EVALUATOR cmc EVALUATION DATE 7/14/92

METHOD 5: SECONDARY EMISSIONS TEST REPORT EVALUATION

STATE: WY FACILITY: FMC Wyoming Corp. TEST DATE: 5/19/83

PROCESS(ES) TESTED: 14-24 sesqui plant gas-fired calciners w/ wet scrubbers

SAMPLING DURATION 3
must have at least 3 runs, each ≥ 1 hour duration, with sampling ≥ 2 minutes at each traverse point, and total sampling volume ≥ 30 dscf

PRODUCTION RATE 3
is process or production rate during testing representative of normal rates

CONTROL DEVICE(S) 2
are devices described, and their efficiencies given
no

METHOD 1 3
are calculations accurate, and is figure provided

METHODS 2,3 2
are data and calculations included for gas velocity, cyclonic flow, and molecular weight determination, and is source of barometric pressure noted
no

METHOD 4 3
are data and calculations included for moisture content determination, and is moisture content realistic (< saturation)

FIELD DATA 3
is field data on standard forms, and does raw data correspond with printout

BOILER TESTS N/A
calculation of F_0 from Orsat accurate

SAMPLING TEMPERATURE 3
both probe and filter must be maintained at 248 ± 25°F or other temperature specified in NSPS

BACK-HALF 3
if any, what method was used to catch and recover condensible matter
WY

EQUIPMENT 2
were a borosilicate glass probe liner and a glass fiber filter used
no doc.

CALIBRATION were both pre- and post-test calibrations performed for

- meter box 2
- pitot tube 2
- temperature sensor 2
- nozzle (3 φ) 2

no doc

LEAK CHECKS 3
both pre- and post-test

BLANKS 3
were filter and reagent blanks analyzed, and were any problems addressed

SAMPLE PREP 3
filter desiccation and tare weights documented

ISOKINETICS 3
within 100±10% for all runs

FMC Wyoming Corporation

Box 872
Green River Wyoming 82935
307 875 2580

FMC

May 24, 1988

Mr. Lee Gribovicz
District II Engineer
Air Quality Division
Department of Environmental Quality
210 Lincoln Street
Lander, Wyoming 82520

RE: Compliance Test Report
Emission Source: RA-24 A&B
Notice of Violation - Opacity
Emission

Dear Mr. Gribovicz:

As a result of the Notice of Violation we received concerning opacity emissions from emission source RA-24 A&B, we submitted a Compliance Schedule to the Division with cover letter dated February 5, 1988. As you will remember, the schedule consisted of a Modification Section and a Replacement Section. Per the agreement reached with Division personnel, we were allowed to modify the scrubbers in an attempt to reduce the emissions from this source. In the schedule, a date of June 1, 1988 was targeted as the date when a decision would be made as to whether the modifications were successful. If unsuccessful, the replacement portion of the schedule would immediately be implemented. Per my letter dated April 13, 1988, the modifications made to the scrubbers showed that improved performance had been achieved. Therefore, compliance testing on this unit was scheduled to verify these results.

Attached is the report of this testwork which includes a summary of the test results, and sampling and analysis procedures used to run the tests. The report also contains an Appendix which includes all field data, laboratory worksheets, and calculations for each test. Diagrams in the report include:

- location of the sample ports in the stacks.
- location and number of sample points in each sample diameter.
- modifications made to the scrubber internals.

The section which contains the calculation of feedrate to the unit, and the logsheets of operating parameters monitored during the testwork has been separated from the main report and marked "CONFIDENTIAL" as provided for in § 35-11-1101 of the Wyoming Environmental Quality Act. We consider this information to be trade secret and proprietary as it is not available to the public or to our competitors. We would appreciate you treating it as such.

As we discussed in our telephone conversation of May 19, we encountered some difficulties which required that the compliance tests be run on May 19. For the record, I would like to reiterate below the circumstances which led to the change in schedule of the compliance tests:

> The testwork was originally scheduled for May 17 and 18. The first test was run on May 17, but because of extreme fluctuations in feed to the system, a decision was made to defer the rest of the testing to May 18 when plant operating conditions would allow a more consistant feedrate. The second test of the original three-test series was run the morning of May 18. However, during this test, pressure drop instrumentation attached to the scrubbers showed a pressure drop which was approximately half of what we normally would expect across these units. Because of this discrepancy, a water manometer was used to check the pressure drop across these units with the instrument reading being verified. As a result, the unit was shut down and a full system inspection done to determine the cause of the low pressure drop readings across the scrubbers. No problems were found in the scrubbers themselves as the restriction rings were in place, and waterflow and nozzle operation was found to be acceptable. However, during the inspection of the cyclones, a large material buildup was found in the ductwork of both sets of cyclones (two cyclones service each scrubber separately). It was felt at this time that this buildup not only affected the performance of the cyclone but also accounted for the lower pressure drop observed in the scrubbers. This buildup was removed and when the system was started up, pressure drop in the scrubbers returned to normal. The condition found in the system was not representative of normal system operation. Therefore, the tests run on May 17 and 18 were discarded and the three-test compliance set run on May 19, 1988.

If you have any questions concerning this report, or need any additional information, give me a call.

Yours very truly,

Carl R. Demshar, Jr.
Environmental Manager

jc

cc: Charles Collins, DEQ - Cheyenne
JW Coykendall*, JF Herink*, EA Dunn* - Green River

*Summary Table I included with cover letter

COMPLIANCE TEST REPORT

EMISSION SOURCE DA-24 A&B (MODIFIED)

FMC WYOMING CORPORATION

GREEN RIVER, WYOMING

May 24, 1988

COMPLIANCE TEST REPORT

EMISSION SOURCE: RA-24 A&B

FMC WYOMING CORPORATION
GREEN RIVER, WYOMING

TEST DATE: MAY 19, 1988
REPORT DATE: MAY 24, 1988

COMPLIANCE TEST REPORT
EMISSION SOURCE: RA-24 A&B

Introduction

Compliance tests on emission source RA-24 A&B were orginally scheduled for May 17 and 18, 1988. Keeping with this schedule, one test was run on May 17 with plans to finish the testing on May 18. However, during the first test on May 18, it was noted that the pressure drop in the scrubbers was significantly less than normal. Further investigation showed this had also been the case during the May 17 test. Therefore, the system was shut down and inspected. During this inspection no problems were found in the scrubbers, but large material buildups were found in the cyclone ductwork which service each scrubber. Not only was this buildup reponsible for the reduced pressure drop in the scrubbers, but it also had an adverse effect on cyclone efficiency. Observations of the probes and filter pads from the first two tests showed more dust accumulation than normal. Based on these observations, these two tests were discarded since the emission control system was not operating in a routine, normal mode. The buildup was removed from the ductwork and when operation of the system resumed, pressure drops in the scrubbers returned to normal. Therefore, the three emission tests, required to show compliance, were run on May 19, 1988.

Mr. Lee Gribovicz, the Air Quality Division's District Engineer, was in the plant on both May 17 and 18, but was unable to read stack opacities because the weather conditions were cool, overcast, and raining.

FMC Wyoming Corporation's personnel taking part in the testwork were:

Carl Demshar	Environmental Manager
Dale Clark	Senior Environmental Engineer
Ted Brown	Environmental Engineer
Simon Lee	Environmental Engineering Technician
Kieth Norris	Senior Laboratory Analyst

Summary of Results

This section summarizes the results of the compliance tests performed May 19, 1988 on emission source RA-24 A & B. Table I is a general summary showing the results of the testwork in relation to the maximum allowable emission for this unit. Table II is a summary of the results obtained from each of the compliance tests. Details of the individual tests, including field data sheets, laboratoty data sheets, and calculation sheets can be found in the Appendix.

From Table I, it can be seen that the individual test results are well within the allowable emission rate for this particular unit.

