3	29.5
4	70.5
5	85.3
6	95.6



Example showing circular stack cross section divided into 12 equal areas, with location of traverse points indicated.

APPENDIX B

Nomenclature and Equations for Calculation of Source Emissions

Example Particulate Calculations

1. Volume of Dry Gas Sampled At Standard Conditions.*

$$V_{m_{std}} = V_m \left[\frac{T_{std}}{T_m + 460} \right] \left[\frac{P_b + \frac{P_m}{13.6}}{P_{std}} \right]$$

$$V_{m_{std}} = 17.65\ V_m \left[\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right] = \text{dscf}$$

$$V_{m_{std}} = \text{dscf} \times 0.028317 = \text{dscm}$$

2. Volume of Water Vapor Collected At Standard Conditions.*

$$V_{w_{gas}} = \frac{(V_w - \text{gms } SO_2 - \text{gms } H_2S)\ \rho_{H_2O}\ R\ T_{std}}{P_{std}\ M_{H_2O}\ 453.6}$$

$$V_{w_{gas}} = 0.0472\ (V_w - \text{gms } SO_2 - \text{gms } H_2S) = \text{scf}$$

$$V_{w_{gas}} = \text{scf} \times 0.02831? = \text{scm}$$

3. Percent Moisture in Stack Gas.

$$\%M = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \%$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

4. Mole Fraction of Dry Gas.

$$M_d = \frac{100 - \%M}{100}$$

5. Average Molecular Weight of Dry Stack Gas.

$$MW_d = \left(\%CO_2 \times \frac{44}{100}\right) + \left(\%O_2 \times \frac{32}{100}\right) + \left(\%N_2 \times \frac{28}{100}\right) + \left(\%CO \times \frac{28}{100}\right) = \text{lb/lb-mole}$$

$$= \text{g/g-mole}$$

6. Molecular Weight of Stack Gas.

$$MW = MW_d \times M_d + 18\ (1-M_d) = \frac{\text{lb}}{\text{lb-mole}} = \text{g/g-mole}$$

7. Percent Excess Air At Sampling Point.

$$\%EA = \frac{100\ (\%O_2 - 0.5\%\ CO)}{0.265\ (\%N_2) - (\%O_2) + 0.5\ (\%CO)}$$

8. Stack Pressure.

$$P_s = P_b + \frac{\text{stack pressure } "H_2O}{13.6} = "\text{Hg Absolute}$$

$$P_s = "\text{Hg Abs.} \times 25.4 = \text{mm Hg}$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

9. Stack Velocity At Stack Conditions.

$$V_s = C_p\ 60 \left[\frac{2g \times \rho_{man} \times P_{std} \times MW_{air} \times (T_s + 460) \times \Delta P_s}{12 \times \rho_{air} \times P_s \times MW \times T_{std}} \right]^{1/2}$$

$$V_s = 5123.8\ C_p \left[\frac{(T_s + 460)}{P_s \times MW} \right]^{\frac{1}{2}} \times \text{Average} \left[(\Delta P)^{\frac{1}{2}} \right] = \text{fpm}$$

$$V_s = \text{fpm} \times 0.00508 = \text{m/sec}$$

10. Dry Stack Gas Volume At Standard Conditions.*

$$Q_s = \frac{1}{144} V_s \times A_s \times M_d \times \frac{T_{std}}{T_s + 460} \times \frac{P_s}{P_{std}}$$

$$Q_s = \frac{0.123\ V_s \times A_s \times M_d \times P_s}{T_s + 460} = \text{DSCFM}$$

$$Q_s = \text{DSCFM} \times 1.6990 = \text{dscm/hr}$$

11. Actual Stack Gas Volume At Stack Conditions.

$$Q_a = \frac{V_s \times A_s}{144} = \text{ACFM}$$

$$Q_a = \text{ACFM} \times 1.6990 = \text{m}^3/\text{hr}$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

12. Percent Isokinetic

$$\%I = \frac{V_{m_{std}} \times (T_s + 460) \times P_{std} \times 100 \times 144}{M_d \times T_{std} \times P_s \times T_t \times V_s \times \frac{\pi D_n^2}{4}}$$

$$\%I = \frac{1039\ V_{m_{std}} \times (T_s + 460)}{M_d \times P_s \times T_t \times V_s\ D_n^2}$$

