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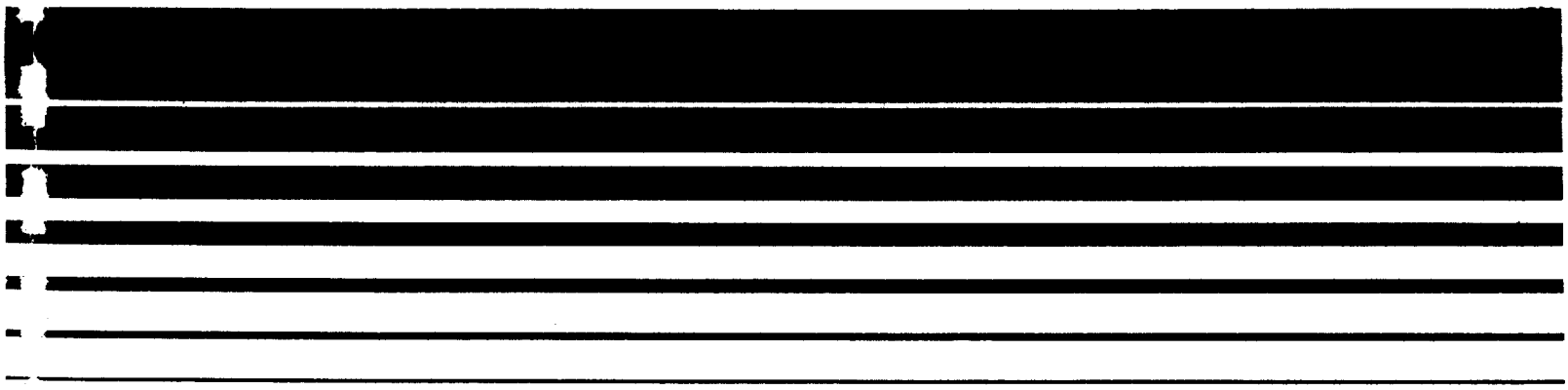
Air

EPA

Urea Manufacture

Emission Test Report C. F. Industries Donaldsonville, Louisiana



CA-800

REPORT ON "B" GRANULATOR AND SYNTHESIS TOWER EMISSIONS AT THE CF INDUSTRIES, INC., UREA FERTILIZER PLANT IN DONALDSONVILLE, LOUISIANA

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March 1, 1980

NOTE:

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PREFACE

The work reported herein was conducted by personnel from TRC - Environmental Consultants, Inc. (TRC), the GCA/Technology Division (GCA), CF Industries, Inc. (CFI), Donaldsonville, Louisiana, and the U.S. Environmental Protection Agency (EPA).

The scope of work issued under EPA Contract No. 68-02-2820, Work Assignment No. 10 was under the supervision of the TRC Project Manager, Mr. Willard A. Wade, III. Mr. Reed W. Cass of TRC served as Project Engineer and was responsible for summarizing the test and analytical data in this report. Analysis of the samples was performed at the CFI Donaldsonvlle, Louisiana plant under the direction of Ms. Margaret Fox of TRC and at the TRC labs in Wethersfield, Connecticut under the direction of Ms. Joanne J. Marchese.

Mr. Stephen A. Capone and Mr. Timothy L. Curtin of GCA were responsible for monitoring the process operations during the testing program. GCA personnel were also responsible for writing the Process Description and Operation section along with Appendix I of this report.

Members of CF Industries, Inc., Donaldsonville, Louisiana whose assistance and guidance contributed greatly to the success of the test program include Mr. Thomas Carville, Senior Environmental Engineer, Mr. Stephen Thompson, Area Supervisor, and Mr. David Campo, Laboratory Supervisor.

Mr. Eric A. Noble, Office of Air Quality Planning and Standards, Industrial Studies Branch, EPA, served as Test Process Project Engineer and was responsible for coordinating the process operations monitoring.

Mr. Clyde E. Riley, Office of Air Quality Planning and Standards, Emission Measurement Branch, EPA, served as Technical Manager and was responsible for coordinating the emission test program.

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INTRODUCTION

Section III of the Clean Air Act of 1970 charges the Administrator of the U.S. Environmental Protection Agency (EPA) with the responsibility of establishing Federal standards of performance for new stationary sources which may significantly contribute to air pollution. When promulgated, these standards of performance for new stationary sources (SPNSS) are to reflect the degree of emission limitation achievable through application of the best demonstrated emission control technology. To assemble this background information, EPA utilizes emission data obtained from controlled sources in the particular industry under consideration.

EPA's Office of Air Quality Planning and Standards (OAQPS) selected the CF Industries, Inc. urea manufacturing plant at Donaldsonville, Louisiana as a site for an emission test program. The test program was designed to provide a portion of the emission data base required for SPNSS for the processes associated with the production of urea.

The CF Industries, Inc. urea manufacturing plant at Donaldsonville, Louisiana produces granulated urea for fertilizer use. The urea is made by seven Spherodizers• (granulators) which operate continuously, 24 hours a day and 7 days a week, as production demands.

Each granulator has its own impingement type water scrubber. The granulator exhaust is ducted through the scrubber fan and is discharged from a stack. Flow through the granulator to the constant flow scrubber is controlled with a dilution damper which varies the ratio of dilution air to exhaust gas. A schematic of the granulator and control system is shown in Figure 1-1.

Emissions sampling was conducted on the "B" granulator of the three older units while its urea production rate was approximately 333 ton/day. Emission sampling was also conducted on the main exhaust vent atop the urea synthesis tower (see Figure 1-1). This vent combines the various solution forming process gases into one common stack before exhausting them to the atmosphere.

EPA engaged TRC to measure urea, ammonia and formaldehyde concentrations and mass flow rates; particle size distributions; and plume opacities. All measurements made at this facility were performed during times of normal operation of the urea production process as described in Section 3, "Process Description and Operation."

The measurement program was conducted at the CF Industries, Inc. urea manufacturing facility in Donaldsonville, Louisiana during the week of January 15 through January 19, 1979 and consisted of the following:

"B" Granulator Scrubber Measurements

1. Urea, Formaldehyde, and Ammonia in Gas Stream

   Three runs of concurrent inlet and outlet tests were performed. The tests were conducted in accordance with the prescribed EPA methods for urea, ammonia, and formaldehyde and provided velocity, moisture, ammonia, formaldehyde and urea particulate mass flow rate data.

2. Particle Size Distributions in Gas Streams

   Three runs of an inlet test were conducted. The tests were performed using the procedures provided by the cascade impactor manufacturer.

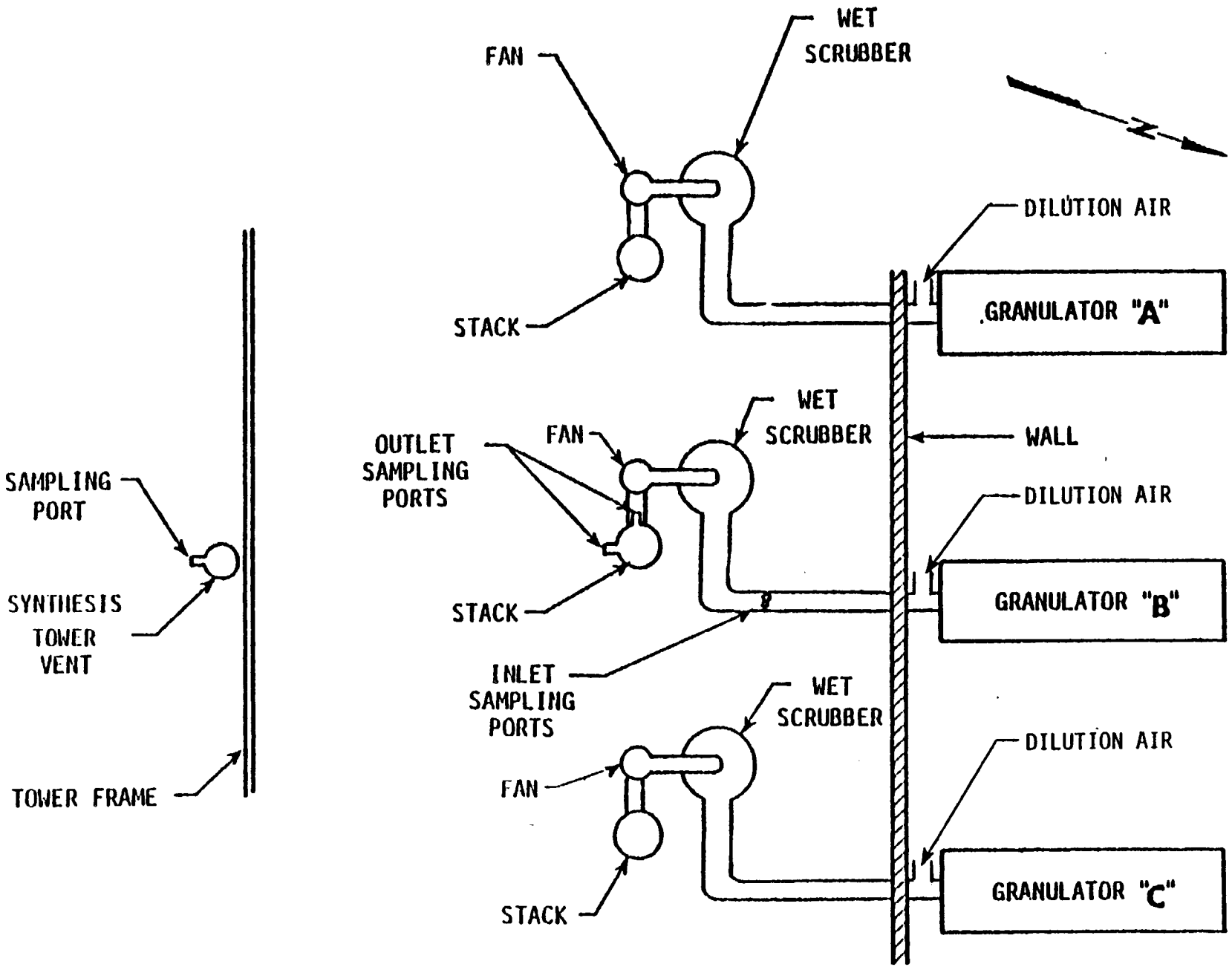

FIGURE 1-1: OVERHEAD VIEW SHOWING LOCATIONS OF SYNTHESIS TOWER VENT & GRANULTORS A, B & C EXHAUST DUCTING, SCRUBBERS & SAMPLING POINTS AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

3. Visible Emissions from Scrubber Stack

Approximately six hours of visible emissions observations were recorded on the scrubber stack discharge. Observations were performed in accordance with EPA Method 9 guidelines.

4. Gas Pressure Drop Across Scrubber

Pressure drop measurements were recorded approximately every five minutes during the testing periods.

5. Ambient Air Temperature,Pressure and Relative Humidity

Wet and dry bulb ambient air temperatures and the barometric pressure were recorded at frequent intervals during the test days.

6. Scrubber Liquid Sampling

Samples of inlet and outlet scrubber water were taken during the urea, ammonia and formaldehyde testing. The pH and temperature of each sample were recorded. The samples were composited into three inlet and three outlet samples which were analyzed for urea, ammonia, and formaldehyde, and percent solids.

7. Urea, Ammonia, and Formaldehyde Contents of Product

A single grab sample of the urea melt was taken and analyzed for urea, ammonia, and formaldehyde. In addition, three grab samples of the unscreened granulator product were analyzed for sieve, bulk density, and percent moisture. These samples were then combined for a urea and formaldehyde determination. The percent moisture determinations were performed by CFI personnel.

Urea Synthesis Tower Vent Measurements

Urea and Ammonia in Gas Stream

Three test runs were performed according to procedures prescribed in EPA methods for velocity, urea, and ammonia and for sampling gas streams with high moisture content.