TABLE I

Comparison of Compliance Test Results With Allowable Emission Rates

Emission Source	Test Number	Emission Rate, lb/hr: Compliance Test	Emission Rate, lb/hr: Allowable
RA-24 A & B	88-03-S-P	25.58	45.0
RA-24 A & B	88-04-S-P	28.50	45.0
RA-24 A & B	88-05-S-P	20.35	45.0
	Average:	24.81	45.0

TABLE II

SUMMARY OF STACK SAMPLING CALCULATIONS

Stack: RA-24 A & B

	TEST 1	TEST 2	TEST 3
Test Code Number	88-03-SP	88-04-SP	88-05-SP
Barometric Pressure at site, (in Hg)	23.95	23.95	23.95
Absolute stack gas pressure, (in Hg)	23.36	23.36	23.37
Absolute average stack gas temp. A, (R)	610.8	604.5	589.9
Absolute average stack gas temp. B, (R)	599.7	593.2	589.0
Absolute average dry gas meter temp., (R)	537.05	552.1	556.3
Total volume of water collected, (ml)	205.5	204.7	197.4
Volume of gas through dry gas meter, (ft3)	67.876	68.913	68.273
Average pressure drop across orifice, (in H2O)	0.778	0.812	0.761
Pitot tube coefficient	0.84	0.84	0.84
Average velocity head of stack gas A, (in H2O)	1.038	1.034	1.001
Average velocity head of stack gas B, (in H2O)	1.095	1.006	0.976
Cross sectional area of stack, (ft2)	7.069	7.069	7.069
Front half particulate collected, (gm)	0.2825	0.3239	0.2308
Back half particulate collected, (gm)	0.0006	0.0007	0.0018
Total particulate collected, (gm)	0.2831	0.3246	0.2326
Total sampling time, (min)	120	120	120
Cross sectional area of nozzle, (ft2*10-4)	1.7672	1.7672	1.7672
Gas volume A, (acfm)	31000	30718	29357
Gas volume B, (acfm)	32404	29605	28602
Gas volume A, (scfm)	21001	21027	20602
Gas volume B, (scfm)	22359	20652	20103
Percent isokinetic	98.06	100.85	101.23
Emission rate, (lb/hr)	25.58	28.50	20.35

Sampling and Analysis Procedure

Compliance testing on emission source RA-24 A&B was conducted on May 19, 1988, using EPA Method No. 5, "Determination of Particulate Emissions from Stationary Sources". This unit consists of two stacks, RA-24A and RA-24B. Each emission test consisted of traversing two sample diameters in each stack with six points being sampled on each diameter. Every point was sampled for five minutes resulting in a sample time of sixty minutes for each stack and a total emission test sample of two hours. Only one sample box was used for sampling both stacks for each emission test. Figure 1, located in Section A-2 of the Appendix, shows the location of the sample ports in relation to the nearest flow disturbance such as an expansion, contraction, or bend in the stack, and the location of the sample points in each sample diameter. In addition to this drawing, a sketch of the modifications made to the internals of the scrubbers is also contained in this section of the report as Figure 2. A brief discussion of these modifications is also included in this section.

The operator's control room logsheets and circular natural gas flow chart, containing data pertinent to the operation of the system during the testwork can be found in the Confidential Section of the Compliance Test Report.

Calculation of Production Rate:

Emission Source: RA-24 A&B

Test Date: May 19, 1988

Test No. 88-03-S-P	52.1 tons per hour
Test No. 88-04-S-P	54.2 tons per hour
Test No. 88-05-S-P	52.1 tons per hour

Details of these calculations, along with the operator's control room logsheet and circular natural gas flow chart, containing the data used in these calculations are contained in the attached Confidential packet.

APPENDIX

Section A-1, Test Data

- Field Data Sheets
- Laboratory Data Sheets
- Test Calculations
- Preliminary Test Data

1 — 59

STACK SAMPLING FIELD DATA

Company: FMC Wy Corp.
Plant Location: Green River, Wy
Run No. 88-03-S-P
Sampling Location: R-15 RA-24AB
Date: 5-19-88
Start Time: 08:32/09:10
Finish Time:
Filter No.

Assumed Moisture, %: 15
Probe Tip Diameter, in.: 0.18 (1.76715)
Probe Length, ft.: 5
Ambient Temperature, °F:
Bar. Pressure, in. Hg.: 23.95 "Hg
Initial Leak Check, CFS
CFM .006 at 15 in. Hg.
Final Leak Check, CFS
CFM ___ at ___ in. Hg.

RA-24 "A" West"

Stack Area: 7.069

Point No.	Time (min)	Dry Gas Meter FT^3	Pitot in. H_2O P	Pitot VP	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in. Hg Gauge	Sample Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg	Stack Temp. °F
North Port													
1	0	264.833	.90	0.949	0.69	0.69	51	43	3.0	256	42	-7.3	146
2	5	267.4	1.0	1.000	0.77	0.77	60	47	3.1	253	42	-7.5	151
3	10	270.0	1.05	1.025	0.81	0.81	66	51	3.3	257	42	-7.6	148
4	15	272.7	1.20	1.095	0.93	0.93	71	55	3.8	259	42	-7.6	152
5	20	275.6	1.20	1.095	0.93	0.93	76	59	4.0	266	43	-7.[illegible]	154
6	25	278.6	1.20	1.095	0.93	0.93	74	62	4.0	269	44	-7.6	15[illegible]
	30	281.5											
East Port													
1	0	281.5	1.0	1.000	0.77	0.77	76	66	3.7	266	48	-7.3	143
2	5	284.2	1.05	1.025	0.81	0.81	82	69	3.9	269	50	-7.3	151
3	10	286.9	1.1	1.049	0.85	0.85	84	71	4.0	267	51	-7.3	153
4	15	289.6	0.95	0.975	0.73	0.73	85	73	4.0	271	51	-7.8	153
5	20	292.5	1.1	1.049	0.85	0.85	87	73	4.2	273	50	-7.8	154
6	25	295.2	1.2	1.095	0.93	0.93	88	74	4.5	269	45	-7.8	153
	30	298.2											
Total	Vm	67.876		12.452		10.000	1647 68.6°F					-7.54	1508°F
Average				VP 1.038		ΔH 0.833	528.6°R					P_s = 23.40	610.8°R

1.0389 × 65.335 = 67.876

Orsat
%CO_2 = 2.2
%O_2 = 12.6
%CO = 0.0

33.367, 31.969, 34.65, 33.217, 1.0389

1810, 1677, 24, 1453, 605.3, 1810

avg ΔH 0.778   avg Tm: 537.05°R   avg. P_s = 23.36"Hg   605.3 avg

(1) (SPL)

STACK SAMPLING FIELD DATA

Company fmc Wy. Corp.

Plant Location Green River, Wy.

Run No. 88-03-S-P

Sampling Location R-15

Date 5-19-88

Start Time 09:48/10:27

Finish Time

Filter No.

Assumed Moisture, %

Probe Tip Diameter, in.

Probe Length, ft.

Ambient Temperature, °F

Bar. Pressure, in. Hg. 23.95

Initial Leak Check, CFS
CFM ____ at ____ in. Hg.

Final Leak Check, CFS
CFM 0.001 at 6.0 in. Hg.

RA-24B "East"

Point No.	Time (min)	Dry Gas Meter FT^3	Pitot in. H_2O P	Pitot $\sqrt{P}$	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in. Hg Gauge	Sample Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg	Stack Temp. °F
West Port													
1	0	298.2	0.80	0.894	0.62	0.62	84	76	3.9	266	47	-8.4	[illegible]
2	5	301.1	0.45	0.671	0.35	0.35	86	77	3.4	268	48?	-8.8?	143
3	10	303.1	0.40	0.632	0.31	0.31	86	72	3.2	266	50	-8.6	144
4	15	304.9	1.1	1.049	0.85	0.85	90	79	4.8	273	47	-8.5	145
5	20	307.6	1.1	1.049	0.85	0.85	92	80	5.0	279	44	-8.5	142
6	25	310.5	1.1	1.049	0.85	0.85	92	81	5.1	221	49	-8.4	134
	30	313.4											
North Port													
1	0	313.4	0.95	0.975	0.73	0.73	87	80	4.5	257	54	-8.0	127
2	5	316.0	0.95	0.975	0.73	0.73	92	81	5.0	257	54	-8.2	137
3	10	318.8	1.0	1.000	0.77	0.77	93	83	5.0	257	53	-8.5	137
4	15	321.4	1.2	1.095	0.93	0.93	94	83	5.9	262	55	-8.6	142
5	20	324.4	1.1	1.049	0.85	0.85	95	84	5.9	256	58	-8.5	140
6	25	327.3	1.1	1.049	0.85	0.85	95	84	6.0	252	60	-8.5	141
	30	330.168											
			23.929 avg 0.997										
			11.487				2052					103.42	1677
Total			~~13.137~~		8.69		85.5°F					-8.62"	139.7°F
Average			√P ~~.7095~~ 0.957		ΔH 0.724		545.5°R					P_s 23.33"Hg	599.7°R

TEST NO. 88-03-S-P DATE 05-19-88

VELOCITY AND VOLUME DETERMINATION

****

DRY GAS VOLUME

Vmstd=(17.71 deg R/in. Hg)*Vm*(Pbar+deltaH/13.6)/Tm)

Where Vmstd=Volume(ft3) of gas sample at 70F and 29.92 in. Hg
Vm=Volume (ft3) of gas at meter conditions
Tm=Average dry gas meter temperature (R)
Pbar=Barometric pressure (in. Hg)
deltaH=Pressure drop across orifice (in. WG)

Vmstd=17.71* 67.88*(23.95+0.778/13.6)/537.1 = 53.736 ft3

VOLUME OF WATER VAPOR

Vwstd=(0.0474 ft3/ml)*Vlc

Where Vwstd=Volume (ft3) of water vapor
Vlc=Total volume of water collected (ml)