13. Particulate - Probe, Cyclone, and Filter.

$$C_{an} = \frac{m_f}{V_{m_{std}}} \times \frac{1\ gr}{64.8\ mg}$$

$$C_{an} = 0.0154\ \frac{m_f}{V_{m_{std}}} = gr/dscf$$

$$C_{an} = gr/dscf \times 2.290 = g/dscm$$

14. Particulate - Total.

$$C_{ao} = 0.0154 \times \frac{m_t}{V_{m_{std}}} = gr/dscf$$

$$C_{ao} = gr/dscf \times 2.290 = g/dscm$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

15. Particulate - Probe, Cyclone, and Filter At Stack Conditions.

$$C_{at} = C_{an} \times \frac{P_s}{P_{std}} \times \frac{(T_{std})}{(T_s + 460)} \times M_d$$

$$C_{at} = \frac{17.65 \times C_{an} \times P_s \times M_d}{T_s + 460} = gr/CF$$

$$C_{at} = gr/CF \times 2.290 = g/m^3$$

16. Particulate - Total, At Stack Conditions.

$$C_{au} = \frac{17.65 \times C_{ao} \times P_s \times M_d}{T_s + 460} = gr/CF$$

$$C_{au} = gr/CF \times 2.290 = g/m^3$$

17. Particulate - Probe, Cyclone, and Filter.

$$C_{aw} = C_{an} \times Q_s \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{1 \text{ lb}}{7000 \text{ gr}}$$

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = lbs/hr$$

$$C_{aw} = lbs/hr \times 0.4536 = kg/hr$$

18. Particulate - Total.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = lbs/hr$$

$$C_{ax} = lbs/hr \times 0.4536 = kg/hr$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

Nomenclature for Particulate Calculations

Symbol	English Units	Metric Units	Description
A_s	$in.^2$	m^2	Stack Area
C_{an}	gr/dscf	g/dscm	Particulate - Probe, Cyclone and Filter
C_{ao}	gr/dscf	g/dscm	Particulate - Total
C_{at}	gr/CF @ Stack Conditions	g/m^3	Particulate - Probe, Cyclone and Filter
C_{au}	gr/CF @ Stack Conditions	g/m^3	Particulate - Total
C_{aw}	lbs/hr	kg/hr	Particulate - Probe, Cyclone and Filter
C_{ax}	lbs/hr	kg/hr	Particulate - Total
C_p			Pitot Tube Calibration Factor
D_n	in.	m	Sampling Nozzle Diameter
%EA			Percent Excess Air At Sampling Point
g	32.2 ft/sec^2		Acceleration of Gravity
%I			Percent Isokinetic
%M			Percent Moisture in the Stack Gas by Volume

* 528° R, 29.92 "Hg (20°C, 760 mm Hg)

Symbol	English Units	Metric Units	Description
M_d			Mole Fraction of Dry Gas
mf	mg	mg	Particulate - Probe, Cyclone and Filter
M_{H_2O}	18 lb/lb-mole		Molecular Weight of Water
m_t	mg	mg	Particulate - Total
MW_{air}	lb/lb-mole	g/g-mole	Molecular Weight Of Stack Gas
MW	28.95 lb/ lb-mole		Molecular Weight Of Air
MW_d	lb/lb-mole	g/g-mole	Molecular Weight Of Dry Stack Gas
P_b	"Hg Absolute	mm Hg	Barometric Pressure
P_m	"H_2O	mm H_2O	Orifice Pressure Drop
P_s	"Hg Absolute	mm Hg	Stack Pressure
ΔP_s	"H_2O	mm H_2O	Velocity Head of Stack Gas
P_{std}	29.92 "Hg	760 mm Hg	Standard Barometric Pressure
Q_a	ACFM	m^3/hr	Stack Gas Volume At Actual Stack Conditions
Q_s	DSCFM	dscm/hr	Stack Gas Volume At 29.92 "Hg, 528°R, Dry
R	21.83 "Hg ft^3/lb-mole-°R		Universal Gas Constant