TRC personnel were responsible for collecting and measuring the above emission parameters. Concurrently, GCA was responsible for monitoring and recording necessary process parameters. A copy of TRC's Work Assignment and Technical Directives is included in Appendix N.

The sequence of events for this sampling program is shown in Tables 1-1 through 1-3 (Daily Summary Logs).

Several of the test runs were discontinuous due to the excessive particulate loading at the granulator scrubber inlet sampling location. These interruptions, which also delayed the concurrent outlet sampling, occurred throughout the test program.

The following sections of this report cover the summary of results (Section 2), process description and operation (Section 3), location of sampling points (Section 4), and sampling and analysis methodologies (Section 5). In addition, Appendix L contains the results of the cleanup evaluations performed on the sample collectors used during the test program. Detailed descriptions of methods and procedures, field and laboratory data, and calculations are presented in various appendices, as noted in the Table of Contents.

TABLE 1-1

DAILY SUMMARY LOG FOR "B" GRANULATOR SAMPLING ON JANUARY 17, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Clock Time	Production Rate tons/hour		"B" Granulator Scrubber Urea Particulate		Stack Visible Emissions	Scrubber Liquid Inlet		Scrubber Liquid Outlet		Pressure Drop ("H_2O)	Ambient Conditions			Process Sampling
	Granulator	Syn. Tower	Inlet	Outlet		pH	Temp (°F)	pH	Temp (°F)		Temp (°F)	R.H. (%)	Pressure ("Hg)	
1200	Confidential		Start Run 1											
1201	Per CFI			Start Run 1										
1202	Request				Start									
1207										21.8				
1210			Pitot Plugged											
1212										21.6				
1215						9.50	135	8.15	126					
1217										20.9				
1222			Run Continued											
1223			Probe Plugged											
1226			Run Continued											
1227										20.7				
1230											69	76	-	
1232										20.7				
1237										20.7				
1242										21.1				
1245											69	76	-	
1247										21.1				
1252										20.7				
1255						9.25	154	8.10	124					
1257										20.5				
1301				Complete 1st Traverse							65	76	30.40	
1306														
1310			Complete 1st Traverse											
1316				Start 2nd Traverse										
1318			Start 2nd Traverse Nozzle Plugged											
1320											69	76	30.40	
1321										20.5				
1326										20.7				
1327			Run Continued											
1331						9.15	164	8.10	124	20.9				
1333														
1336										20.9				
1341										20.7				
1343														Unscreened Product
1346										20.7				
1351										20.7				
1356										20.9	69	79	30.39	

TABLE 1-1 (Continued)

DAILY SUMMARY LOG FOR "B" GRANULATOR SAMPLING ON JANUARY 17, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Clock Time	Production Rate tons/hour		"B" Granulator Scrubber Urea Particulate		Stack Visible Emissions	Scrubber Liquid Inlet		Scrubber Liquid Outlet		Pressure Drop ("H_2O)	Ambient Conditions			Process Sampling
	Granulator	Syn. Tower	Inlet	Outlet		pH	Temp (°F)	pH	Temp (°F)		Temp (°F)	R.H. (%)	Pressure ("Hg)	
1401	Confidential Per CFI Request									20.7				
1406										20.5				
1411										20.5				
1416				Complete Run 1		9.10	152	7.95	120	20.5				
1417														
1422														
1423			Complete Run 1		Stop									
1448											70	74	30.39	
1523											69	79	30.39	
1548			Start Run 2											
1549				Start Run 2						20.2				
1550					Start	9.7	166	8.3	129					
1554										20.2				
1559										20.2				
1604										20.8				
1609										20.9				
1614										20.9				
1619										20.7				
1620						9.5	183	8.2	128					
1624										20.8				
1629										20.9				
1634										21.0				
1635											67	85	30.39	
1637					Stop									
1639										21.0				
1644			Complete 1st Traverse							20.2				
1649				Complete 1st Traverse										
1653				Start 2nd Traverse										
1655						9.2	174	8.2	129					
1657			Start 2nd Traverse Probe Plugged											
1658										20.4				

TABLE 1-1 (Continued)

DAILY SUMMARY LOG FOR "B" GRANULATOR SAMPLING ON JANUARY 17, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Clock Time	Production Rate tons/hour		"B" Granulator Scrubber Urea Particulate		Stack Visible Emissions	Scrubber Liquid Inlet		Scrubber Liquid Outlet		Pressure Drop ("H_2O)	Ambient Conditions			Process Sampling
	Granulator	Syn. Tower	Inlet	Outlet		pH	Temp (°F)	pH	Temp (°F)		Temp (°F)	R.H. (%)	Pressure ("Hg)	
1702	Confidential Per CFI Request		Run Continued							20.4				
1703										20.4				
1708										20.2				
1713											68	80	30.39	
1715										20.3				
1718										20.4				
1723						9.2	167	8.1	128					
1725										20.6				
1728														Unscreened Product
1730														
1733										20.6				
1738										20.6				
1743										20.4				
1748										20.4				
1753				Complete Run 2						20.2				
1756			Complete Run 2											
1800						9.0	172	8.0	129		66	85	30.38	
1815														

TABLE 1-2

DAILY SUMMARY LOG FOR "B" GRANULATOR SAMPLING ON JANUARY 18, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Clock Time	Production Rate tons/hour		"B" Granulator Scrubber Urea Particulate		Stack Visible Emissions	Scrubber Liquid				Pressure Drop ("H_2O)	Ambient Conditions			Process Sampling	Synthesis Tower Sampling
						Inlet		Outlet							
	Granulator	Syn. Tower	Inlet	Outlet		pH	Temp (°F)	pH	Temp (°F)		Temp (°F)	R.H. (%)	Pressure ("Hg)		
0945	Confidential Per CFI Request										62	94	30.39		
0946				Start Run 3						21.6					
0947			Start Run 3												
0951										21.2					
0955						9.2	180	8.3	128						
0956										21.0					
1001										21.1					
1005											62	94	30.39		
1006										21.0					
1011										21.2					
1016										21.0					
1017			Pitot Plugged												
1020											64	90	30.39		
1021			Continue - Probe Plugged							20.7					
1026										20.5					
1030			Continue			9.3	172	8.25	126						
1031										20.7					
1036										20.6					
1040										20.7	64.5	87	30.38		
1041															
1045														Unscreened Product	
1046				Complete 1st Traverse											
1047			Probe Plugged												
1055			Continue								66	82	30.38		
1102			Complete 1st Traverse												
1105						9.3	177	8.25	129						
1107			Start 2nd Traverse												
1108			Probe Plugged												
1112			Continue												
1115											67.5	85	30.36		
1117				Start 2nd Traverse											
1122										20.5					

TABLE 1-2 (Continued)

DAILY SUMMARY LOG FOR "B" GRANULATOR SAMPLING ON JANUARY 18, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Clock Time	Production Rate tons/hour		"B" Granulator Scrubber Urea Particulate		Stack Visible Emissions	Scrubber Liquid Inlet		Scrubber Liquid Outlet		Pressure Drop ("H_2O)	Ambient Conditions			Process Sampling	Synthesis Tower Sampling
	Granulator	Syn. Tower	Inlet	Outlet		pH	Temp (°F)	pH	Temp (°F)		Temp (°F)	R.H. (%)	Pressure ("Hg)		
1127	Confidential Per CFI Request									20.5					
1132										20.4					
1137										20.6					
1140						9.3	173	8.20	127		67	83	30.36		
1142										20.3					
1147										20.3					
1152										20.2					
1157										20.1					
1200											68	85	30.36		
1202										19.8					
1207										20.0					
1210			Complete Run 3												
1212										19.7					
1215						9.2	173	8.2	124						
1217				Complete Run 3						19.5					
1244					Start										
1344					Stop						69	85	30.28		
1435											71	77	30.28		
1500											73	73	30.27		
1525															
1528			Start Cascade Run 1												
1540											71	77	30.27		Start Run 1 (Test 4)
1543			Complete Cascade Run 1												
1555															Complete Run1 (Test 4)
1615			Start Moisture Run												
1649			Complete Moisture Run												

TABLE 1-3

DAILY SUMMARY LOG FOR "B" GRANULATOR SAMPLING ON JANUARY 19, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Clock Time	Production Rate tons/hour		"B" Granulator Scrubber Urea Particulate		Stack Visible Emissions	Scrubber Liquid Inlet		Scrubber Liquid Outlet		Pressure Drop ("H_2O)	Ambient Conditions			Process Sampling	Synthesis Tower Sampling
	Granulator	Syn. Tower	Inlet	Outlet		pH	Temp (°F)	pH	Temp (°F)		Temp (°F)	R.H. (%)	Pressure ("Hg)		
0953	Confidential Per CFI Request				Start										
1000			Start Cascade Run 2								68	90	30.17		
1015			Complete Cascade Run 2												
1020											68	90	30.17		
1030															Start Run 2 (Test 5)
1040											70	86	30.17		
1046															Complete Run2
1100											70	86	30.17		
1120											70	86	30.14		
1125			Start Cascade Run 3												
1135															Start Run 3 (Test 6)
1140			Complete Cascade Run 3								75	70	30.12		
1150															Complete Run3
1153					Stop										
1200											77	66	30.10		
1230											73	75	30.10		

SECTION 2

SUMMARY OF RESULTS

INTRODUCTION

This section presents the results of a testing program conducted during the week of January 15 through 19, 1979 at the CF Industries, Inc., urea manufacturing facility in Donaldsonville, Louisiana. Testing was performed on gas and water streams entering and exiting the "B" Granulator Scrubber and on the gas stream venting from the Urea Synthesis Tower.

The inlet gas sampling location for the "B" Granulator Scrubber (designated TP-1) was in a 23-foot straight section of horizontal duct located upstream of the scrubber. The integrated gas samples for the urea, ammonia and formaldehyde tests were collected isokinetically from 36 traverse points located in accordance with EPA Reference Method.[1] The gas samples for the particle sizing tests were collected from a single point located at the centroid of the duct's cross sectional area.

The outlet gas sampling locations for the "B" Granulator Scrubber (designated TP-2) was in the 80-foot vertical stack located downstream of the scrubber. The integrated gas samples for the urea, ammonia and formaldehyde tests were

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[1]Standards of Performance for New Stationary Sources, Appendix A. Federal Register, Vol. 42, No. 160-Thursday, August 18, 1977, pp. 41756-41758.

collected isokinetically from 12 traverse points located in accordance with EPA Reference Method 1.

The gas sampling location for the Synthesis Tower Vent (designated TP-1) was in the 46-foot straight section of vertical duct. The samples were extracted from a single point located at the centroid of the duct's cross sectional area.

UREA, FORMALDEHYDE AND AMMONIA TESTS ON "B" GRANULATOR SCRUBBER

The overall summaries of the urea, formaldehyde and ammonia results at the "B" Granulator inlet (TP-1) and outlet (TP-2) are contained in Tables 2-1(a) and 2-1(b) in English and SI metric units, respectively. The calculated urea, formaldehyde and ammonia removal efficiencies of the "B" Granulator Scrubber averaged 99.8%, 50.2% and 20.5%, respectively.

Tables 2-2 and 2-3 present seperately the inlet and outlet data, respectively. In addition, these two tables show the "corrected" urea data (corrected for possible urea loss during the Kjeldahl analysis method), and the "corrected" and "uncorrected" ammonia data resulting from the distillation-and-Nesslerization analysis method. The ammonia correction is for potential conversion of urea to ammonia during distillation. This second ammonia analysis method was added because of the potential susceptibility of the direct Nesslerization method to interferences.[2] Details of the analysis methods are contained in Section 5 and Appendix K. Because of the uncertainties involved in correcting the urea and ammonia data for urea conversion during analysis, the data in Table 2-1

[2] Standard Methods for the Analysis of Water and Wastewater, 14th Edition, APHA, AWWA, WPCF, 1975.