Vwstd = .00474* 205.5 = 9.741 ft3

MOISTURE CONTENT

Bwo=Vwstd*100/(Vwstd+Vmstd)

Where Bwo=Percent moisture

Bwo = 9.74*100/(9.74+ 53.74) = 15.345 percent

CONCENTRATION

Cs'=(15.43 grains/gm)*Mn/(Vmstd+Vwstd)

Where Cs'=Concentration (grains/scf)
Mn=Total particulate collected (gm)

Cs' = 15.43*0.2831/(53.74+ 9.74) = 0.0688 grains/scf

STACK VELOCITY

Where V=Stack velocity (ft/sec)
Ts=Stack absolute temperature (R)
deltaP=Average pitot reading (in. WG)
Mw=Molecular wt. of stack gas (lb/lb mole)
Kp=Pitot tube coefficient

Mw=0.18*15.35+0.44* 1.86+0.32*10.67+0.28*72.13 = 27.190 lb/mole

RA-24A V=0.84*85.48*1.038*SQR(610.8/(27.19*23.36)) = 73.088 ft/sec
RA-24B V=0.84*85.48*1.095*SQR(599.7/(27.19*23.36)) = 76.398 ft/sec

STACK VOLUME

ACFM=V*A*60 AND SCFM=ACFM*530*Ps/(Ts*29.92)

Where ACFM=Actual cubic Ft per minute at stack conditions
A=Stack area (ft2)
SCFM=Standard cubic ft. per min. (29.92 in. Hg & 530 R)

RA-24A ACFM = 73.09* 7.069*60 = 31000 acfm
RA-24B ACFM = 76.40* 7.069*60 = 32404 acfm
RA-24A SCFM = 31000*530*23.36/(610.8*29.92) = 21001 scfm
RA-24B SCFM = 32404*530*23.36/(599.7*29.92) = 22359 scfm

CALCULATED DUST LOAD

lb/hr=Cs'*SCFM*60/7000 grains/lb

DUST LOAD= 0.0688* 43360*60/7000 = 25.58 Lb/Hr

ISOKINETIC RATE

I = 98.05684 %

1

LABORATORY DATA

Company FMC Wy. Corp. Run No.: 88-03-85-P

Sampling Location R-15 Date: 5-19-88

MOISTURE COLLECTED

		GM/ML	Water Weight/Volume Gain GM/ML
IMPINGER 1	Final Weight/Volume	683.6	
	Initial Weight/Volume	540.9	
	Increase	142.7	142.7
IMPINGER 2	Final Weight/Volume	597.3	
	Initial Weight/Volume	557.8	
	Increase	39.5	39.5
IMPINGER 3	Final Weight/Volume	434.8	
	Initial Weight/Volume	428.7	
	Increase	6.1	6.1
IMPINGER 4	Final Weight/Volume	625.9	
	Initial Weight/Volume	608.7	
	Increase	17.2	17.2
	TOTAL MOISTURE CATCH		205.5

PARTICULATE COLLECTED

"Sample"

75.0099
74.9945 tare
.0154

FRONT-HALF ANALYSIS (Nozzle, Probe, Cyclone, Filter Front-Half)

Filter & Particulates	0.8032
Filter Tare Weight	0.5359
Particulate	0.2673
Washings	0.0154
Particulate Catch	0.2827
Acetone Blank	0.0002
TOTAL FRONT CATCH	0.2825

BACK-HALF ANALYSIS (Impingers, Filter Back-Half)

1-BH

Extractable Weight	73.3333
Boil Down Weight	73.3327
Impinger Catch	0.0006
Water Blank	
TOTAL BACK CATCH	0.0006
TOTAL TRAIN CATCH	0.2831

1-B "Blank"

.2132
.2130
.0002

(2)

STACK SAMPLING FIELD DATA

Company FMC Wyo. Corp.

Plant Location Green River, Wyo.

Run No. 88-04-5-P

Sampling Location P-15 A

Date 5-19-88

Start Time 11:17am 11:52am

Finish Time 11:47am 12:22pm

Filter No. ______

Assumed Moisture, % 15

Probe Tip Diameter, in. 0.18

Probe Length, ft. 5

Ambient Temperature, °F ______

Bar. Pressure, in. Hg 23.95

Initial Leak Check, CFS
CFM 0.000 at 16 in. Hg.

Final Leak Check, CFS
CFM ______ at ______ in. Hg.

Stack Area = 7.069

Point No.	Time (min)	Dry Gas Meter FT^3	Pitot in. H_2O P	Pitot in. H_2O VP	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in. Hg Gauge	Sample Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg	Stack Temp. °F
North Port													
1	0	330.490	0.87	0.933	0.66	0.66	82	82	3.6	265	48	-7.0"	140
2	5	333.0	0.94	0.969	0.73	0.73	92	84	4.0	268	38	-7.30"	146
3	10	335.6	0.98	0.989	0.76	0.76	95	85	4.2	267	39	-7.46"	146
4	15	338.6	1.30	1.140	1.00	1.00	97	86	5.3	260	39	-7.75'	145
5	20	341.3	1.36	1.166	1.05	1.05	98	87	5.8	268	40	-7.70"	147
6	25	344.4	1.30	1.140	1.00	1.00	98	87	5.8	267	40	-7.70"	146
	30	347.446											
East Port													
1	0	347.446	0.90	0.949	0.69	0.69	85	85	4.3	265	48	-7.30"	141
2	5	349.9	0.93	0.964	0.73	0.73	96	88	5.0	267	44	-7.38"	142
3	10	352.5	1.06	1.029	0.81	0.81	98	88	5.2	267	45	-7.43"	145
4	15	355.2	0.98	0.989	0.76	0.76	98	88	5.3	271	45	-7.80"	145
5	20	357.9	1.10	1.049	0.85	0.85	99	89	6.0	266	44	-7.86"	145
6	25	360.9	1.20	1.095	0.93	0.93	99	89	6.8	268	46	-7.92	146
	30	363.730											
		12.416					2173					90.79	1734
Total	Vm =	68.913	12.412		9.97		90.5°F					-7.56"	144.5°
Average			VP 1.034		ΔH: 0.831		550.5°R					Ps 23.40" Hg	604.5°R

1.0389 X 66.33 = 68.913

33.740 X 1.0389 = 34.387 ... = 34.533

33.093

Orsat
% CO_2 : 2.4
% O_2 : 13.1
% CO : 0.0

1.04 avg ΔH: 0.812 avg Tm: 552.1°R avg Ps = 23.36" Hg

②

STACK SAMPLING FIELD DATA

.034 / .000 Final

Company *FMC Wyo. Corp.*

Plant Location *Green River, Wyo.*

Run No. *88-04-5-P*

Sampling Location *R-15 B*

Date *5-19-88*

Start Time *12:30 PM* | *1:09 PM*

Finish Time *1:00 PM* | *1:39 PM*

Filter No. *RA-24-B*

Assumed Moisture, % *15*

Probe Tip Diameter, in. *0.18*

Probe Length, ft. *5*

Ambient Temperature, °F

Bar. Pressure, in. Hg. *23.95*

Initial Leak Check, CFS
CFM ____ at ____ in. Hg.

Final Leak Check, CFS
CFM *<.001* at *10.0* in. Hg.

Point No.	Time (min)	Dry Gas Meter FT^3	Pitot in. H_2O P	Pitot in. H_2O √P	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in. Hg Gauge	Sample Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg	Stack Temp. °F
West Port													
1	0	363.730	0.87	0.933	0.66	0.66	86	86	5.0	264	54	-8.38"	130
2	5	366.2	0.80	0.894	0.63	0.62	97	89	5.0	266	50	-8.60"	131
3	10	368.6	0.42	0.648	0.31	0.31	99	90	4.0	267	50	-8.90"	132
4	15	370.5	1.20	1.095	0.93	0.93	97	90	7.0	265	51	-8.60"	136
5	20	373.5	1.20	1.095	0.93	0.93	101	91	7.0	265	49	-8.50"	137
6	25	376.6	1.20	1.095	0.93	0.93	102	91	7.5	275	49	-8.50"	137
	30	379.454											
North Port													
1	0	379.4	0.95	0.975	0.73	0.73	88	88	6.0	264	54	-8.0	130
2	5	382.1	0.94	0.969	0.72	0.72	98	91	6.4	267	47	-8.1	131
3	10	384.8	0.98	0.989	0.76	0.76	99	91	7.0	271	46	-8.4	133
4	15	387.6	1.3	1.140	1.00	1.00	101	91	8.3	276	47	-8.6	134
5	20	390.7	1.3	1.140	1.00	1.00	100	91	9.0	274	49	-8.5	135
6	25	393.8	1.2	1.095	0.93	0.93	100	91	9.0	272	50	-8.5	133
	30	396.823											
		33.093											
			24.488 / 24 / 1.020										
			12.072				2248					101.6	1599
Total			~~12.060~~		9.52		93.7°F					-8.47"	133.2°F
Average			TS ~~1.006~~ 1.006		ΔH 0.793		553.7°R					Ps 23.33" Hg	593.2°R