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

Symbol	English Units	Metric Units	Description
T_m	°F	°C	Average Gas Meter Temperature
T_t	min	min	Net Time of Test
T_s	°F	°C	Stack Temperature
T_{std}	528°R	293°K	Standard Temperature
V_m	ft^3	m^3	Volume of Dry Gas Sampled @ Meter Conditions
$V_{m_{std}}$	dscf	dscm	Volume of Dry Gas Sampled @ Standard Conditions
V_s	fpm	m/sec	Stack Velocity @ Stack Conditions
V_w	ml	ml	Total water Collected in Impingers And Silica Gel
$V_{w_{gas}}$	scf	scm	Volume of Water Vapor Collected @ Standard Conditions
ρ_{air}	0.0748 lbs/ft^3		Density of Air
ρ_{H_2O}	1 g/ml		Density of Water
ρ_{man}	51.63 lbs/ft^3		Density of Manometer Oil

Standard Conditions: 68°F, 29.92 "Hg (20°C, 760 mm Hg)

STACK EMISSIONS SURVEY
PETROTOMICS COMPANY
URANIUM MILL
SHIRLEY BASIN, WYOMING

MAY 1985

FILE NUMBER 8510-117

SOURCE EMISSION CALCULATIONS

Symbol	Description	Units	YCD	PKG EXHST
Run No.			1	1
Date			05/02/85	05/02/85
Begin			1218 MDT	1337 MDT
End			1320 MDT	1439 MDT
P_b	barometric pressure	"Hg Abs. (mm Hg)	22.95 582.93	22.95 582.93
P_m	orifice pressure drop	"H_2O (mm H_2O)	1.29 32.81	0.75 18.94
V_m	volume dry gas sampled @ meter conditions	$ft.^3$ (m^3)	46.431 1.315	39.879 1.129
T_m	avg. gas meter temp	°F (°C)	82 28	89 32
$V_{m_{std}}$	volume dry gas sampled @ standard conditions*	dscf (dscm)	34.874 .988	29.476 .835
V_w	total H_2O collected, impingers & silica gel	ml	167.3	87.9
$V_{w_{gas}}$	volume water vapor collected @ standard conditions*	scf (scm)	7.897 .224	4.149 .117
%M	moisture in stack gas by volume	%	18.46	12.34

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

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Source Emission Calculations

Symbol	Description	Units	YCD 1	PKG EXHST 1
M_d	mole fraction of dry gas	-----	.8154	.8766
CO_2		%	2.2	0
O_2		%	17.1	21
N_2		%	80.6	79
%EA	excess air @ sampling point	%	402	---
MW_d	molecular weight of dry stack gas	lb/lb-mole (g/g-mole)	29.01 29.01	28.84 28.84
MW	molecular weight of stack gas	lb/lb-mole (g/g-mole)	26.98 26.98	27.50 27.50
ΔPs	velocity head of stack gas	"H_2O (mm H_2O)	.782 19.86	.121 3.07
T_s	stack temperature	°F (°C)	165 75	122 51
P_s	stack pressure	"Hg Abs. (mm Hg)	22.99 583.86	22.95 583.02
V_s	stack velocity @ stack conditions	fpm (m/sec)	3811 19.36	1430 7.27
A_s	stack area	$in.^2$ (m^2)	113 0.07	82 0.05
Q_s	dry stack volume @ standard conditions*	DSCFM (dscm/hr)	1588 2698.29	499 847.60
Q_a	actual stack gas volume @ stack conditions	ACFM (m^3/hr)	2991 5081.23	815 1383.98

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

PETROTOMICS COMPANY
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Source Emission Calculations

Symbol	Description	Units	YCD	PKG EXHST
			1	1
T_t	net time of test	min.	60	60
D_n	sampling nozzle diam.	in. (m)	.235 .006	.305 .008
%I	percent isokinetic	%	95.70	110.93
m_f	particulate - probe, cyclone and filter	mg	148.6	11
m_t	particulate - total	mg	---	---
C_{an}	particulate - probe, cyclone and filter	gr/dscf* (g/dscm)	.0656 .1502	.0057 .0131
C_{ao}	particulate - total	gr/dscf* (g/dscm)	--- ---	--- ---
C_{at}	particulate - probe, cyclone and filter @ stack conditions	gr/cf (g/m^3)	.0347 .0795	.0035 .008
C_{au}	particulate total @ stack conditions	gr/cf (g/m^3)	--- ---	--- ---
C_{aw}	particulate - probe, cyclone and filter	lbs/hr (kg/hr)	.893 .405	.024 .011
C_{ax}	particulate - total	lbs/hr (kg/hr)	--- ---	--- ---