TABLE 2-1(a) ENGLISH

SUMMARY OF RESULTS OF UREA, AMMONIA AND FORMALDEHYDE TESTS ON GASES ENTERING AND LEAVING THE "B" GRANUALTOR SCRUBBER ON JANUARY 17 AND 18, 1979 AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1		Run 2		Run 3		Average	
Date	01-17-79		01-17-79		01-18-79			
Location	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Volume of Gas Sampled - DSCF[a]	63.18	102.5	65.97	102.7	66.45	102.4	65.20	102.5
Percent Moisture by Volume[b]	2.257	5.522	2.253	5.733	2.257	5.608	2.256	5.621
Average Gas Temperature (°F)	192.1	100.5	190.2	100.7	183.1	102.5	188.5	101.2
Stack Volumetric Flowrate - DSCFM[c]	40180	46260	41410	45590	41760	45760	41117	45870
Scrubber Liquid pH	9.25	8.08	9.32	8.16	9.26	8.24	9.28	8.16
Average Percent Opacity		7.7		8.7		5.5		7.3
Production Rate* (tons/hr)								
Percent Isokinetic	104.5	100.7	105.0	102.4	102.9	101.6	104.1	101.6
UREA DATA								
Kjeldahl Analysis Method[d]								
Total Sample Weight (mg)	23920	70.6	20690	73.1	26258	62.3	25423	68.7
gr/DSCF[e]	5.830	0.0106	6.090	0.0110	6.085	0.0094	6.005	0.0103
lb/hr	2007	4.205	2161	4.283	2178	3.674	2116	4.058
lb/ton	111.5	0.232	120.1	0.238	125.2	0.211	118.9	0.228
collection efficiency (%)		99.8		99.8		99.8		99.8
AMMONIA DATA								
Direct Nesslerization Analysis Method								
Total Sample Weight (mg)	410	450	441	694	514	387	455	510
gr/DSCF	0.0999	0.0676	0.1029	0.1041	0.1191	0.0582	0.1073	0.0766
lb/hr	34.40	26.80	36.52	40.17	42.62	22.82	37.85	30.10
lb/ton	1.90	1.48	2.03	2.26	2.45	1.31	2.13	1.69
collection efficiency (%)		22.1		<0		46.5		20.5
FORMALDEHYDE DATA								
Chromotropic Acid Analysis Method								
Total Weight of Sample (mg)	2.476	2.523	1.545	1.172	3.087	1.296	2.369	1.664
gr/DSCF	0.000604	0.000379	0.000361	0.000176	0.000715	0.000195	0.000560	0.000250
lb/hr	0.2078	0.1503	0.1280	0.0687	0.2560	0.0764	0.1972	0.0983
lb/ton	0.0115	0.0083	0.0071	0.0038	0.0147	0.0044	0.0111	0.0055
collection efficiency (%)		27.7		46.3		70.2		50.2

[a] Dry standard cubic feet @ 68°F, 29.92 inches Hg
[b] Inlet values based on seperate moisture run
[c] Dry standard cubic feet per minute
[d] Uncorrected for urea loss during distillation
[e] Grains per dry standard cubic foot
* Production rate information is confidential per CFI request

TABLE 2-1(b) METRIC

SUMMARY OF RESULTS OF UREA, AMMONIA AND FORMALDEHYDE TESTS ON GASES ENTERING AND LEAVING THE "B" GRANULATOR SCRUBBER ON JANUARY 17 AND 18, 1979 AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1		Run 2		Run 3		Average	
Date	01-18-79		01-19-79		01-19-79			
Location	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Volume of Gas Sampled-Nm^3[a]	1.789	2.903	1.868	2.908	1.882	2.899	1.846	2.903
Percent Moisture by Volume[b]	2.257	5.522	2.253	5.733	2.257	5.608	2.256	5.621
Average Gas Temperature (°C)	88.9	38.0	87.8	38.2	83.9	39.2	86.9	38.4
Stack Volumetric Flowrate-Nm^3M[c]	1137	1310	1173	1291	1187	1296	1164	1299
Scrubber Liquid pH	9.25	8.08	9.32	8.16	9.26	8.24	9.28	8.16
Average Percent Opacity		7.7		8.7		5.5		7.3
Production Rate* (Mg/Hour)	312		312		330		388	
Percent Isokinetic	104.5	100.7	105.0	102.4	102.9	101.6	104.1	101.6
UREA DATA								
Kjeldahl Analysis Method[d]								
Total Sample Weight (mg)	23920	70.6	26090	73.1	26258	62.3	25423	68.7
g/Nm^3[e]	13.34	0.0242	13.93	0.0252	13.92	0.0215	13.74	0.0236
Kg/hour	910.4	1.907	980.23	0.0049	987.9	1.66	959.8	1.841
Kg/Mg	55.75	0.116	60.05	0.119	62.6	0.105	59.4	0.114
Collection Efficiency (%)		99.8		99.8		99.8		99.8
AMMONIA DATA								
Direct Nesslerization Analysis Method								
Total Sample Weight (milligrams)	410	450	441	694	514	387	344	510
g/Nm^3	0.2286	0.155	0.235	0.238	0.272	0.133	0.2455	0.1753
Kg/hour	15.60	12.16	16.56	18.45	19.33	10.35	17.17	13.65
Kg/Mg	0.95	0.74	1.01	1.13	1.22	0.65	1.06	0.85
Collection Efficiency (%)		22.1		<0		46.5		20.5
FORMALDEHYDE DATA								
Chromotropic Acid Analysis Method								
Total Weight of Sample (milligrams)	2.476	2.523	1.545	1.172	3.087	1.296	2.369	1.664
g/Nm^3	0.00138	0.0022	0.000826	0.000402	0.00164	0.00045	0.0013	0.000572
Kg/hour	0.0942	0.068	0.058	0.0311	0.116	0.035	0.0894	0.0446
Kg/Mg	0.00575	0.0041	0.00355	0.0019	0.00735	0.0022	0.0055	0.0027
Collection Efficiency (%)		27.8		46.3		70.1		50.3

(a) Normal Cubic Meters @ 20°C, 760 mm Hg.
(b) Inlet values based on separate moisture run.
(c) Normal Cubic Meters per minute.
(d) Uncorrected for Urea loss during distillation.
(e) Grams per Normal Cubic Meter.
* Confidential Per CFI Request

TABLE 2-2

SUMMARY OF RESULTS OF UREA, AMMONIA AND FORMALDEHYDE TESTS ON GASES ENTERING THE "B" GRANULATOR SCRUBBER ON JANUARY 17 AND 18, 1979 AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1		Run 2		Run 3		Average	
Date	01-17-79		01-17-79		01-18-79			
Volume of Gas Sampled-DSCF[a]	63.18		65.97		66.45		65.2	
Percent Moisture by Volume[b]	2.257		2.253		2.257		2.256	
Average Gas Temperature (°F)	192.1		190.2		183.1		188.5	
Stack Volumetric Flowrate-DSCFM[c]	40180		41410		41760		41117	
Scrubber Liquid pH	9.25		9.32		9.26		9.28	
Production Rate* (Tons/hr)								
Percent Isokinetic	104.5		105.0		102.9		104.1	
Net Sampling Time (Minutes)	111		110		111		111	
UREA DATA	e	f						
Kjeldahl Analysis Method:	Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected
Total Sample Weight (mg)	23920	25594	26090	27916	26258	28096	25423	27203
gr/DSCF[d]	5.830	6.238	6.090	6.516	6.085	6.511	6.005	6.425
lb/hr	2007	2147	2161	2312	2178	2330	2116	2264
lb/ton	111.5	119.3	120.1	128.5	125.2	134.0	118.9	127.2
AMMONIA DATA	g	h	i					
Nesslerization Analysis Method:	Direct	Uncorrected Distilled	Corrected Distilled	Direct	Uncorrected Distilled	Corrected Distilled	Direct	Uncorrected Distilled	Corrected Distilled
Total Sample Weight (mg)	410	888	-127	441	941	-166	514	944	-170	455	924	-155
gr/DSCF	0.0999	0.2164		0.1029	0.2196		0.1191	0.2187		0.1073	0.2179	
lb/hr	34.40	74.50		36.52	77.93		42.62	78.27		37.85	76.86	
lb/ton	1.90	4.12		2.03	4.33		2.45	4.50		2.13	4.33	
FORMALDEHYDE DATA												
Chromotropic Acid Analysis Method:												
Total Sample Weight (mg)	2.476			1.545			3.087			2.369		
gr/DSCF	0.000604			0.000361			0.000715			0.000560		
lb/hr	0.2078			0.1280			0.2560			0.1972		
lb/ton	0.0115			0.0071			0.0147			0.0111		

[a] Dry Standard Cubic Feet @ 68°F, 29.92 inches Hg.
[b] Based on separate moisture run
[c] Dry Standard Cubic Feet per minute
[d] Grains per DSCF.
[e] Uncorrected for urea conversion during distillation.
[f] Corrected for urea conversion during distillation. Corrected = uncorrected x 1.07.
[g] Direct Nesslerization.
[h] Distillation and Nesslerization, uncorrected for conversion of urea to ammonia.
[i] Distillation and Nesslerization, corrected for conversion of urea to ammonia. Corrected = uncorrected -0.07 x corrected urea/1.765
* Confidential

TABLE 2-3

SUMMARY OF RESULTS OF UREA, AMMONIA AND FORMALDEHYDE TESTS ON GASES LEAVING THE "B" GRANULATOR SCRUBBER ON JANUARY 17 and 18, 1979 AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1			Run 2			Run 3			Average		
Date	01-17-79			01-17-79			01-17-79					
Volume of Gas Sampled - DSCF[a]	102.5			102.7			102.4			102.5		
Percent Moisture by Volume	5.522			5.733			5.608			5.621		
Average Gas Temperature (°F)	100.5			100.7			102.5			101.2		
Stack Volumetric Flowrate - DSCFM[b]	46260			45590			45760			45870		
Scrubber Liquid pH	8.08			8.16			8.24			8.16		
Production Rate* (tons/hr)												
Percent Isokinetic	100.7			102.4			101.6			101.6		
Pressure Drop Across Scrubber (inches H_2O)	20.8			20.5			20.6			20.6		
Net Sampling Time (minutes)	120			120			120			120		
UREA DATA		d uncorrected	e corrected		uncorrected	corrected		uncorrected	corrected		uncorrected	corrected
Kjeldahl Analysis Method:												
Total Sample Weight (mg)		70.6	75.5		73.1	78.2		62.3	66.7		68.7	73.5
gr/DSCF[c]		0.0106	0.0113		0.0110	0.0118		0.0094	0.0101		0.0103	0.0110
lb/hr		4.205	4.499		4.283	4.583		3.674	3.931		4.058	4.342
lb/ton		0.232	0.248		0.238	0.255		0.211	0.226		0.228	0.244
AMMONIA DATA												
Nesslerization Analysis Method:	f direct	g uncorrected distilled	h corrected distilled	direct	uncorrected distilled	corrected distilled	direct	uncorrected distilled	corrected distilled	direct	uncorrected distilled	corrected distilled
Total Sample Weight (mg)	450	438	435	694	426	423	387	388	385	510	417	414
gr/DSCF	0.0676	0.0658	0.0653	0.1041	0.0639	0.0635	0.0582	0.0584	0.0579	0.0766	0.0626	0.0622
lb/hr	26.80	26.08	25.91	40.17	24.96	24.79	22.82	22.88	22.70	30.10	24.61	24.43
lb/ton	1.48	1.44	1.43	2.26	1.39	1.38	1.31	1.31	1.30	1.68	1.37	1.36
FORMALDEHYDE DATA												
Chromotropic Acid Analysis Method												
Total Sample Weight (mg)		2.523			1.172			1.296			1.664	
gr/DSCF		0.000379			0.000176			0.000195			0.000250	
lb/hr		0.1503			0.0687			0.0764			0.0983	
lb/ton		0.0083			0.0038			0.0044			0.0055	

[a] Dry Standard Cubic Feet @ 68°F, 29.92 inches Hg
[b] Dry Standard Cubic Feet per minute
[c] grains per DSCF
[d] Uncorrected for urea conversion during distillation
[e] Corrected for urea conversion during distillation. Corrected = uncorrected x 1.07
[f] Direct Nesslerization
[g] Distillation and Nesslerization, uncorrected for conversion of urea to ammonia
[h] Distillation and Nesslerization, corrected for conversion of urea to ammonia (corrected = uncorrected - 0.07 x corrected urea/1.765)
* Confidential Per CFI Request

(uncorrected urea and direct Nesslerization ammonia) should be viewed as the most accurate data, with the following qualification.