TEST NO. 88-04-S-P DATE 05-19-88

VELOCITY AND VOLUME DETERMINATION

****

DRY GAS VOLUME

Vmstd=(17.71 deg R/in. Hg)*Vm*(Pbar+deltaH/13.6)/Tm)

Where Vmstd=Volume(ft3) of gas sample at 70F and 29.92 in. Hg
Vm=Volume (ft3) of gas at meter conditions
Tm=Average dry gas meter temperature (R)
Pbar=Barometric pressure (in. Hg)
deltaH=Pressure drop across orifice (in. WG)

Vmstd=17.71* 68.91*(23.95+0.812/13.6)/552.1 = 53.075 ft3

VOLUME OF WATER VAPOR

Vwstd=(0.0474 ft3/ml)*Vlc

Where Vwstd=Volume (ft3) of water vapor
Vlc=Total volume of water collected (ml)

Vwstd = .00474* 204.7 = 9.703 ft3

MOISTURE CONTENT

Bwo=Vwstd*100/(Vwstd+Vmstd)

Where Bwo=Percent moisture

Bwo = 9.70*100/(9.70+ 53.07) = 15.456 percent

CONCENTRATION

Cs'=(15.43 grains/gm)*Mn/(Vmstd+Vwstd)

Where Cs'=Concentration (grains/scf)
Mn=Total particulate collected (gm)

Cs' = 15.43*0.3246/(53.07+ 9.70) = 0.0798 grains/scf

STACK VELOCITY

Where V=Stack velocity (ft/sec)
Ts=Stack absolute temperature (R)
deltaP=Average pitot reading (in. WG)
Mw=Molecular wt. of stack gas (lb/lb mole)
Kp=Pitot tube coefficient

Mw=0.18*15.46+0.44* 1.86+0.32*11.08+0.28*71.61 = 27.195 lb/mole

RA-24A V=0.84*85.48*1.034*SQR(604.5/(27.20*23.36)) = 72.424 ft/sec
RA-24B V=0.84*85.48*1.006*SQR(593.2/(27.20*23.36)) = 69.801 ft/sec

STACK VOLUME

ACFM=V*A*60 AND SCFM=ACFM*530*Ps/(Ts*29.92)

Where ACFM=Actual cubic Ft per minute at stack conditions
A=Stack area (ft2)
SCFM=Standard cubic ft. per min. (29.92 in. Hg & 530 R)

RA-24A ACFM = 72.42* 7.069*60 = 30718 acfm
RA-24B ACFM = 69.80* 7.069*60 = 29605 acfm
RA-24A SCFM = 30718*530*23.36/(604.5*29.92) = 21027 scfm
RA-24B SCFM = 29605*530*23.36/(593.2*29.92) = 20652 scfm

CALCULATED DUST LOAD

lb/hr=Cs'*SCFM*60/7000 grains/lb

DUST LOAD= 0.0798* 41679*60/7000 = 28.50 Lb/Hr

ISOKINETIC RATE

I = 100.8515 %

2

LABORATORY DATA

Company FMC Wv. Corp. Run No.: 88-04-S-P

Sampling Location RA-24 A+B Date: 05-18-89

MOISTURE COLLECTED

		GM/ML	Water Weight/Volume Gain GM/ML
IMPINGER 1	Final Weight/Volume	645.4	
	Initial Weight/Volume	501.2	
	Increase	144.2	144.2
IMPINGER 2	Final Weight/Volume	570.1	
	Initial Weight/Volume	532.5	
	Increase	37.6	37.6
IMPINGER 3	Final Weight/Volume	423.5	
	Initial Weight/Volume	417.1	
	Increase	6.4	6.4
IMPINGER 4	Final Weight/Volume	647.0	
	Initial Weight/Volume	630.5	
	Increase	16.5	16.5
	TOTAL MOISTURE CATCH		204.7

PARTICULATE COLLECTED

2-S "sample"

FRONT-HALF ANALYSIS (Nozzle, Probe, Cyclone, Filter Front-Half)

73.5164
73.5050 tare
.0114

Filter & Particulates	0.8930
Filter Tare Weight	0.5792 tare
Particulate	0.3138
Washings	0.0114
Particulate Catch	0.3252
Acetone Blank	0.0013
TOTAL FRONT CATCH	0.3239

BACK-HALF ANALYSIS (Impingers, Filter Back-Half)

2-BH

Extractable Weight	74.7263
Boil Down Weight	74.7256 tare
Impinger Catch	.0007
Water Blank	-0-
TOTAL BACK CATCH	0.0007
TOTAL TRAIN CATCH	0.3246

2-B "Blank"

74.8786
74.8773 tare
.0013

3 (5PL)

STACK SAMPLING FIELD DATA

Company FMC Wy Corp.
Plant Location Green River, Wy
Run No. 88-05-5-P
Sampling Location R-15 RA-24A
Date 5-19-88
Start Time 14:55 / 15:31
Finish Time
Filter No.

Assumed Moisture, % 15
Probe Tip Diameter, in. .18
Probe Length, ft. 5
Ambient Temperature, °F
Bar. Pressure, in. Hg. 23.95
Initial Leak Check, CFS
CFM .007 at 15 in. Hg.
Final Leak Check, CFS
CFM at in. Hg.

"West" Stack — Stack Area = 7.069

Point No.	Time (min)	Dry Gas Meter FT^3	Pitot in. H_2O P	$\sqrt{P}$	Orifice ΔH in. H_2O Desired	Actual	Dry Gas Temp. °F Inlet	Outlet	Pump Vacuum in. Hg Gauge	Sample Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg	Stack Temp. °F
West													
South Port													
1	0	397.365	0.87	0.933	0.67	0.67	90	88	2.8	262	60	-7.0	116
2	5	400.0	0.87	0.933	0.67	0.67	95	89	2.9	268	59	-7.1	128
3	10	402.5	1.0	1.000	0.77	0.77	98	89	3.0	267	59	-7.3	144
4	15	405.3	1.15	1.072	0.89	0.89	100	90	3.4	272	58	-7.2	146
5	20	408.2	1.15	1.072	0.89	0.89	101	90	3.5	265	57	-7.2	145
6	25	411.1	1.10	1.049	0.85	0.85	100	90	3.2	262	58	-7.2	145
	30	413.9											
East Port													
1	0	413.9	0.80	0.894	0.62	0.62	95	88	3.0	264	63	-7.1	128
2	5	416.4	0.89	0.943	0.68	0.68	99	89	3.3	266	64	-7.1	139
3	10	419.0	1.0	1.000	0.77	0.77	101	90	3.7	256	62	-7.2	143
4	15	421.9	1.05	1.025	0.81	0.81	103	90	3.9	266	60	-7.5	144
5	20	424.5	1.05	1.025	0.81	0.81	104	92	4.0	262	59	-7.5	145
6	25	427.4	1.15	1.072	0.89	0.89	105	93	4.2	257	58	-7.5	145
	30	430.3											
Total	Vm	68.273		12.019 (12.018)		9.32	2269 / 945°F					86.9 / -7.24"	1667 / 138.9°F
Average				1.001 (1.001)		ΔH 0.777	554.5°R					P_s 23.40" Hg	598.9°R

Orsat
$\%CO_2$ = 2.1
$\%O_2$ = 13.4
$\%CO$ = 0.0

1.0389 × 65.717 = 68.273

= 34.716
= 31.057
32.999 × 1.0389
32.782

1.001 avg ΔH = 0.761   avg Tm = 556.3   Avg P_s = 23.37" Hg

STACK SAMPLING FIELD DATA (3) FMC CORPORATION, GREEN RIVER, WY. 572

RUN NUMBER 88-05-S-P DATE ______

SAMPLING LOCATION R-15 RA-24B East FILTER NUMBER ______

ASSUMED MOISTURE 15 % PROBE TIP DIAMETER ______ in.

BAROMETRIC PRESSURE 23.95 in. Hg PROBE LENGTH ______ ft.