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

APPENDIX C

Calibration of Equipment

APPENDIX C

Calibration Data

March 29, 1985

NOZZLES

Set #A

Nozzle No.	Diameter (inches)
2A	0.197
3A	0.258
4A	0.305
5A	0.356
6A	0.384
7A	0.446
8A	0.497
9A	0.496
10A	0.579

Set #B

Nozzle No.	Diameter (inches)
1B	0.126
2B	0.177
3B	0.235
4B	0.299
5B	0.356
6B	0.368
7B	0.498

Set I

Nozzle No.	Diameter (inches)
I-1	0.127
I-2	0.193
I-3	0.247
I-4	0.302
I-5	0.374
I-6	0.413
I-7	0.489
I-8	0.471
I-9	0.615

Set II

Nozzle No.	Diameter (inches)
II-1	0.122
II-2	0.197
II-3	0.249
II-5	0.375
II-6	0.435
II-7	0.498
II-8	0.556
II-9	0.612

Set III

Nozzle No.	Diameter (inches)
III-1	0.126
III-3	0.252
III-4	0.366
III-5	0.366
III-6	0.428
III-7	0.500
III-8	0.559
III-9	0.607

APPENDIX C

Calibration Data

March 29, 1985

PITOT TUBES

Pitot Length (effective length)	Calibration Factor		Pitot Length (effective length)	Calibration Factor	
28-1	High	0.825	122-1	High	0.829
	Low	0.823		Low	0.823
32-1	High	0.838	128-1	High	0.824
	Low	0.829		Low	0.830
46-1	High	0.815	132-1	High	0.825
	Low	0.815		Low	0.830
49-1	High	0.828	132-2	High	0.843
	Low	0.837		Low	0.836
72-1	High	0.828	156-1	High	0.804
	Low	0.834		Low	0.809
72-2	High	0.818	156-2	High	0.836
	Low	0.823		Low	0.827
73-1	High	0.841			
	Low	0.840			
74-1	High	0.833			
	Low	0.836			
96-1	High	0.825			
	Low	0.826			