The direct Nesslerization outlet ammonia mass flow rate appears to be very high in Run 2 compared to those of Runs 1 and 3 (Table 2-3). The following observations clarify this point:

1. Runs 1 and 3 each have mass flow rates which are nearly equal for both the direct-Nesslerization and the distillation-and-Nesslerization analysis.
2. Run 2 has a mass flow rate (by distillation-and-Nesslerization) consistent with the mass flow rates of Runs 1 and 3.
3. Run 2 has a mass flow rate (by direct-Nesslerization) more than 50% greater than those of Runs 1 and 3.

Thus, the Run 2 direct Nesslerization ammonia outlet result is suspect.

SAMPLING AND ANALYSIS PROBLEMS WITH UREA, FORMALDEHYDE AND AMMONIA TESTS

As noted in Section 1, some test runs were discontinuous because the high concentration and large size of urea particles at the scrubber inlet caused plugging of the pitot tubes and the probe and nozzle. In order to quickly remove these plugs from the nozzle, water was squirted into the probe each time a plug occurred. Since this additional water contributed to the total amount of water collected during each run, a seperate run for moisture alone was performed at the scrubber inlet. Details of these problems are contained in Section 5.

At the B granulator scrubber inlet, the large difference between the results of the two ammonia analysis methods is believed to be due to the conversion of the

urea to ammonia during distillation. The analysis by direct Nesslerization was performed at CF Industries in Donaldsonville, and the distillation/Nesslerization analysis was performed at the TRC laboratory in Wethersfield, CT. The distillation/Nesslerization method was done in addition to the direct Nesslerization because of interferences due to turbidity in the direct Nesslerization method. However, it is documented in the literature that approximately 7 percent of the urea is converted to ammonia during the distillation procedure. This conversion factor is not precise, and when the concentration of urea greatly exceeds that of ammonia, even a small deviation from the 7 percent conversion factor would mean a considerable amount of ammonia when compared to amount of ammonia actually measured. Details of this urea conversion are presented in Section 5. The negative ammonia concentrations shown in Table 2-2 serve to illustrate the magnitude of error that can result with the distilled Nesslerization method. Therefore, the ammonia results determined by the direct Nesslerization procedure are considered to be the more accurate values.

The average ammonia results at the scrubber outlet (Table 2-3) are contrary to those expected because conversion of urea to ammonia during distillation should yield a greater ammonia mass flow rate for the distillation/Nesslerization method than for the direct Nesslerization method. The probability that the direct Nesslerization results for Run 2 may be anomalously high, as discussed above,may partially explain this situation.

VISIBLE EMISSIONS FROM "B" GRANULATOR SCRUBBER STACK

The opacity of the plume from the "B" Granulator Scrubber stack ranged from 5 to 10 percent. The six-minute arithmetic averages are presented

graphically in Figure 2-1 and are summarized in Table 2-4. The observations were made from the synthesis tower with the local terrain as background. The detailed information on the visible emission measurements can be found in Appendix C.

PARTICLE SIZE TESTS ON "B" GRANULATOR SCRUBBER INLET (TP-1)

Particle size distribution tests were conducted on the "B" Granulator Scrubber Inlet (TP-1). Summaries of these test results are presented in Table 2-5. The size of the particulates entering the "B" Granulator Scrubber was 100% >5.7 μm. That is, all the particulate was collected in the cyclone precollector. Therefore, it was not possible to plot cumulative size distribution curves.

PRESSURE DROP MEASUREMENTS ACROSS "B" GRANULATOR SCRUBBER

The pressure drop measurements across the "B" Granulator Scrubber were made with a vertical U-tube water manometer which was connected to pressure taps at the scrubber inlet and outlet. The pressure drop across the scrubber was recorded at approximately 5 to 15 minute intervals during the tests for urea, ammonia and formaldehyde.

The pressure drops across the "B" Granulator Scrubber ranged from 19.5 to 21.8 inches of vertical water column and are presented in Table 2-6.

UREA, AMMONIA AND FORMALDEHYDE IN SCRUBBING LIQUID ENTERING AND EXITING "B" GRANULATOR SCRUBBER

Half-liter samples of the scrubbing liquid streams entering and leaving the "B" Granulator Scrubber were collected at approximately 30-minute intervals during the test runs. The solution temperature was measured immediately after

FIGURE 2-1: SIX MINUTE ARITHMETIC AVERAGES OF JANUARY 17, 18, AND 19, 1979 OPACITY READINGS ON "B" GRANULATOR SCRUBBER STACK AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

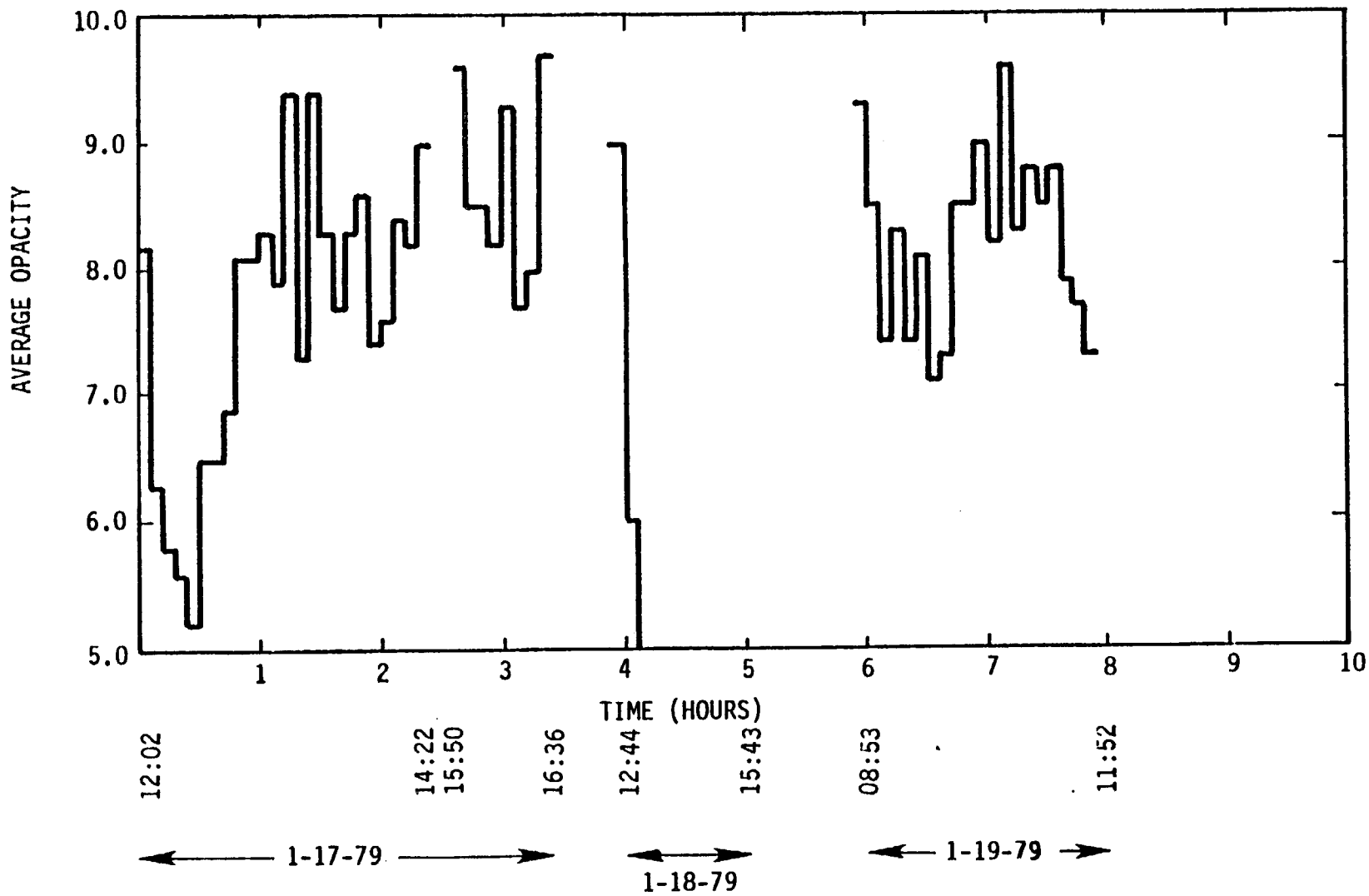

TABLE 2-4

SIX MINUTE ARITHMETIC AVERAGE OPACITY READINGS
ON "B" GRANULATOR SCRUBBER STACK
ON JANUARY 17, 1979, AT CF INDUSTRIES, INC.,
DONALDSONVILLE, LOUISIANA

TIME	AVG. OPACITY FOR 6 MIN.	DATE
12:02 - 12:07	8.2	1-17-79
12:08 - 12:13	6.3	
12:14 - 12:17	5.8	
12:20 - 12:25	5.6	
12:26 - 12:31	5.2	
12:32 - 12:37	6.5	
12:38 - 12:43	6.5	
12:44 - 12:49	6.9	
12:50 - 12:55	8.1	
12:56 - 13:01	8.1	
13:02 - 13:07	8.3	
13:08 - 13:13	7.9	
13:14 - 13:19	9.4	
13:20 - 13:25	7.3	
13:26 - 13:31	9.4	
13:32 - 13:37	8.3	
13:38 - 13:43	7.7	
13:44 - 13:49	8.3	
13:50 - 14:55	8.6	
13:56 - 14:01	7.4	
14:02 - 14:07	7.6	
14:08 - 14:13	8.4	
14:14 - 14:19	8.8	
14:20 - 14:22*	9.0	
15:50 - 15:55	9.6	
15:56 - 16:01	8.5	
16:02 - 16:07	8.5	
16:08 - 16:13	8.2	
16:14 - 16:19	9.3	
16:20 - 16:25	7.7	
16:26 - 16:31	8.0	
16:32 - 16:36*	9.7	

* Less than 6 min average

TABLE 2-4 (Continued)

SIX MINUTE ARITHMETIC AVERAGE OPACITY READINGS
ON "B" GRANULATOR SCRUBBER STACK
ON JANUARY 18, 1979, AT CF INDUSTRIES, INC.,
DONALDSONVILLE, LOUISIANA

TIME	AVG. OPACITY FOR 6 MIN.	DATE
12:44 - 12:49	9.0	1-18-79
12:50 - 12:55	6.0	
12:56 - 13:01	5.0	
13:02 - 13:07	5.0	
13:08 - 13:13	5.0	
13:14 - 13:19	5.0	
13:20 - 13:25	5.0	
13;26 - 13:31	5.0	
13:32 - 13:37	5.0	
13:38 - 13:43	5.0	

TABLE 2-4 (Continued)

SIX MINUTE ARITHMETIC AVERAGE OPACITY READINGS
ON "B" GRANULATOR SCRUBBER STACK
ON JANUARY 19, 1979, AT CF INDUSTRIES, INC.,
DONALDSONVILLE, LOUISIANA

TIME	AVG. OPACITY FOR 6 MIN.	DATE
09:53 - 09:58	9.3	1-19-79
09:59 - 10:04	8.5	
10:05 - 10:10	7.4	
10:11 - 10:16	8.3	
10:17 - 10:22	7.4	
10:23 - 10:28	8.1	
10:29 - 10:34	7.1	
10:35 - 10:40	7.3	
10:41 - 10:46	8.5	
10:47 - 10:52	8.5	
10:53 - 10:58	9.0	
10:59 - 11:04	8.2	
11:05 - 11:10	9.6	
11:11 - 11:16	8.3	
11:17 - 11:22	8.8	
11:23 - 11:28	8.5	
11:29 - 11:34	8.8	
11:35 - 11:40	7.9	
11:41 - 11:46	7.7	
11:47 - 11:52	7.3	