INITIAL LEAK CHECK ______ cfm @ ______ in. Hg FINAL LEAK CHECK .004 cfm @ 6.0 in. Hg

Start: 16:06 / 16:43 Finish 17:13 RA-24B East

Pt.	Min.	Dry Gas Meter Ft^3	Pitot P	Pitot $\sqrt{P}$	Orifice ΔH in. H2O Desired	Orifice ΔH in. H2O Actual	Dry Gas Temp. In	Dry Gas Temp. Out	Pump Vac. in.Hg	Sample Box Temp.	Imp. Temp.	Stack Press. in. Hg	Stack Temp.
East"													
[illegible]													
[illegible]rt													
1	0	430.3	0.68	0.825	0.52	0.52	99	92	3.4	272	57	-8.2	126
2	5	433.0	0.60	0.774	0.46	0.46	101	94	3.2	277	57	-8.4	126
3	10	435.2	0.40	0.632	0.31	0.31	100	94	3.0	225	59	-8.7	127
4	15	437.0	1.05	1.025	[illegible]	[illegible]	104	94	4.2	276	57	[illegible]	[illegible]
5	20	439.7	1.1	1.049	0.85	0.85	105	94	4.5	267	58	-8.5	133
6	25	442.7	1.1	1.049	0.85	0.85	105	94	4.6	261	59	-8.5	132
	30	445.5											
North													
[illegible]rt													
1	0	445.5	1.1	1.049	0.85	0.85	99	93	4.8	265	57	-8.4	122
2	5	448.4	1.1	1.049	0.85	0.85	103	94	4.9	262	55	-8.5	126
3	10	451.3	1.1	1.049	0.85	0.85	103	94	5.0	271	52	-8.6	129
4	15	454.2	1.15	1.072	0.89	0.89	104	94	5.2	257	52	-8.6	130
5	20	457.2	1.15	1.072	0.89	0.89	104	94	5.5	250	52	-8.6	132
6	25	460.1	1.15	1.072	0.89	0.89	103	93	5.8	266	52	-8.6	133
	30	*463.082*											

32.782

23.736 / 24 = 0.989 avg

11.718

~~11.717~~

avg. √ΔP 0.976 ✓

9.02

avg ΔH: 0.752

2354

98.1°F

558.1°R

102.1

-8.51"

P_s = 23.32"Hg

1548

129°F

589°R

TEST NO. 88-05-S-P DATE 05-19-88

VELOCITY AND VOLUME DETERMINATION

****

```
DRY GAS VOLUME
 Vmstd=(17.71 deg R/in. Hg)*Vm*(Pbar+deltaH/13.6)/Tm)
 Where Vmstd=Volume(ft3) of gas sample at 70F and 29.92 in. Hg
      Vm=Volume (ft3) of gas at meter conditions
      Tm=Average dry gas meter temperature (R)
      Pbar=Barometric pressure (in. Hg)
      deltaH=Pressure drop across orifice (in. WG)

     Vmstd=17.71* 68.27*(23.95+0.761/13.6)/556.3 =  52.177 ft3

VOLUME OF WATER VAPOR
 Vwstd=(0.0474 ft3/ml)*Vlc
 Where Vwstd=Volume (ft3) of water vapor
      Vlc=Total volume of water collected (ml)

                          Vwstd = .00474* 197.4 =   9.357 ft3
MOISTURE CONTENT
 Bwo=Vwstd*100/(Vwstd+Vmstd)
 Where Bwo=Percent moisture

              Bwo =   9.36*100/(  9.36+ 52.18) = 15.206 percent
CONCENTRATION
 Cs'=(15.43 grains/gm)*Mn/(Vmstd+Vwstd)
 Where Cs'=Concentration (grains/scf)
      Mn=Total particulate collected (gm)

            Cs' = 15.43*0.2326/( 52.18+  9.36) =  0.0583 grains/scf

STACK VELOCITY
 Where V=Stack velocity (ft/sec)
      Ts=Stack absolute temperature (R)
      deltaP=Average pitot reading (in. WG)
      Mw=Molecular wt. of stack gas (lb/lb mole)
      Kp=Pitot tube coefficient

 Mw=0.18*15.21+0.44* 1.78+0.32*11.36+0.28*71.65 = 27.219 lb/mole

RA-24A   V=0.84*85.48*1.001*SQR(589.9/(27.22*23.37)) =  69.215 ft/sec
RA-24B   V=0.84*85.48*0.976*SQR(589.0/(27.22*23.37)) =  67.435 ft/sec

STACK VOLUME
 ACFM=V*A*60    AND   SCFM=ACFM*530*Ps/(Ts*29.92)
 Where ACFM=Actual cubic Ft per minute at stack conditions
      A=Stack area (ft2)
      SCFM=Standard cubic ft. per min. (29.92 in. Hg & 530 R)

            RA-24A  ACFM =  69.22*  7.069*60 =  29357 acfm
            RA-24B  ACFM =  67.44*  7.069*60 =  28602 acfm
   RA-24A   SCFM =  29357*530*23.37/(589.9*29.92) =  20602 scfm
   RA-24B   SCFM =  28602*530*23.37/(589.0*29.92) =  20103 scfm

CALCULATED DUST LOAD
 lb/hr=Cs'*SCFM*60/7000 grains/lb

            DUST LOAD= 0.0583* 40705*60/7000 =    20.35 Lb/Hr

ISOKINETIC RATE
                        I =  101.2268 %
```

(3)

LABORATORY DATA

Company FMC Wy Corp. Run No.: 88-05-S-P

Sampling Location RA-24 A & B Date: 05-18-88

MOISTURE COLLECTED

		GM/ML	Water Weight/Volume Gain GM/ML
IMPINGER 1	Final Weight/Volume	664.5	
	Initial Weight/Volume	506.9	
	Increase	157.6	157.6
IMPINGER 2	Final Weight/Volume	541.7	
	Initial Weight/Volume	518.5	
	Increase	23.2	23.2
IMPINGER 3	Final Weight/Volume	439.7	
	Initial Weight/Volume	436.8	
	Increase	2.9	2.9
IMPINGER 4	Final Weight/Volume	712.7	
	Initial Weight/Volume	699.0	
	Increase	13.7	13.7
	TOTAL MOISTURE CATCH		197.4

PARTICULATE COLLECTED

3-S "sample"

FRONT-HALF ANALYSIS (Nozzle, Probe, Cyclone, Filter Front-Half)

75.0318
75.0213 tare
.0105

Filter & Particulates	0.7552
Filter Tare Weight	0.5336 tare
Particulate	0.2216
Washings	0.0105
Particulate Catch	0.2321
Acetone Blank	0.0013
TOTAL FRONT CATCH	0.2308

BACK-HALF ANALYSIS (Impingers, Filter Back-Half)

3-BH

Extractable Weight	74.4380
Boil Down Weight	74.4362 tare
Impinger Catch	0.0018
Water Blank	
TOTAL BACK CATCH	0.0018
TOTAL TRAIN CATCH	0.2326

3-B "Blank"

73.3049
73.3036 tare
.0013

Section A-2, Stack Information
And Scrubber Modifications

- Drawing showing location of sample ports and number of points per traverse (Figure 1)

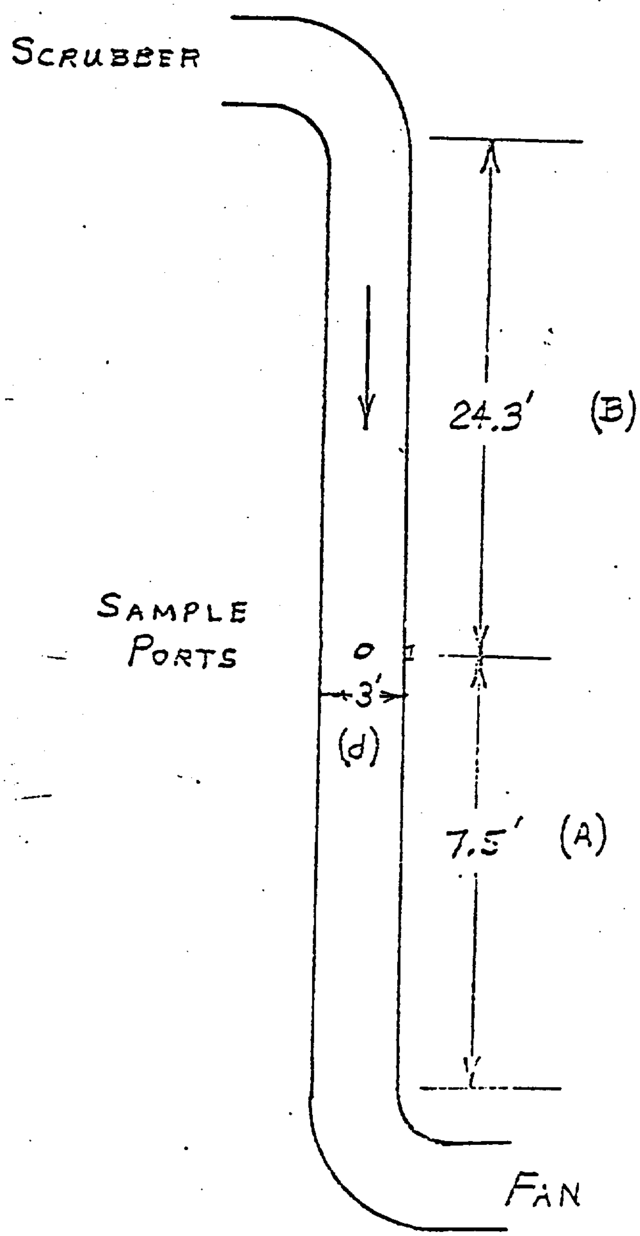
- Drawing showing modifications made to internals of scrubbers (Figure 2)