APPENDIX C

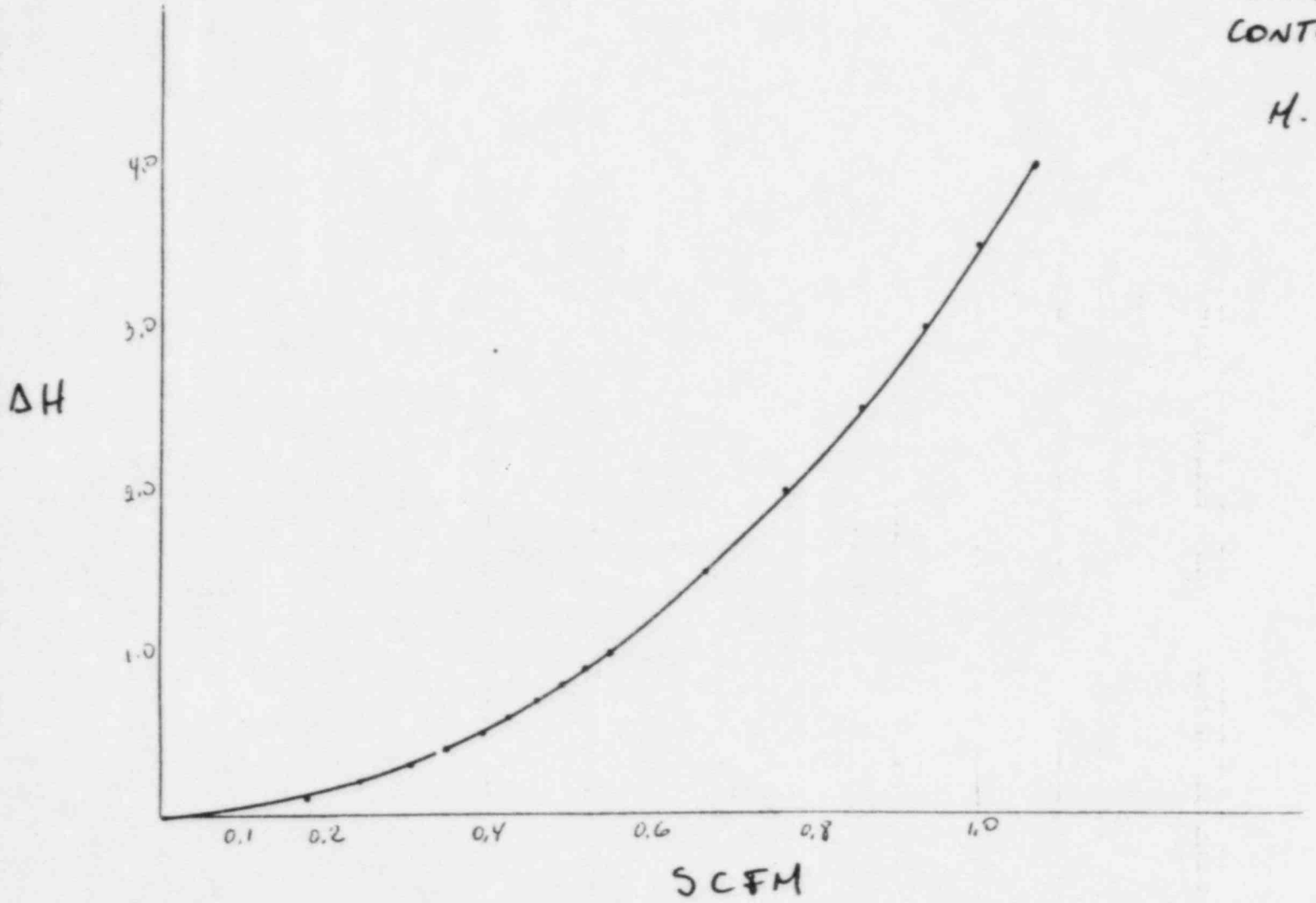
Calibration Data

March 29, 1985

DRY GAS METER

Unit Number	Calibration Factor
1	0.993
2	1.008
3	1.012
4	1.010

WEST INC.
ORIFICE CURVE
CONTROL MODULE #4
3/29/85
H. A. VINCENT



APPENDIX D

Field Testing Data

Job No. 8510-117 PAPT. FIELD DATA

Job Name PETROTOMICS

Run No. 1 4CD

Location 4CD/YELLOW CAKE PROBE

Date 5-7-85

Operator INEDT-ERICSON

Sample Box No. 4 Meter Box No. 4

Read and Record at the Start of Each Test Point.

Nomograph Setting ΔP 0.90 ΔH 150

Ambient Temp. °F 71

Assumed Moisture % 16

Probe Length 32"

Pitot Tube Leak Check OK OK (before / after)

Initial Leak @ 15.0 "Hg = 0.000 cfm

Final Leak @ 8.0 "Hg = 0.000 cfm

Point	Clock Time	Dry Gas Meter, CF 441.974	Pitot in. H_2O ΔPs	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Pump Vacuum In. Hg Gauge Pm	Stack Temp °F Ts	Probe Temp °F	Oven Temp °F	Effluent Temp °F	Dry Gas Temp °F Inlet Tm	Dry Gas Temp °F Outlet	Remarks
A 6	1218	~~441.974~~	0.81	1.30	1.30	4.0	177	252	232	72	80	77	
5	1223	445.735	0.80	1.30	1.30	4.5	165	239	235	59	79	75	
4	1228	449.600	0.78	1.30	1.30	5.0	168	235	237	58	79	75	
3	1233	453.338	0.78	1.30	1.30	5.0	169	237	241	62	82	77	
2	1238	457.061	0.72	1.20	1.20	5.0	169	229	234	70	83	77	
1	1243	460.845	0.77	1.30	1.30	5.0	169	231	236	71	84	79	
END	1248	464.782	—	—	—	—	—	—	—	—	—	—	
B 6	1250	464.782	0.83	1.40	1.40	6.0	167	235	240	74	85	80	
5	1255	468.841	0.92	1.35	1.35	6.0	169	234	244	80	85	80	
4	1300	~~473~~.700	0.75	1.25	1.25	5.5	152	232	252	73	87	80	
3	1305	476.490	0.74	1.20	1.20	5.5	165	231	237	69	87	81	
2	1310	480.210	0.79	1.30	1.30	6.0	155	253	243	67	89	82	
1	1315	484.100	0.79	1.30	1.30	6.0	157	254	241	65	84	83	
END ALL	1320	487.945	—	—	—	—	—	—	—	—	—	—	