TABLE 2-5

SUMMARY OF INLET PARTICLE SIZE TEST RESULTS ON "B" GRANULATOR
SCRUBBER ON JANUARY 18, 1979, AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

TRC Test No.	Sampling Location	Test Date	Test Time	Particulate Concentration, grains/dscf	Aerodynamic Size Range, μm	Mass In Size Range, %
CI-1	Scrubber Inlet	1/18/79	15:28-15:43	4.512	> 6.0	99+
CI-2	Scrubber Inlet	1/19/79	10:00-10:15	3.717	> 5.7	99+
CI-3	Scrubber Inlet	1/19/79	11:25-11:40	0.935	> 5.8	99+

TABLE 2-6

SUMMARY OF JANUARY 17 AND 18, 1979 "B" GRANULATOR SCRUBBER PRESSURE DROP MEASUREMENTS AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

DATE	RUN	CLOCK TIME	ΔP, "H_2O	DATE	RUN	CLOCK TIME	ΔP "H_2O
01/17/79	1	1207	21.8	01/17/79	2	1644	20.2
		1212	21.6			1658	20.4
		1217	21.5			1703	20.4
		1222	20.9			1708	20.4
		1227	20.7			1713	20.2
		1232	20.7			1718	20.3
		1237	20.7			1723	20.4
		1242	21.1			1728	20.6
		1247	21.1			1733	20.6
		1252	20.7			1738	20.6
		1257	20.5			1743	20.4
01/17/79		1321	20.5			1748	20.5
		1326	20.7			1753	20.2
		1331	20.9				
		1336	20.9			Average	20.5
		1341	20.7				
		1346	20.7	01/18/79	3	0946	21.6
		1351	20.7			0951	21.2
		1356	20.9			0956	21.0
		1401	20.7			1001	21.1
		1406	20.5			1006	21.0
		1411	20.5			1011	21.2
		1416	20.5			1016	21.0
						1021	20.7
		Average	20.9			1026	20.5
						1031	20.7
01/17/79	2	1549	20.2			1036	20.6
		1554	20.2			1041	20.7
		1559	20.2	01/18/79		1122	20.5
		1604	20.8			1127	20.5
		1609	20.9			1137	20.6
		1614	20.9			1142	20.3
		1619	20.7			1147	20.3
		1624	20.8			1152	20.2
		1629	20.9			1157	20.1
		1634	21.0			1202	19.8
		1639	21.0			1207	20.0
						1212	19.7
						1217	19.5
						Average	20.6

each sample was collected. The pH was measured once the sample had cooled to approximately 70° F.

For each test run, the individual samples were combined into two composite samples (one inlet and one outlet) which were analyzed for urea, ammonia and formaldehyde content. Table 2-7 presents a summary of the measured urea, ammonia and formaldehyde concentrations and the percent solids in the scrubber liquid composite samples. Table 2-8 contains the pH and temperature readings of each of the individual samples.

The results of the scrubber liquid analyses show that the average urea concentration of the outlet liquid is more than 5400 times greater than that of the inlet liquid. This would be expected because urea is being scrubbed out of the gas stream entering the scrubber. Analysis of the outlet liquid for ammonia by direct Nesslerization was unsuccessful because the sample solutions turned cloudy when the Nessler reagent was added. This is indicative of interference, due perhaps to the high urea concentration. The distillation-and-Nesslerization ammonia results are questionable, especially the outlet liquid results, because of the possible conversion of urea to ammonia during distillation. The uncertainty of the urea conversion is illustrated by the negative ammonia concentrations that result when the conventional correction is applied.

The average formaldehyde concentration of the inlet liquid is 400 times more than that of the outlet liquid, indicating that formaldehyde may be reacting with the urea in the outlet liquid. The lower temperature of the outlet liquid reflects the endothermic dissolution of urea into the scrubbing medium.

TABLE 2-7

SUMMARY OF UREA, AMMONIA AND FORMALDEHYDE MEASUREMENTS ON THE SCRUBBING LIQUID ENTERING AND LEAVING THE "B" GRANULATOR SCRUBBER AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1		Run 2		Run 3		Average	
Date	01-17-79		01-17-79		01-18-79			
Location	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Urea Concentration (mg/l)[e]								
Uncorrected[a]	114	516300	83	525100	94	538300	97	526600
Corrected[b]	122	552400	89	561900	101	576000	104	563400
Ammonia Concentration (mg/l)								
Direct Nesslerization	180	f	44	f	23	f	82	-
Distilled Uncorrected[c]	138[i]	14100	52[j]	12800	31	13100	74	13330
Distilled Corrected[d]	133	-7800	85	-9500	27	-9700	82	-
Formaldehyde Concentration (mg/l)	26	0.01	20	0.08	14	0.05	20	0.05
pH[g]	9.25	8.08	9.32	8.16	9.26	8.24	9.28	8.16
Temperature (°F)[h]	151	124	172	128	175	127	166	126
Percent Solids	1.2	3.9	0.9	4.6	3.6	4.8	1.9	4.4

[a] Kjeldahl analysis results uncorrected for urea conversion during distillation.
[b] Kjeldahl analysis results corrected for urea conversion during distillation (corrected = uncorrected x 1.07).
[c] Distillation/Nessleration (D/N) analysis results uncorrected for urea conversion during distillation.
[d] D/N analysis results corrected for urea conversion (corrected = uncorrected - 0.07*corrected urea/1.765).
[e] Milligrams per liter.
[f] Average spectrophotometric measurement not possible due to turbidity.
[g] Average of several individual liquid samples taken during each run.
[h] Average of individual sample temperatures taken immediately after collection.
[i] Average slight turbidity may have given high instrument readings. Visual estimate for this sample is 60 mg/l.
[j] Average slight turbidity may have given high instrument readings. Visual estimate for this sample is 30 mg/l.

TABLE 2-8

SUMMARY OF pH AND TEMPERATURE
MEASUREMENTS ON INDIVIDUAL SAMPLES OF SCRUBBING LIQUID
ENTERING AND EXITING "B" GRANULATOR SCRUBBER AT
CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

Run No.	Date	Sampling Time	Scrubber Inlet		Scrubber Outlet	
			pH	°F	pH	°F
1	01/17-79	1215	9.50	135	8.15	126
		1255	9.25	154	8.10	124
		1331	9.15	164	8.10	124
		1416	9.10	152	7.95	120
		Average	9.25	151	8.08	124
2	01/17/79	1550	9.70	166	8.30	129
		1620	9.50	183	8.20	128
		1655	9.20	174	8.20	129
		1725	9.20	167	8.10	128
		1800	9.00	172	8.00	129
		Average	9.32	172	8.16	129
3	01/18/79	0955	9.20	180	8.30	128
		1030	9.30	172	8.25	126
		1105	9.30	177	8.25	129
		1140	9.30	173	8.20	127
		1215	9.20	173	8.20	124
		Average	9.26	175	8.24	127

The higher percent solids evident in the outlet scrubber liquid compared to the inlet may be attributed to organic and inorganic materials insoluable at room temperature (e.g., biuret and pipescale).

"B" GRANULATOR PROCESS SAMPLES UREA, AMMONIA, AND FORMALDEHYDE COMPOSITION

Process samples were taken of the urea melt and the urea product before screening. These samples were analyzed for urea, ammonia and formaldehyde and the results of these analyses are summarized in Table 2-9. CF Industries performed periodic checks on the moisture content of the granulated product. The average values for the testing days is included in Table 2-9. Bulk density and sieve analyses were performed on the granulated product samples. These results are presented in Table 2-10.

AMBIENT TEMPERATURES, BAROMETRIC PRESSURE AND RELATIVE HUMIDITIES AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

Table 2-11 summarizes the periodic meteorological measurements taken at CF Industries, Inc., on January 17 through 19, 1979.

UREA AND AMMONIA TESTS ON SYNTHESIS TOWER MAIN VENT

A summary of the urea and ammonia test results on the Synthesis Tower Main Vent (TP-1) are presented in Table 2-12. The average urea and ammonia mass flow rates were 1.70 and 431 pounds per hour, respectively.

Appendix F contains the pertinent sampling data for the synthesis tower plus all calculations. Special calculations were required because of the high ammonia content in the gas stream.

TABLE 2-9

SUMMARY OF UREA, AMMONIA AND FORMALDEHYDE MEASUREMENTS*
ON THE "B" GRANULATOR MELT AND PRODUCT-BEFORE-SCREENING
ON JANUARY 17 AND 18, 1979
AT CF INDUSTRIES INC., DONALDSONVILLE LOUISIANA

	Percent By Weight	
	Urea Melt	Urea Product Before Screening[a]
Urea Composition		
Uncorrected[b]	90.5	96.1
Corrected[c]	96.8	102.8
Ammonia Composition		
Direct Nesslerization	g	g
Distilled Uncorrected[d]	1.7	2.1
Distilled Corrected[e]	-2.1	-2.0
Formaldehyde Composition	0.4	0.6
Moisture[f]	-	0.2

[a]Composite sample

[b]Kjeldahl analysis results uncorrected for urea conversion during distillation.

[c]Kjeldahl analysis results corrected for urea conversion. (corrected = uncorrected x 1.07)

[d]Distillation/Nesslerzation (D/N) analysis results uncorrected for urea conversion during distillation.

[e]D/N analysis results corrected for urea conversion. (corrected = uncorrected - 0.07*corrected urea/1.765.

[f]Average of measurements by CF Industries Inc.

[g]Turbidity prevented sample evaluation.

*The data in this table are considered questionable, based on other analyses performed by CFI and the fact that product samples contain many other compounds not analyzed for here.

TABLE 2-10

SUMMARY ON SIEVE AND BULK DENSITY MEASUREMENTS
ON THE "B" GRANULATOR PRODUCT BEFORE SCREENING ON JANUARY 17 and 18, 1979
AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

	Granulator Unscreened Product Sample #1 Collected @1343 on 01/17/79			Granulator Unscreened Product Sample #2 Collected @1730 on 01/17/79			Granulator Unscreened Product Sample #3 Collected @1045 on 01/18/79		
	Mass, gm	Percent of Total Mass	Cumulative Percent of Total Mass	Mass gm	Percent of Total Mass	Cumulative Percent of Total Mass	Mass, gm	Percent of Total Mass	Cumulative Percent of Total Mass
Total Sample To Sieves	237.36			245.26			224.37		
Sieve No. 6	28.25	11.90	100	24.44	10.03	100	16.55	7.39	100
Sieve No. 8	44.50	18.75	88.10	46.77	19.20	89.97	42.92	19.12	92.63
Sieve No. 10	58.42	24.62	69.34	60.74	24.93	70.77	56.15	25.01	73.51
Sieve No. 12	45.56	19.20	44.73	48.87	20.06	45.84	46.20	20.58	48.49
Sieve No. 14	39.91	16.82	25.52	40.43	16.59	25.78	40.58	18.08	27.91
Sieve No. 16	13.75	5.79	8.71	14.74	6.05	9.19	14.37	6.40	9.83
Bottom	6.92	2.92	2.92	7.64	3.14	3.14	7.70	3.43	3.43
Sum of Mass on Sieves	237.31			243.63			224.47		
Bulk Density, Grams Per 250 ml	213.11			214.64			213.53		

TABLE 2-11

SUMMARY OF JANUARY 17, 18 and 19, 1979 AMBIENT TEMPERATURE
RELATIVE HUMIDITY AND BAROMETRIC PRESSURE MEASUREMENTS
FOR "B" GRANULATOR AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