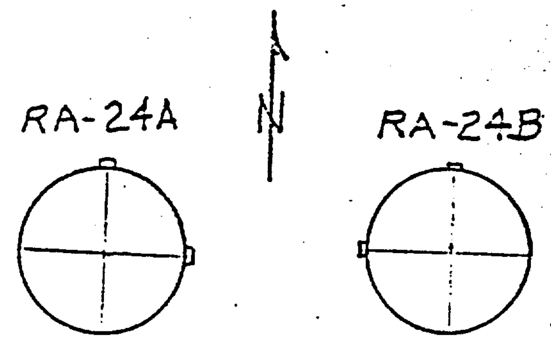
- Brief discussion of modifications made to scrubbers

FIGURE 1

FMC WYOMING CORPORATION
CHEMICAL PRODUCTS GROUP
BOX 872
GREEN RIVER, WYOMING 82935
(307) 875-2580

RA-24 A&B





$\frac{B}{d} = 8.1$

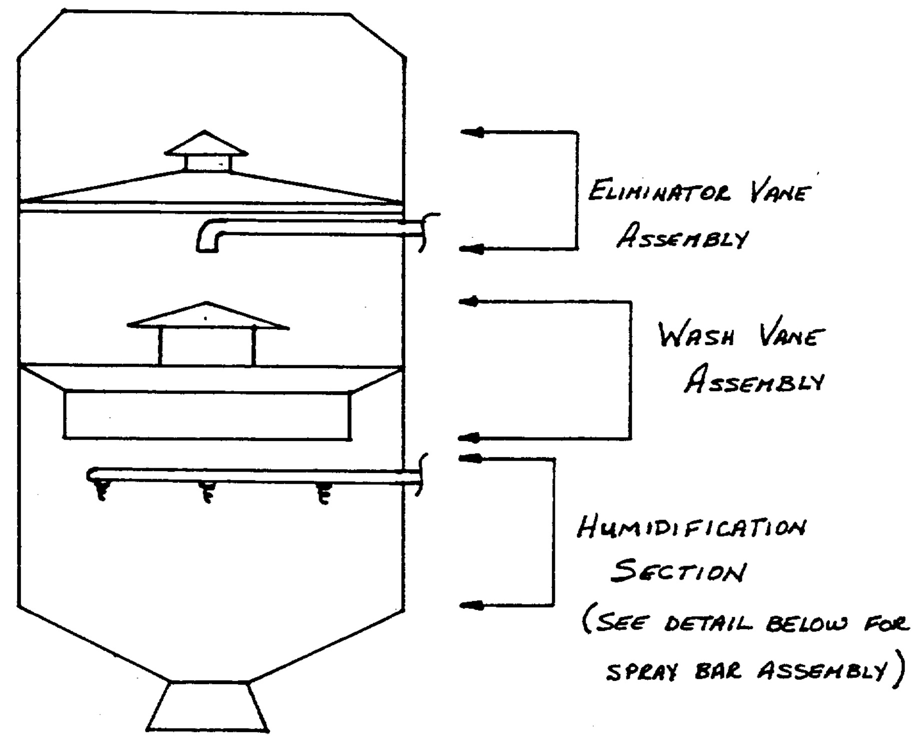
NO. OF POINTS PER TRAVERSE = 12
NO. OF POINTS PER DIAMETER = 6
NO. OF DIAMETERS PER RUN = 4
SAMPLE TIME PER POINT = 5 MINUTES

TRAVERSE POINTS ON EACH DIAMETER

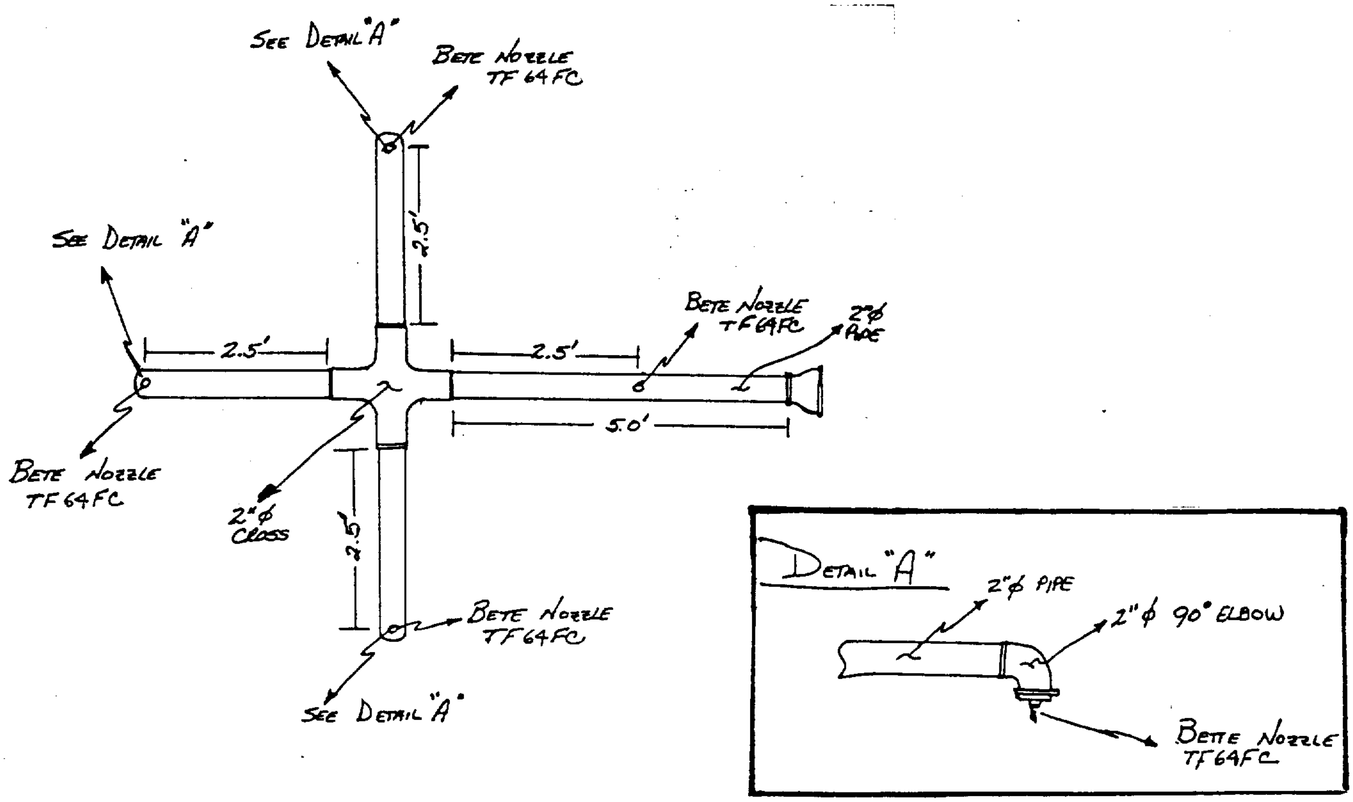
	% OF DIAMETER	DISTANCE FROM INSIDE WALL (IN.)	DISTANCE FROM COUPLING (IN.)
1	4.4	1.58	4.58
2	14.7	5.29	8.29
3	29.5	10.62	13.62
4	70.5	25.38	28.38
5	85.3	30.71	33.71
6	95.6	34.42	37.42

FIGURE 2

MODIFICATIONS MADE TO RA24 A&B DUCON MULTIVANE SCRUBBERS



DETAIL OF SPRAY BAR ASSEMBLY



DISCUSSIONS OF MODIFICATIONS
MADE TO SCRUBBERS
SERVICING SOURCE RA-24 A&B

The RA-24 A&B Compliance Schedule, submitted to the Air Quality Division under cover letter dated November 5, 1988, consisted of two main sections: A Modification Section and A Replacement Section. Under the Modification Section, several modifications were listed that had the potential when implemented, of reducing the emissions from this source. Listed below is a discussion of the modifications made and their resultant impact of reducing the emissions from this unit:

Nozzles - Humidification Section

The original blueprint of the scrubber's internals showed a manifold system much like the one shown in Figure 2. In addition, this print also showed the nozzles in this area as being only one-half inch in diameter (Bete Nozzle No. TF28FC). Through the years of operation, plugging of these nozzles was a problem. Therefore, this manifold/small-nozzle arrangement was replaced by one large Swirl Jet Nozzle. However, during the studies to reduce the emissions from this unit, the water coverage in the Humidification Section was found to be inadequate. Therefore, a decision was made to replace this single nozzle with a manifold system shown in the original print. In addition, larger Bete Nozzles (No. TF64FC), having a diameter of one-and-a-half inches were used. It was felt that these larger nozzles would reduce the chances of plugging.