Pitot Tube Calibration Factor C_p .838 Pitot Tube No. 32-1

Volume Collected V_m 46.431 ft^3 $\%CO_2$ 22 %CO 0.0

Water Collected V_w 167.3 ml $\%O_2$ 17.1 $\%N_2$ 80.6

Time of Test T_t 60 min Area Stack A_2 113 in^2

Baro. Press. P_b 27.95 "Hg Stack Press. 0.50 in. H_2O

Sample Purge: Initial — Final —

Probe Tip No. 3B Probe Tip Dia. .235 in

V_m = Dry Gas Meter Calibration Factor 1.010 X 45.971

[Dry Gas Meter Reading ____ ft^3 - (T_t ____ min x Leak Rate ____ cfm)]

M_F = 148.6 M_T = ____

IMPINGER CATCH

SAMPLE NO.: 1-4CD

IMPINGER NO.	SOLUTION USED	AMOUNT OF SOLUTION (ml)	IMP. TIP CONFIGURATION	WEIGHT (grams)
1	DI	100 ml.	MODIF.	Final 694.6 Initial 591.9 Wt. Gain 102.7
2	DI	100 ml	G. SMITH	Final 599.0 Initial 558.0 Wt. Gain 41.0
3	DRY	—	MODIF.	Final 443.5 Initial 434.1 Wt. Gain 9.4
4	SILICA GEL	—	MODIF	Final 766.5 Initial 752.3 Wt. Gain 14.2
5				Final Initial Wt. Gain
6				Final Initial Wt. Gain
Flask				Final Initial Wt. Gain

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 167.3

DATE: 5-2-85

SIGNATURE: Todd Tweed

ORSAT ANALYSIS RESULTS

Gas Fractional Part

CO_2 2.2

O_2 17.1

CO 0.0

N_2 80.6

SIGNATURE: Todd Tweed

DATE: 5-2-85

TIME: 1250

Job No. 8510-117 | PART | FIELD DATA

Job Name PETROTONICS

Run No. 1 PE

Location PACKAGE EXHAUST

Date 5-2-85

Operator TWEDT - MASON

Sample Box No. 5 Meter Box No. 4

Read and Record at the Start of Each Test Point.

Nomograph Setting ΔP 0.146 ΔH 0.90

Ambient Temp. °F 80

Assumed Moisture %

Probe Length 32"

Pitot Tube Leak Check OK OK

Initial Leak @ 15.0 "Hg = 0.000 cfm

Final Leak @ 7.0 "Hg = 0.000 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔPs)	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Pump Vacuum In. Hg Gauge (Pm)	Stack Temp °F (Ts)	Probe Temp °F	Oven Temp °F	Effluent Temp °F	Dry Gas Temp °F (Tm) Inlet	Dry Gas Temp °F (Tm) Outlet	Remarks
A 6	1337	488.383	0.14	0.87	0.87	5.0	121	250	235	69	89	83	
5	1342	493.235	0.14	0.87	0.87	5.0	121	255	230	62	90	85	
4	1347	498.291	0.12	0.74	0.74	2.0	122	245	233	63	90	85	
3	1352	501.335	0.12	0.74	0.74	2.0	122	265	235	67	90	85	
2	1357	504.400	0.12	0.74	0.74	2.0	122	259	241	67	91	85	
1	1402	507.323	.12	0.74	0.74	2.0	122	263	242	67	91	85	
END	1407	510.311	—	—	—	—	—	—	—	—	—	—	
B 6	1409	510.311	0.11	0.68	0.68	2.0	122	265	261	71	91	89	
5	1414	513.000	0.11	0.68	0.68	2.0	123	273	269	69	92	91	
4	1419	515.989	0.10	0.61	0.61	2.0	123	265	265	69	92	89	
3	1424	518.735	0.14	0.87	0.87	2.5	123	229	241	69	93	89	
2	1429	522.000	0.13	0.80	0.80	2.5	123	239	260	69	94	89	
1	1434	525.115	0.10	0.61	0.61	2.5	119	251	259	65	94	90	
END	1439	527.867	—	—	—	—	—	—	—	—	—	—	