DATE	RUN	SAMPLING TIME	AMBIENT TEMPERATURE °F	RELATIVE HUMIDITY %	BAROMETRIC PRESSURE INCHES Hg
01/17/79	1	1230	69	76	
		1245	69	76	
		1306	69	76	30.40
		1320	69	76	30.40
		1356	69	76	30.39
		1448	70	74	30.39
		Average	69	76	30.40
	2	1523	69	79	30.39
		1635	67	85	30.39
		1715	68	80	30.39
		1815	66	85	30.38
		Average	68	82	30.39
01/18/79	3	0945	62	94	30.39
		1005	62	94	30.39
		1020	64	90	30.39
		1040	64	87	30.38
		1055	66	82	30.38
		1115	67	85	30.36
		1140	67	83	30.36
		1200	68	85	30.36
		1435	69	85	30.28
		1500	71	77	30.28
		1525	73	73	30.27
		1540	71	77	30.27
		Average	67	84	30.34
01/19/79		1000	68	90	30.17
		1020	68	90	30.17
		1040	70	86	30.17
		1100	70	86	30.17
		1120	70	86	30.14
		1140	75	70	30.12
		1200	77	66	30.10
		1230	73	75	30.10
		Average	71	81	30.14

TABLE 2-12

SUMMARY OF RESULTS OF UREA AND AMMONIA TESTS ON GASES EXITING THE UREA SYNTHESIS TOWER VENT ON JANUARY 18 and 19, 1979 AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1		Run 2		Run 3		Average	
Date	01-18-79		01-19-79		01-19-79			
Volume of Gas Sampled (including ammonia)-DSCF[a]	5.07		5.30		5.14		5.17	
Percent Moisture by Volume	67.0		57.8		64.5		63.1	
Average Gas Temperature (°F)	193		186		191		190.0	
Stack Volumetric Flowrate (including ammonia)-DSCFM[b]	306		402		339		349	
Production Rate* (tons/hr)								
Percent Isokinetic	84.2		66.5		77.9		76.2	
Net Sampling Time (minutes)	15		15		15		15	
UREA DATA	d	e						
Kjeldahl Analysis Method:	uncorrected	corrected	uncorrected	corrected	uncorrected	corrected	uncorrected	corrected
Total Sample Weight (milligrams)	189	202	198	212	185	198	191	204
gr/DSCF (including ammonia)[c]	0.574	0.614	0.575	0.615	0.554	0.593	0.580	0.619
lb/hr	1.51	1.62	1.98	2.12	1.61	1.72	1.70	1.82
lb/ton	0.0253	0.0271	0.0352	0.0377	0.0286	0.0306	0.0297	0.0317
AMMONIA DATA	f	g	h					
Nesslerization Analysis Method:	direct	uncorrected distilled	corrected distilled	direct	uncorrected distilled	corrected distilled	direct	uncorrected distilled	corrected distilled	direct	uncorrected distilled	corrected distilled
Total Sample Weight (milligrams)	37720	37920	37910	45840	48620	48610	57810	58230	58220	41720	48260	48250
gr/DSCF (including ammonia)	114.6	115.2	115.2	133.2	141.3	141.3	173.2	174.5	174.5	140.3	143.7	143.7
lb/hr	300.5	302.1	302.0	458.9	486.7	486.6	503.2	506.9	506.8	420.9	431.1	431.0
lb/ton	5.06	5.09	5.09	8.15	8.64	8.64	8.94	9.00	9.00	7.83	8.02	8.02

[a] Dry standard cubic feet @ 68°F, 29.92 inches Hg
[b] Dry standard cubic feet per minute
[c] Grains per DSCF
[d] Uncorrected for urea conversion during distillation
[e] Corrected for urea conversion during distillation (corrected = uncorrected x 1.07)
[f] Direct Nesslerization
[g] Distillation and Nesslerization - uncorrected for urea conversion during distillation
[h] Distillation and Nesslerization - corrected for urea conversion during distillation (corrected = uncorrected - 0.07 x corrected urea/1.765)
* All production rate information is confidential, per CFI request

SECTION 3

PROCESS DESCRIPTION AND OPERATION

PROCESS EQUIPMENT

Urea is produced by reacting liquid ammonia (NH_3) with carbon dioxide (CO_2) at an elevated temperature and pressure. The reaction is exothermic and spontaneous and results in formation of liquid ammonium carbamate (NH_2 CO_2 NH_4). The liquid ammonium carbamate is subsequently decomposed to urea ($CO(NH_2)_2$) and water. The resulting solution of urea in water is concentrated to 89+ percent urea when it is finally solidified.

The Stamicarbon CO_2 Stripping Process is the urea synthesis method employed at this facility. This particular process incorporates emission reduction and energy recovery techniques in its standard design. The exhaust from the steam jet ejector vacuum system on the evaporators usually consists of inerts, ammonia, and traces of urea.

Liquid (70 percent urea) leaving the solution production area goes to a holding tank prior to being concentrated to 99.5 percent in a two-stage vacuum evaporator.

The concentrated molten urea, referred to as melt, leaves the solution synthesis process and is pumped to the solids formation equipment. This facility employs rotary drum granulators, designed by C&I Girdler, as the solids forming devices. A typical diagram displaying the process components is presented in Figure 3-1.

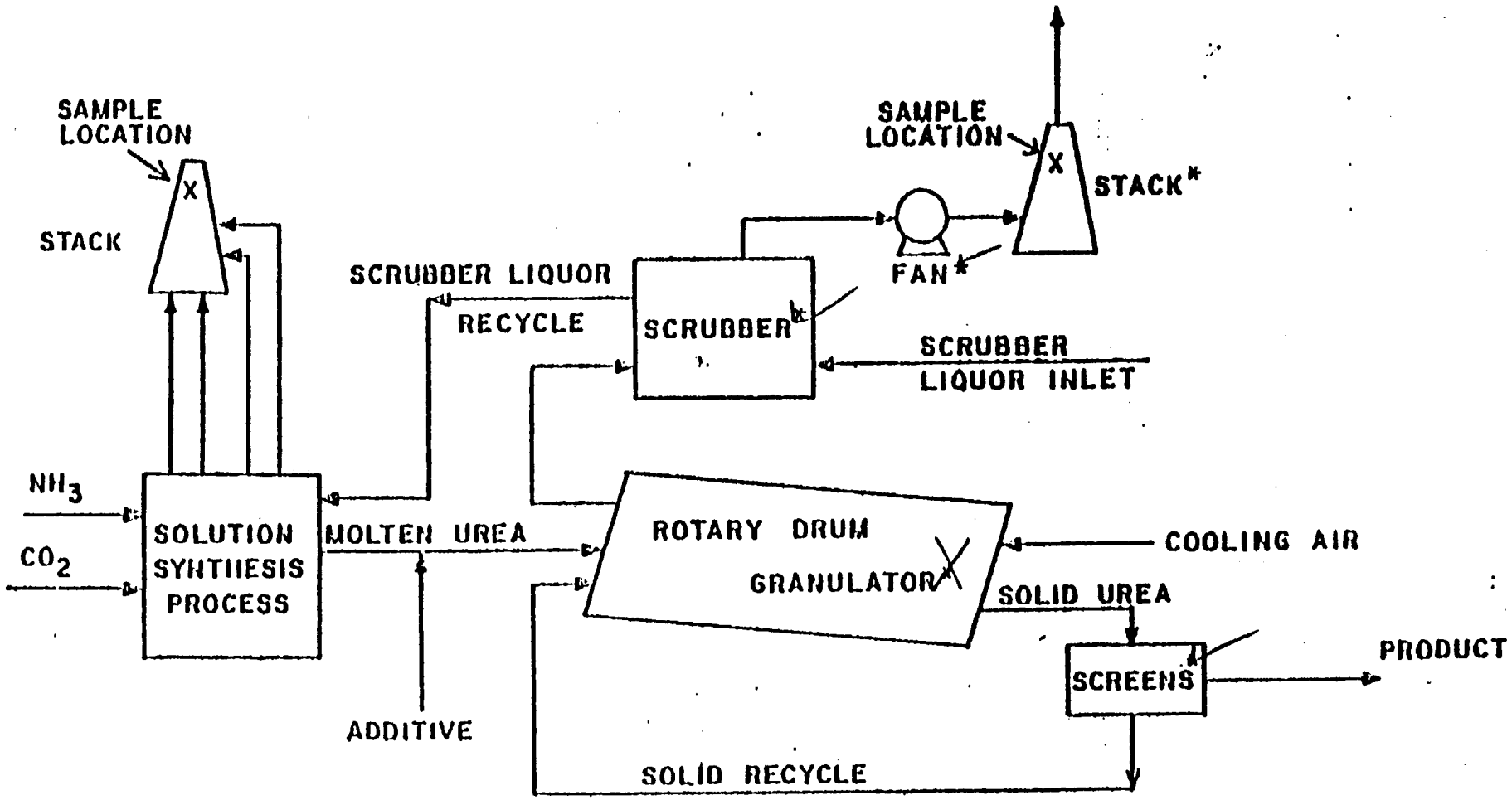

FIGURE 3-1 TYPICAL UREA MANUFACTURING PROCESS AS DESIGNED BY C & I GIRDLER

The molten urea is sprayed onto a bed of solid urea "seed" particles at the higher end of the inclined granulator. Lifting flights arrayed inside the granulator cause the solid urea "seed" particles to continually fall through the molten sprays and a counter-current flow of cooling air. The molten urea solidifies on these "seed" particles, increasing their size. As the particles grow in size, they eventually spill over a retaining dam into the cooling section of the granulator.

Cooled granules leaving the rotary drum granulator are screened. Oversize granules are crushed, combined with undersize granules, and returned in solid form to the bed of material at the spray end of the granulator as make-up "seed." Product size granules are loaded and/or conveyed to a bulk storage warehouse.

This facility does not coat the product urea granules. Instead, a formaldehyde-based additive is added to the molten urea before it is sprayed in the granulator.

Emissions points are the various vents in the solution synthesis process and the granulator cooling air exhaust. The solution synthesis process vents are combined into one stack before exhausting to the atmosphere. The granulator cooling air passes through a scrubber and fan before being exhausted out a stack. Scrubber liquid is returned to the solution synthesis process for urea recovery.

There are two separate urea production lines at this facility. Each line has its own urea solution production plant and rotary drum granulator units for granular urea formation. The production lines are identical except for size and age.

Production line No. 1 was put into service in October 1974, and is rated at 998 Mg/day (1100 tons/day) of solid urea granules. Solid urea is formed in three parallel rotary drum granulators.

Production line No. 2 was put into service in June of 1977 and is rated at 907 Mg/day (1000 tons/day) of solid urea granules. Solid urea is formed in four parallel rotary drum granulators. The urea solution process feeding line No. 2 is sized to allow production of 500 TPD of solution in addition to that required for solids formation.

EMISSION CONTROL EQUIPMENT

Emission points from each urea solution production line include the high pressure scrubber vent, the low pressure scrubber vent, and the steam jet ejector exhaust from the vacuum evaporator concentrators. The high pressure scrubber is utilized to recover ammonia from various process equipment overhead streams. The vent is necessary to remove inerts from the overall process. . . . . .[a]Note 3 . . . . . .The scrubber liquor is carbamate recycle. The low pressure vent on the total recycle part of the plant vents ammonia, water, and inerts. The steam jet ejectors that maintain a vacuum on the vacuum evaporators also emit ammonia, water, and inerts. There are no controls on these three emission points other than standard process stream controls on a total recycle plant.

The exhaust air from each granulator is ducted to separate . . . . . .[b]Note 4 . . . . . scrubbers . . . . . .[c]Note 5 . . . . . On line No. 1, each scrubber exhausts through its own stack.

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[a]Note 3 - See Item 3, Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213.

[b]Note 4 - See Item 4, Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213.

[c]Note 5 - See Item 5, Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213.

PROCESS OPERATION

In order to determine whether production line 1 was operating at representative steady-state conditions during testing, various process and control equipment operating parameters were monitored.