It was also determined that four nozzles in this area would supply better water coverage of the cross-sectional area of the scrubber and thereby increase the incoming air/water contact. Telephone discussions with Ducon personnel (the manufacturer of the scrubbers) indicated that optimum air/water contact in this area (the Humidification Section) was imperative to properly cool the hot incoming gasses, resulting in optimum scrubber performance. The manifold design and nozzle placements can be seen in Figure 2. To further prevent plugging of these nozzles, a Lakos Separator was also installed in the water line leading to the Humidification Section of both scrubbers.

Lakos Separator

Throughout the attempts to reduce the emissions on this unit, it was noted that the spray nozzles had a tendency, over time, to plug with extraneous material. This material consisted mainly of scale from the piping. As a result a Lakos Separator, Model No. IL-3008, was installed on the water line feeding the Humidification Section of the scrubbers. Plugging in the upper or washing section, was not a problem as the flow is through an unrestricted, two-inch open-end pipe. Operation of the scrubbers with the Lakos in place showed the unit to be successful in removing the scale and other extraneous materials which plugged the nozzles.

Burner Modification/Repair

During the work performed to reduce the emissions from Source RA-24 A&B scrubbers, it was noted that the throat on the burner in this calcining unit had been burned away. In essence, this gave a very bushy-type flame pattern which reduced efficient heat transfer in this unit. Past experience has shown that a situation such as this can result in "overfiring" on the feed-end of the calciner to get appropriate calcination temperatures toward the discharge end of the calciner. This overfiring situation can cause excessive particle degradation resulting in excessive amounts of fines being generated, which in turn can cause an overload situation in the emission control sytem. The burner throat was repaired and the flame pattern returned to normal.

Dan
Dale:

MEMORANDUM

TO: FMC Soda Ash Plant Compliance File

THROUGH: Chuck Collins, Air Quality Administrator
Bernie Dailey, Air Quality Supervisor

FROM: Lee Gribovicz, District Air Quality Engineer

SUBJECT: Review of RA-24 Retest

DATED: June 6, 1988

Summary

FMC has completed testing on RA-24 A&B twin exhaust scrubbers and results show dramatic improvement over previous testing. Results show an average total emission rate from the twin stacks of 24.2 pph (back half included) compared to an allowable of 45.0 pph. This result is down 45% from the tested value of 44.4 pph in September, 1987. Modifications included redesigning the internal spray system of the scrubbers, installing a cyclone on the scrubber liquor recirculation lines to remove scale and keep the spray nozzels from plugging, and rebuilding the calciners burner to reduce the generation of fines and reduce the load to the scrubber. These tests should be accepted for satisfying NOV #1908-88.

Discussion

As documented in past file correspondence, this sesqui plant calciner exhaust was suspected of marginal compliance with particulate emission limits due to a history of high opacity readings. The Division asked FMC to test this source to confirm its emission status. This testing was conducted in September, 1987 and showed emissions at 99% of the allowable rate. Although mass rate compliance was demonstrated, the Division obtained opacity readings of 49% and 52% on the twin exhaust stacks off this calciner, providing the basis for issuance of an NOV. NOV and Order #1908-88 required a plan for reducing opacity levels and FMC's response provided a two tiered plan of correction. First, they proposed a period of several months to try to adjust the existing twin Ducon scrubbers to improve their performance, and if that didn't bring the source back into compliance by June 1, 1988, then they would proceed with replacement of the scrubbers.

FMC made modifications to the scrubber and calciner, and felt they had accomplished their goal of returning the unit to compliance, so the week of May 16, 1988 they completed retesting on RA-24. I was on plant May 17-18th to observe portions of the work as described by my memo of May 24, 1988. FMC submitted the test report under a cover letter, also dated May 24th. The test report Section A-2 contains drawings of the scrubber internal components and a description of the modifications made to the units. Basically, FMC returned sprays to original design from the configuration that had evolved over the years by "seat-of-the-pants" design, and took steps to eliminate the nozzle plugging which had led to these "coffee time engineering" changes.

I have reviewed this test report and copies of my review work sheets are attached to this memo. The table below summarizes the test results:

	Test 1	Test 2	Test 3	Average
Maximum Process Rate (TPH)	57	57	57	57
Tested Process Rate (TPH)	52.1	54.2	52.1	52.8
Allowable Emission Rate (pph)	45.0	45.0	45.0	45.0
Tested Emission Rate (pph)	23.89	28.47	20.26	24.21

As can be noted, the source tested at 54% of its allowable rate, while the unit operated at about 93% of its effecitve maximum production rate. Past records have listed the design throughput for this calciner at 70 TPH, but as discussed in the May 24th test observation memo, the actual operational maximum is closer to the stated 57 TPH.

I was not on plant when the reported testing took place. As noted in the test observation memo and in the test report discussion, FMC found plugging problems in the precleaner cyclones after they had completed testing which I observed, and they felt that these first tests were not representative of actual emissions. From looking at the calciner gas usage chart and operators logs accompanying the report, it appears that process conditions were well documented and relatively stable. FMC has a very experienced and professional test crew, thus I have no concerns regarding FMC's sampling technique and procedures. I thus find that the values should be representative of normal emissions from this source and are an acceptable demonstration of compliance.

As stated earlier, although the September, 1987 testing showed marginal compliance (99% of allowable), the NOV was issued based on high opacity readings taken during the testing. The dates I was on plant, May 17th and 18th, the sky was continually heavily overcast, with occasional rain. Because of the densely spaced location of steam plumes from adjacent wet scrubbers in this sesqui plant area and because of the factor of other plant equipment interfering with the view of these stacks, opacity reading on this source is difficult under the best conditions. Thus I was unable to obtain any opacity readings while I was on plant. Because particulate emissions have been reduced so significantly (almost half), I am confident that the opacity of these stacks has dropped roughly proportionately, thus I am satisfied that the concerns of the NOV have been met. I recommend that the Division accept these tests as proof of compliance and notify FMC of this acceptance so that they do not have to pursue the replacement portion of their compliance plan.

LG/jw

TSP

STACK EMISSION REVIEW

COMPANY FMC LOCATION Green River

TESTING FIRM FMC Env. Dept. TESTS CONDUCTED BY Ted Brown, Simon Lee, Keith Morris

DATE TESTED 5/19/88

TEST OBSERVED BY not observed

TEST EVALUATED BY [illegible]

STACK DATA

Stack ht (ft) ____

Stack dia (ft) twin stacks: each 3 ft. diameter

Process venting through stack RA-24A & RA-24B

TRAVERSE POINTS

Nozzle diameter: Test 1 0.18" Test 2 → Test 3 →

Location of sampling ports 24.3' (8.1 dia downstream) ; 7.5' (2.5 dia upstream)

Number of traverse points per test: [redacted] 12 per stack, 24 per test Test 2 → Test 3 →

Do sampling points follow EPA guidelines? Yes X No ____

Comments:

EMISSIONS

	Test 1	Test 2	Test 3	
Process wt rate (ton/hr)	52.1	54.2	52.1	52.8 TPH AVG
Allowable emission (lb/hr)	45.0 pph	Section 25	limit	
Measured emission (lb/hr)	23.89	28.47	20.26	24.21 AVG
% Isokinetic	104%	100%	101%	

70 TPH design maximum but ~57 TPH actual production limit

Comments and recommendations:

Test was run @ appx 93% of the actual production rate limit for this unit.

Emissions are 54% of allowable — ∴ accept test [illegible] 6/2/88

TSP
DATA SHEET

Total Test

P_{std} = 29.92 in Hg

T_{std} = 528°R

		Test 1	Test 2	Test 3
P_{bar}	= barometric pressure at site (in Hg)	23.95	→	→
P_s	= absolute stack gas pressure (in Hg)	23.36	→	23.37
T_s	= absolute average stack gas temp. (°R)	605.3	598.9	594.4
T_m	= absolute average dry gas meter temp. (°R)	537.1 [redacted]	552.1	556.3
V_{ic}	= total volume of water collected (ml)	205.5	204.7	197.4
V_m	= volume of gas through dry gas meter (ft^3)	67.876	68.913	68.273
ΔH	= average pressure drop across orifice (in H_2O)	0.778	0.812	0.761
C_p	= pitot tube coefficient	0.84	→	→
$(\sqrt{\Delta P})_{ave}$	= average velocity head of stack gas (in H_2O)	0.997	1.020	0.989
A_s	= cross-sectional area of stack (ft^2)	14.137	→	→
M_n	= total amount of particulate collected (g)	0.2831	0.3246	0.2326
θ	= total sampling time (min.)	120	→	→
A_n	= cross-sectional area of nozzle (ft^2)	1.767×10^{-4}	→	→

ORSAT ANALYSIS

	Test 1	Test 2	Test 3
% CO_2	2.2	2.4	2.1
% O_2	12.6	13.1	13.4
% CO	0	→	→
% N_2	85.2	84.5	→