Pitot Tube Calibration Factor C_p .838 Pitot Tube No. 32-1

Volume Collected V_m 39.879 ft³ $\%CO_2$ 0.0 %CO 0.0

Water Collected V_w 879 ml $\%O_2$ 21.0 $\%N_2$ 79.0

Time of Test T_t 60 min Area Stack A_2 82 in^2

Baro. Press. P_b 22.95 "Hg Stack Press. +0.05 in. H_2O

Sample Purge: Initial — Final —

Probe Tip No. 4A Probe Tip Dia. .305 in

V_m = Dry Gas Meter Calibration Factor 1.016 X 39.484

[Dry Gas Meter Reading ____ ft^3 - (T_t ____ min x Leak Rate ____ cfm)]

M_F = 11.0 M_T = ____

IMPINGER CATCH

SAMPLE NO.: 1-PE

IMPINGER NO.	SOLUTION USED	AMOUNT OF SOLUTION (ml)	IMP. TIP CONFIGURATION	WEIGHT (grams)
1	DI	100 ML.	MODIF	Final 546.3 Initial 543.5 Wt. Gain 2.8
2	DI	100 ML.	G. SMITH	Final 578.1 Initial 551.1 Wt. Gain 27.0
3	DRY	—	MODIF.	Final 486.5 Initial 485.1 Wt. Gain 1.4
4	SILICA GEL	—	MODIF.	Final 772.2 Initial 765.5 Wt. Gain 6.7
5				Final Initial Wt. Gain
6				Final Initial Wt. Gain
Flask				Final Initial Wt. Gain

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 87.9

DATE: 5-2-85

SIGNATURE: Todd Tweet

ORSAT ANALYSIS RESULTS

Gas Fractional Part

CO_2 0.0

O_2 21.0

CO 0.0

N_2 79.0

SIGNATURE: Todd Tweet DATE: 5-2-85

TIME: 1410

APPENDIX E

Analytical Data

WEST, Inc.

PARTICULATE ANALYSIS

Date 6-25-85

Job No. 8510-117

Name Petrozonics

Location YCD Packaging Exh.

Run No. 1-YCD

Filter No. 1-80 Front Wash 470 ml Impinger 1 Impinger 2

	Front	Impinger 1	Impinger 2
Final	0.7818	107.1906	
Initial	0.6755	107.1476	
	0.1063 = 106.3	0.0430 = 43.0	
	42.3	- 0.7 blank	
	148.6	42.3	

MF 148.6 mg MT _____ mg

Run No. 1-Pack. Exh.

Filter No. 1-81 Front Wash 375 ml Impinger 1 Impinger 2

	Front	Impinger 1	Impinger 2
Final	0.6758	100.8050	
Initial	0.6756	100.7936	
	0.0002 = 0.2	0.0114 = 11.4	
	10.8	- 0.6 blank	
	11.0	10.8	

MF 11.0 mg MT _____ mg

Run No. _____

Filter No. _____ Front Wash _____ ml Impinger 1 Impinger 2

	Front	Impinger 1	Impinger 2
Final			
Initial			

MF _____ mg MT _____ mg

Acetone Blank:

Volume 200 ml Final 110.5320 Initial 110.5319 = 0.0003

Blank: 0.0015 mg/ml Total Weight 0.3

D.I. Water Blank

Volume _____ ml Final Initial _____

Blank: _____ mg/ml Total Weight _____

CORE LABORATORIES, INC.
ANALYTICAL REPORT

RECEIVED MAY 8 1985

REC. 5-3-85 PAGE 1 OF 1

WESTERN ENVIRONMENTAL

6756 WEST URANIUM ROAD
CASPER WY 82604
ATT. JIM MEADOR

JOB: R50175
CHEMIST: DLD
LOCATION: CASPER RADIOCHEM

SMPL NO.	SAMPLE ID.	RN222 PCI/L	± ERROR PCI/L	LLD PCI/L
175-1	YCD 5-2-85	6.4	0.7	0.4
175-2	PACK EX 5-2-85	3.1	0.5	0.4

PETROTOMICS STACK SAMPLES 5-2-85

ALPHA
NUCLEAR
LABORATORIES INC.
A DIVISION OF ALPHA ENERGY LABORATORIES, INC.