PRODUCTION RATES

Production rates were calculated using the flow rate as measured by magnetic volumetric flow meters. These meters measured the urea melt to the rotary drum granulators in conjunction with the insitu density of the urea melt (1.2 gm/cc).[1] As a check, totalizer readings on the product conveyor weigh belt were also monitored. Average product rates for the B granulator during emissions tests of its scrubber are presented in Table 3-1. Average product rates of the solution production equipment during emissions testing of this equipment are presented in Table 3-2. These were calculated using the totals of the feed rates to all three granulators.

PRODUCTION AND CONTROL EQUIPMENT OPERATION

In addition to the process rate parameters mentioned above, many other parameters were monitored to insure representative steady-state process operation. During testing of B granulator emissions, inlet and outlet temperatures of the urea and air streams through the B granulator were monitored, as was the inhibitor addition rate. The ammonia feed rate for production line 1 was also monitored. For the B granulator scrubber, liquor level, temperature, outlet concentration, and inlet and outlet flow rates were monitored.

TABLE 3-1 GRANULATOR B FEED RATE DURING GRANULATION EMISSIONS TESTING

Test	Granulator B Feed Rate
Scrubber Inlet and Outlet Test No. 1	...
Scrubber Inlet and Outlet Test No. 2	...
Scrubber Inlet and Outlet Test No. 3	...
Scrubber Inlet Particle Size Test No. 1	...
Scrubber Inlet Particle Size Test No. 2	...
Scrubber Inlet Particle Size Test No. 3	...

See Note 6[a]

[a]Note 6 - See Item 6, Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213.

TABLE 3-2 SOLUTION FORMATION RATE FOR PRODUCTION LINE 1 DURING SOLUTION FORMATION EMISSIONS TESTING

Test	Output as 100 Percent
1	...
2	...
3	...

See Note 7[a]

[a]Note 7 - See Item 7, Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213.

During emissions testing of the solution production equipment, CO_2 compressor rate and vent scrubber overheads pressure (T105) were monitored in addition to the above parameters.

Relative average values and relative standard deviations of all the above parameters monitored during the emissions tests are shown in Table 3-3. A value of 100 percent for a parameter represents the exact arithmetic average of all values of that parameter monitored during all tests. Granulator and scrubber parameters were monitored during the particle size and solution tower tests, and these values were incorporated into the relative averages and standard deviations shown for the granulator scrubber inlet and outlet tests. Standard deviations are not presented for tests where the number of readings was three or less. Actual values of monitored parameters are presented in Appendix I.

"B" GRANULATOR AND SCRUBBER OPERATION

Average temperatures of the air inlet and outlet streams and the urea outlet stream to the granulator show considerable variation between test periods. The difference between average temperatures of a given stream for two test periods often exceeds the standard deviations of the temperatures during the two tests. The effect of these variations on the particulate concentration entering the 'B' granulator scrubber cannot be predicted. Inhibitor addition rate was gradually reduced between January 17, when the first scrubber air inlet and outlet tests were made, and January 18, when the last tests were made. It was maintained at a constant value during particle size characterization tests, although this rate was somewhat lower than the rates used during scrubber inlet and outlet tests.

TABLE 3-3 RELATIVE AVERAGE VALUES OF OPERATING PARAMETERS DURING TESTING

PARAMETER	Granulator Scrubber Inlet and Outlet Tests						Particle Size Tests Granulator Emissions			Solution Tower Emissions Tests		
	1/17; 1200-1515		1/17; 1545-1803		1/18; 0945-1217		1/18 1530-1545	1/18 1600-1018	1/18 1115-1147	1/18 1545-1603	1/19 1030-1047	1/19 1130-1200
	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.						
Production Rate Parameters												
Urea Melt Feed to Granulator A	100	0.9	83	0.6	111	0.7	111	100	100	111	100	100
Urea Melt Feed to Granulator B	101	0.8	100	0.0	97	0.7	98	100	100	98	100	100
Urea Melt Feed to Granulator C	105	0.5	90	6.0	108	0.5	105	94	94	102	94	94
Total Solids from A, B, and C	100	-	92		104	-	119	98	97	80	101	102
B Granulator Operating Parameters												
Air Inlet Temperature	101	1.6	100	1.7	92	1.5						
Air Outlet Temperature	100	0.3	103	0.6	98	0.5						
Urea Inlet Temperature	100	0.7	100	0.6	100	0.3						
Solids Outlet Temperature	101	1.7	99	0.7	94	0.7						
Formaldehyde Addition Rate	106	4.7	104	0.0	100	3.3						
Scrubber Operating Parameters												
Liquor Level	101	1.0	101	1.0	101	1.0						
Liquor Temperature	99	0.5	104	0.5	99	0.0						
Liquor Feed Rate	105	0.0	107	5.6	111	9.2						
Liquor Blowdown Rate	70	68.	120	63.	136	136.						
Blowdown Urea Content	101	0.8	98	2.0	100	4.2						
Solution Production Operating Parameters												
Ammonia Feed Pump Rate (RPM)	100	1.1	102	1.0	100	2.1	98	99	99	98	99	99
CO_2 Compressor Rate (SCFM)										102	99	99
T105 Overheads Pressure										101	99	98
Solution Feed to Evaporator										97	101	101

Scrubber liquor level was maintained constant during tests of scrubber air outlet. There was some variation of average liquor feed and blow-down rates, temperature, and concentration between the three tests, as can be seen in Table 3-4. The effect of variations in these last three parameters on emissions cannot be predicted.

SOLUTION PRODUCTION EQUIPMENT OPERATION

Average values of the ammonia feed pump RPM, CO_2 compressor rate, and urea solution feed to the evaporators were fairly uniform for the various test periods. Vent scrubber overheads pressure also showed little variation.

TABLE 3-4 SCRUBBER OPERATING PARAMETERS DURING SCRUBBER AIR INLET AND OUTLET PARTICULATE LOADING TESTS

Test Number	See Note 8[a]
1	
2	See Note 8[a]
3	

[a]Note 8 - See Item 8, Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213.

On the morning of January 18, the plant was having trouble maintaining the correct ammonia to CO_2 feed ratio. No testing of solution formation equipment was conducted that morning, and the feed ratio problem is not expected to have affected emissions from solids formation.

REFERENCES

1. Letter to T. Curtin, GCA/Technology Division, from M. Dial, Vice President, Manufacturing, Lousiana Region, CF Industries, Inc., Donaldsonville, Louisiana, May 28, 1979.

SECTION 4

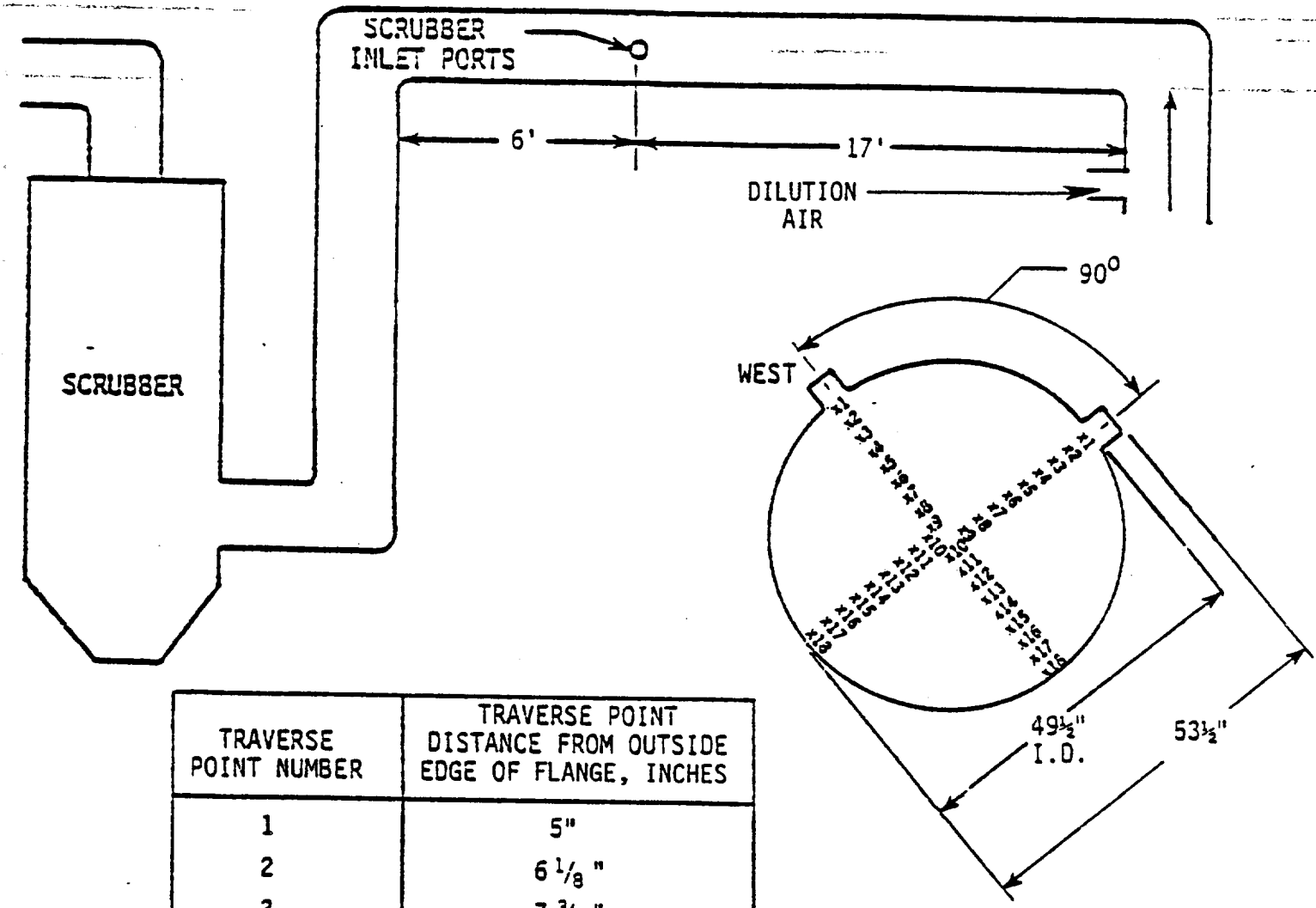
LOCATION OF SAMPLING POINTS

Testing was conducted on the "B" Granulator Scrubber and the Synthesis Tower Vent at the CF Industries, Inc., urea plant in Donaldsonville, Louisiana. This section presents the detailed descriptions of the sampling locations for the urea, ammonia, formaldehyde, particle size and the opacity measurements.

SCRUBBER INLET, TP-1

The scrubber inlet sampling site was located in a 49 1/2 inch I.D. horizontal section of steel duct. A schematic of the sampling site including the traverse point sampling locations and duct dimensions is presented in Figure 4-1. Two 4-inch pipe-flange sampling ports positioned 90° apart were located 6 feet (1.45 duct diameters) upstream of a short radius right-angle bend. The distance from the ports to the nearest upstream disturbance (another right-angle bend) was 17 feet (4.12 duct diameters).

This inlet sampling location did not meet the "eight and two diameter" criterion as outlined in EPA Method 1; consequently 18 sampling points were chosen for each axis traverse for a total of 36 sampling points as specified in the method. Figure 4-1 shows a cross sectional view of the duct at the sampling location and lists the exact distance of each traverse point from the outside flange edge.



TRAVERSE POINT NUMBER	TRAVERSE POINT DISTANCE FROM OUTSIDE EDGE OF FLANGE, INCHES
1	5"
2	6 1/8 "
3	7 3/4 "
4	9 3/8 "
5	11 1/4 "
6	13 1/4 "
7	15 5/8 "
8	18 5/8 "
9	22 7/8 "
10	34 5/8 "
11	38 7/8 "
12	41 7/8 "
13	44 1/4 "
14	46 1/4 "
15	48 1/8 "
16	49 3/4 "
17	51 3/8 "
18	52 1/2 "

FIGURE 4-1: LOCATIONS OF "B" GRANULATOR SCRUBBER INLET TEST PORTS AND POINTS AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

SCRUBBER OUTLET, TP-2

The cleaned gases exiting the scrubber unit are ducted to an induced draft fan adjacent to the scrubber system. The fan discharge is directed vertically through a steel stack to the atmosphere.