Total Test

CALCULATIONS

1. $V_{w\ std}$ = volume of water vapor in gas @ STP (ft^3)

$V_{w\ std} = 0.0474\ ft^3/ml \cdot V_{ic}$

$V_{w\ std}$ = 9.74, 9.70, 9.36 ft^3

2. $V_{m\ std}$ = volume of gas sample through dry gas meter @ STP (ft^3)

$$V_{m\ std} = \left(17.65\ \frac{°R}{in\ Hg}\right) V_m \left(\frac{P_{bar} + \frac{H}{13.6}}{T_m}\right)$$

$V_{m\ std}$ = 53.55, 52.90, 52.00 ft^3

3. B_{wo} = proportion by volume of water vapor in gas stream (dimensionless)

$$B_{wo} = \frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$$

B_{wo} = 0.15, 0.16, 0.15

4. Molecular weight (lb/lb mole)

$M_d = 0.44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ N_2 + \%\ CO)$

M_d = 28.86, 28.91, 28.87 lb/lb mole

$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

M_s = 27.19, 27.22, 27.21 lb/lb mole

5. V_s = stack gas velocity (ft/sec)

$$V_s = 85.48\ C_p\ (\sqrt{\Delta p})_{ave} \sqrt{\frac{T_s}{P_s\ M_s}}$$

V_s = 69.88, 71.08, 68.65 ft/sec

6. Q_s = volumetric flow rate, dry basis, @ STP (ft^3/min)

$$Q_s = 60\ (1 - B_{wo})\ V_s \cdot A_s \left(\frac{528}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

Q_s = 34,161, 35,069, 34,242 ft^3 min

Q_a = 59,284 60,294 58,233

59,270

Total Test

PARTICULATE
CALCULATIONS (CONTINUED)

7. C_s = concentration (lb/ft^3)

$$C_s = 2.205 \times 10^{-3} \frac{M_n}{V_{m\ std}}$$

C_s = 1.17×10^{-5}, 1.35×10^{-5}, 0.97×10^{-5} lb/ft^3

8. E = emission rate lb/hr

$$E = C_s \cdot Q_s \cdot 60$$

E = 23.89, 28.47, 20.26 lb/hr

9. % Isokinetic

$$I = \frac{1.667\ T_s \left(0.00267\ V_{ic} + \frac{V_m}{T_m} \left[P_{bar} + \frac{\Delta H}{13.6}\right]\right)}{\theta\ V_s\ P_s\ A_n}$$

I = 104.41, 100.47, 101.15 %

TSP
DATA SHEET

RA-24A ONLY

P_{std} = 29.92 in Hg

T_{std} = 528°R

		Test 1	Test 2	Test 3
P_{bar}	= barometric pressure at site (in Hg)	23.95	→	→
P_s	= absolute stack gas pressure (in Hg)	23.40	23.40	23.42
T_s	= absolute average stack gas temp. (°R)	610.8	604.5	587.9
T_m	= absolute average dry gas meter temp. (°R)	528.6 [redacted]	550.5	554.5
V_{ic}	= total volume of water collected (ml)	[redacted]		
V_m	= volume of gas through dry gas meter (ft^3)	34.665	34.533	34.216
ΔH	= average pressure drop across orifice (in H_2O)	0.833	0.831	0.777
C_p	= pitot tube coefficient	0.84	→	→
$(\sqrt{\Delta P})_{ave}$	= average velocity head of stack gas (in H_2O)	1.038	1.035	1.002
A_s	= cross-sectional area of stack (ft^2)	7.069	→	→
M_n	= total amount of particulate collected (g)	[redacted]		
θ	= total sampling time (min.)	60	→	→
A_n	= cross-sectional area of nozzle (ft^2)	1.767×10^{-4}	→	→

ORSAT ANALYSIS

	Test 1	Test 2	Test 3
% CO_2	2.2	2.4	2.1
% O_2	12.6	13.1	13.4
% CO	0	0	0
% N_2	85.2	84.5	84.5

RA-24 A
ONLY

CALCULATIONS

1. $V_{w\ std}$ = volume of water vapor in gas @ STP (ft^3)

$V_{w\ std} = 0.0474\ ft^3/ml \cdot V_{ic}$

$V_{w\ std}$ = [redacted], not calculated, ____ ft^3

2. $V_{m\ std}$ = volume of gas sample through dry gas meter @ STP (ft^3)

$$V_{m\ std} = \left(17.65\ \frac{°R}{in\ Hg}\right) V_m \left(\frac{P_{bar} + \frac{H}{13.6}}{T_m}\right)$$

$V_{m\ std}$ = 27.79, 26.58, 26.15 ft^3

assume two stack average if applicable

3. B_{wo} = proportion by volume of water vapor in gas stream (dimensionless)

$$B_{wo} = \frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$$

B_{wo} = 0.15, 0.16, 0.15

4. Molecular weight (lb/lb mole)

$M_d = 0.44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ N_2 + \%\ CO)$

M_d = 28.86, 28.91, 28.87 lb/lb mole

$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

M_s = 27.19, 27.22, 27.21 lb/lb mole

5. V_s = stack gas velocity (ft/sec)

$$V_s = 85.48\ C_p\ (\sqrt{\Delta p})_{ave} \sqrt{\frac{T_s}{P_s\ M_s}}$$

V_s = 73.03, 72.40, 69.77 ft/sec

6. Q_s = volumetric flow rate, dry basis, @ STP (ft^3/min)

$$Q_s = 60\ (1 - B_{wo})\ V_s \cdot A_s \left(\frac{528}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

Q_s = 17,718, 17,725, 17,431 ft^3 min

Q_a = 30,974 30,707 29,356

30,346

51% of the flow

RA-24 B
ONLY

TSP
DATA SHEET

P_{std} = 29.92 in Hg

T_{std} = 528°R

Symbol	Description	Test 1	Test 2	Test 3
P_{bar}	= barometric pressure at site (in Hg)	23.95	→	→
P_s	= absolute stack gas pressure (in Hg)	23.32	→	→
T_s	= absolute average stack gas temp. (°R)	599.7	593.2	589.0
T_m	= absolute average dry gas meter temp. (°R)	545.5 [redacted]	553.7	538.1
V_{ic}	= total volume of water collected (ml)	[redacted]	[redacted]	[redacted]
V_m	= volume of gas through dry gas meter (ft^3)	33.212	34.380	34.057
ΔH	= average pressure drop across orifice (in H_2O)	0.724	0.793	0.752
C_p	= pitot tube coefficient	0.84	→	→
$(\sqrt{\Delta P})_{ave}$	= average velocity head of stack gas (in H_2O)	0.987 [redacted]	1.006	0.976
A_s	= cross-sectional area of stack (ft^2)	7.069	→	→
M_n	= total amount of particulate collected (g)	[redacted]	[redacted]	[redacted]
θ	= total sampling time (min.)	60	→	→
A_n	= cross-sectional area of nozzle (ft^2)	1.767×10^{-4}	→	→

ORSAT ANALYSIS

	Test 1	Test 2	Test 3
% CO_2	2.2	2.4	2.1
% O_2	12.6	13.1	13.4
% CO	0	0	0
% N_2	85.2	84.5	84.5

RA-24 B ONLY

CALCULATIONS

1. $V_{w\ std}$ = volume of water vapor in gas @ STP (ft^3)

$V_{w\ std} = 0.0474\ ft^3/ml \cdot V_{ic}$

$V_{w\ std}$ = not calculated ft^3

2. $V_{m\ std}$ = volume of gas sample through dry gas meter @ STP (ft^3)

$$V_{m\ std} = \left(17.65\ \frac{°R}{in\ Hg}\right) V_m \left(\frac{P_{bar} + \frac{H}{13.6}}{T_m}\right)$$

$V_{m\ std}$ = 25.79, 26.39, 25.98 ft^3

3. B_{wo} = proportion by volume of water vapor in gas stream (dimensionless)

$$B_{wo} = \frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$$

B_{wo} = 0.15, 0.16, 0.15

Assume two stack average is applicable

4. Molecular weight (lb/lb mole)

$M_d = 0.44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ N_2 + \%\ CO)$

M_d = 28.86, 28.91, 28.87 lb/lb mole

$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

M_s = 27.19, 27.22, 27.21 lb/lb mole

5. V_s = stack gas velocity (ft/sec)

$$V_s = 85.48\ Cp\ (\sqrt{\Delta p})ave \sqrt{\frac{T_s}{P_s\ M_s}}$$

V_s = 68.93, 69.83, 67.51 ft/sec

6. Q_s = volumetric flow rate, dry basis, @ STP (ft^3/min)

$$Q_s = 60\ (1 - B_{wo})\ V_s \cdot A_s \left(\frac{528}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

Q_s = 16,973, 17,362, 16,955 ft^3 min

Q_a = 29,334 29,617 28,633

29,195

49% of the flow