REPORT OF ANALYSIS

ANL JOB# 85-167

WESTERN ENVIRONMENTAL

2 AIRS FOR RA TH PB AND U REC 5-20-85 PO# 8510-117

SAMPLE I. D.	ISOTOPE	CONCENTRATION (UCI/ML)	LLD (UCI/ML)
PETROTOMICS 5-2-85	RA-226	(1.02 ± 1.24) X 10^{-12}	2 X 10^{-12}
RUN 1 FRONT	TH-230	(2.52 ± 1.03) X 10^{-12}	5 X 10^{-13}
PKG EXH	PB-210	(1.7 ± 63) X 10^{-13}	1 X 10^{-11}
7677	U-NAT	(1.27 ± 0.02) X 10^{-9}	4 X 10^{-12}
PETROTOMICS 5-2-85	RA-226	(1.06 ± 1.03) X 10^{-12}	2 X 10^{-12}
RUN FRONT YCD	TH-230	(3.09 ± 1.66) X 10^{-12}	6 X 10^{-13}
7678	PB-210	(7.1 ± 4.3) X 10^{-12}	7 X 10^{-12}
	U-NAT	(4.09 ± 0.06) X 10^{-9}	7 X 10^{-12}

W J Bumgarner 6/28/85

9982 MONROE DRIVE SUITE 405 DALLAS, TEXAS 75220 (214) 351-6092

APPENDIX F

Chain of Custody and Analysis Request

WESTERN ENVIRONMENTAL SERVICES & TESTING

Chain of Custody and Analysis Request

Job Number 117

Date(s) Sampled 5-2-85

Job Name PETROTOMICS

Number of Runs 1-4CD 1-PE

Source Location SHIRLEY BASIN WY6

Unit Tested 4CD, PE

Absorbing Solution/Analysis For

Run	Filter Number	Imp 1	Imp 2	Imp 3	Imp 4	Probe Wash
4CD	L-80	DI/MOIST	DI/MOIST	DRY/MOIST	SILICA GEL/MOIST.	ACETONE/PARTICULATES
PE	L-81	"	"	"	"	"
3						
4						

No_x: —

Other —

Total Number of Sample Bottles: 3

Total Number of Filters: 2

Comments:

Person Responsible for Samples: Todd Tweedt

Sample No.	Recovered by	Date	Time	Location
4CD	Todd Tweedt	5-2-85	1330	ON SITE
PE	Todd Tweedt	5-2-85	1445	ON SITE
3				
4				

Samples Received by Todd Tweedt for transport Date: 5-2-85 Time: 1500

Samples Received at lab by Mike Jakubec Date: 5-2-85 Time: 1650

Samples Analyzed by Alan D. Rogers Date: 6-25-85 Time: —

APPENDIX G

Resumes of Test Personnel

RUSSELL S. MASON

CURRENT:
6/1/81 to present — Senior Technician, Western Environmental Services and Testing, Inc., Casper, Wyoming and Dallas, Texas; an environmental monitoring and consulting firm. Conducted over 50 source emissions surveys, and assisted in more than 175 surveys. Presently involved in overseeing various ambient air networks.

EXPERIENCE:
12/1/80 to 5/31/81 — Air Quality Department, Kumpe and Associates, P.C., Casper, Wyoming, an engineering and consulting firm. Headed several ambient air monitoring stations. Assisted with stack sampling, contributing to over 45 source studies.

EDUCATION: — Received an Associate of Science degree in Physiology from Casper College, Casper, Wyoming (1977). Two years Environmental Biology, University of Wyoming, Laramie, Wyoming.

TODD R. TWEDT

CURRENT:

3/4/85 to Present	Senior Technician Western Environmental Services & Testing, Inc. Casper, Wyoming and Dallas, Texas An environmental consulting and monitoring firm.
4/20/84 to 3/3/85	Technician Western Environmental Services & Testing, Inc.
EDUCATION:	Graduate of Stevensville High School Stevensville, Montana 1983
TECHNICAL EXPERIENCE:	Assisted in over 30 stack sampling tests.