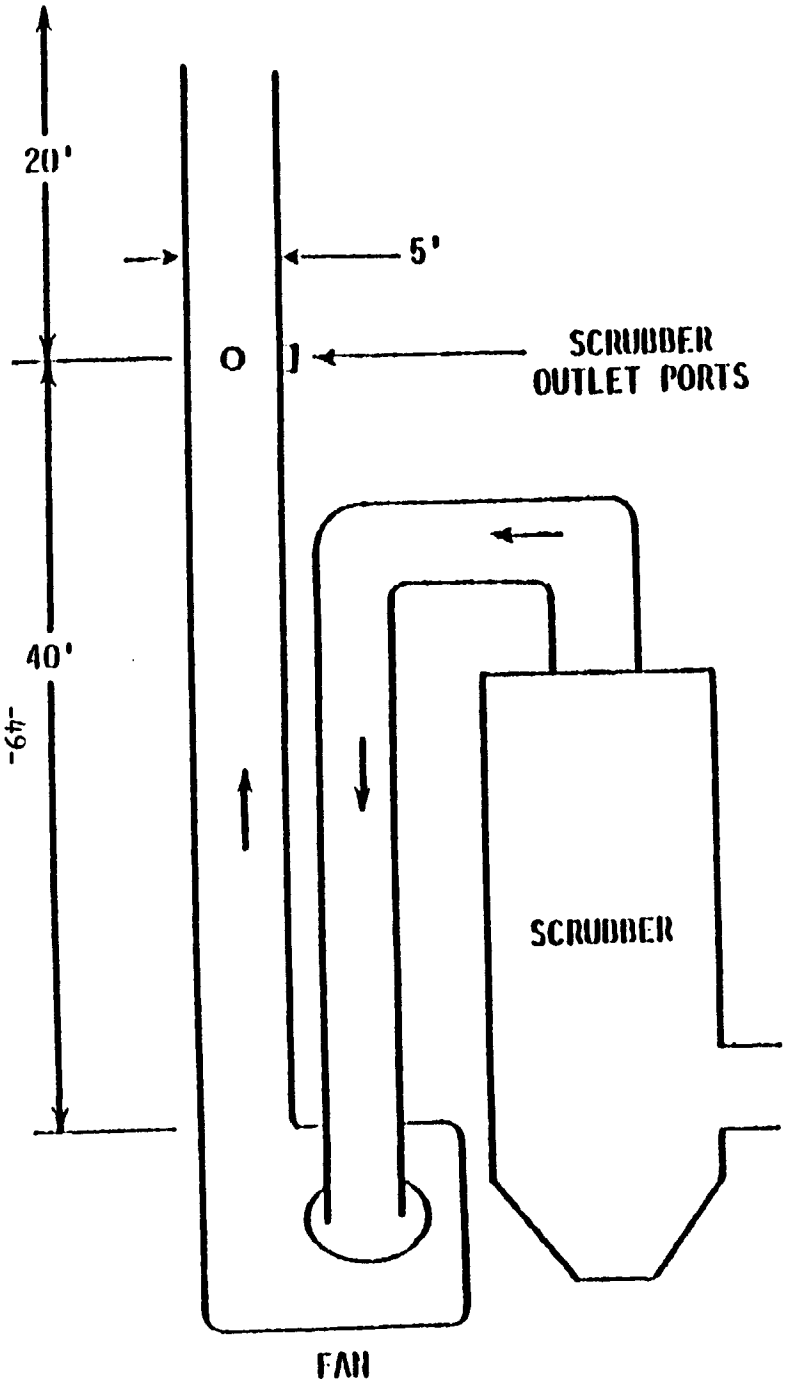
The "B" scrubber 60 inch I.D. outlet stack was fitted with two 3-inch pipe flange sampling ports positioned 90° apart in a horizontal plane. The two ports were located 40 feet (8 stack diameters) downstream from the fan discharge, and 20 feet (4 stack diameters) upstream of the top of the stack. See Figure 4-2. The port locations met the "eight and two diameter" criterion as delineated in EPA Method 1; consequently 6 sampling points were used for each axis traverse for a total of 12 sampling points as specified in the method.

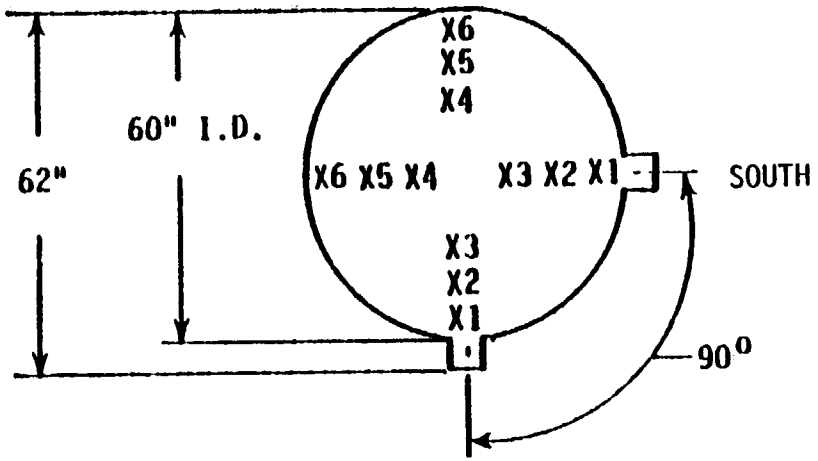
INLET PARTICLE SIZE SAMPLING LOCATION, TP-1

Particle sizing test runs were performed in the "B" granulator scrubber inlet gas stream. An in-stack cascade impactor was positioned in the duct through the test ports used for the emissions tests. The impactor nozzle was located at the geometric center of the duct for each impactor run. Only this one central sampling point was used in order to maintain isokinetic sampling, per standard procedures established by the cascade impactor manufacturer.

VISIBLE EMISSIONS OBSERVATION LOCATIONS

The white scrubber stack plume was observed from a position 90 feet above ground level and about 10 feet above the top of the stack. Observations were made looking north to the stack, 150 feet away. The plume was observed against a background consisting of a railroad bed and the ground nearby. This position was





TRAVERSE POINT NO.	TRAVERSE POINT DISTANCE FROM OUTSIDE EDGE OF NIPPLE (INCHES)
1	4 5/8"
2	10 3/4"
3	19 3/4"
4	44 1/4"
5	53 1/4"
6	59 3/8"

FIGURE 4-2: LOCATIONS OF "B" GRANULATOR SCRUBBER OUTLET TEST PORTS AND POINTS AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

selected to conform to the EPA Method 9 requirements. The location of the smoke observer is shown in Figure 4-3.

SCRUBBER PRESSURE DROP MEASUREMENT LOCATIONS

Pressure drop across the "B" granulator scrubber was measured with a vertical U-tube water manometer which was connected to pressure taps at the scrubber inlet and outlet. The inlet pressure tap was located in the inlet duct 10 feet upstream of the scrubber. The outlet pressure tap consisted of a hole drilled through the transition ducting between the scrubber outlet and the inlet of the fan.

SCRUBBER LIQUID COLLECTION LOCATIONS

Scrubber solution samples were collected from the streams entering and leaving the "B" granulator scrubber. See Figure 4-4. The inlet sample was tapped from the solution line just before it entered the scrubber. The outlet sample was tapped from the pump discharge.

PROCESS SAMPLE COLLECTION LOCATIONS

Throughout the testing program, process samples were collected directly from their applicable process units/operations. These consisted of samples of urea melt and the granulator unscreened product.

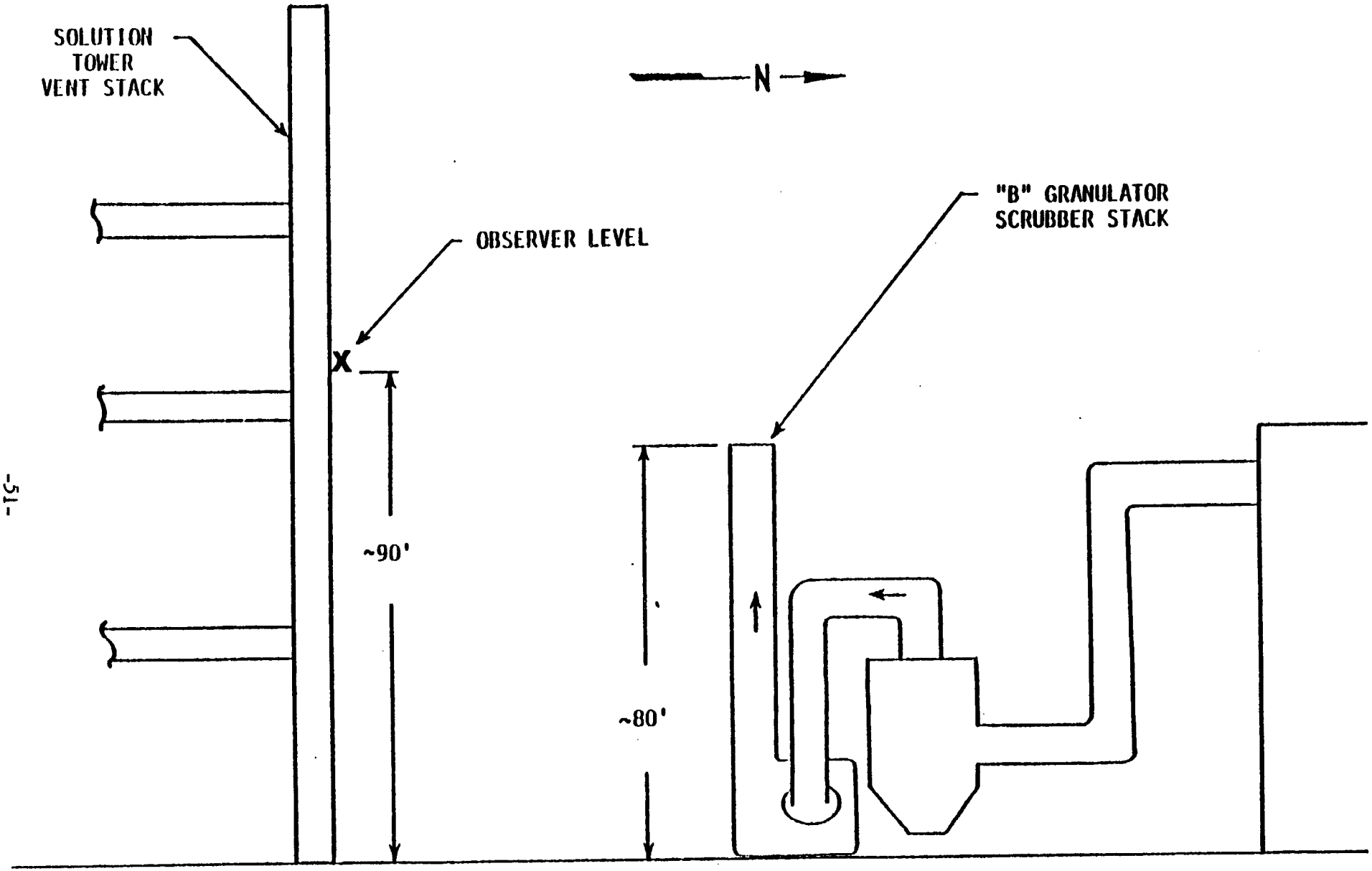


FIGURE 4-3: LOCATION OF SMOKE OBSERVER FOR JANUARY 17 - 19, 1979 OPACITY READINGS ON "B" GRANULATOR SCRUBBER STACK AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

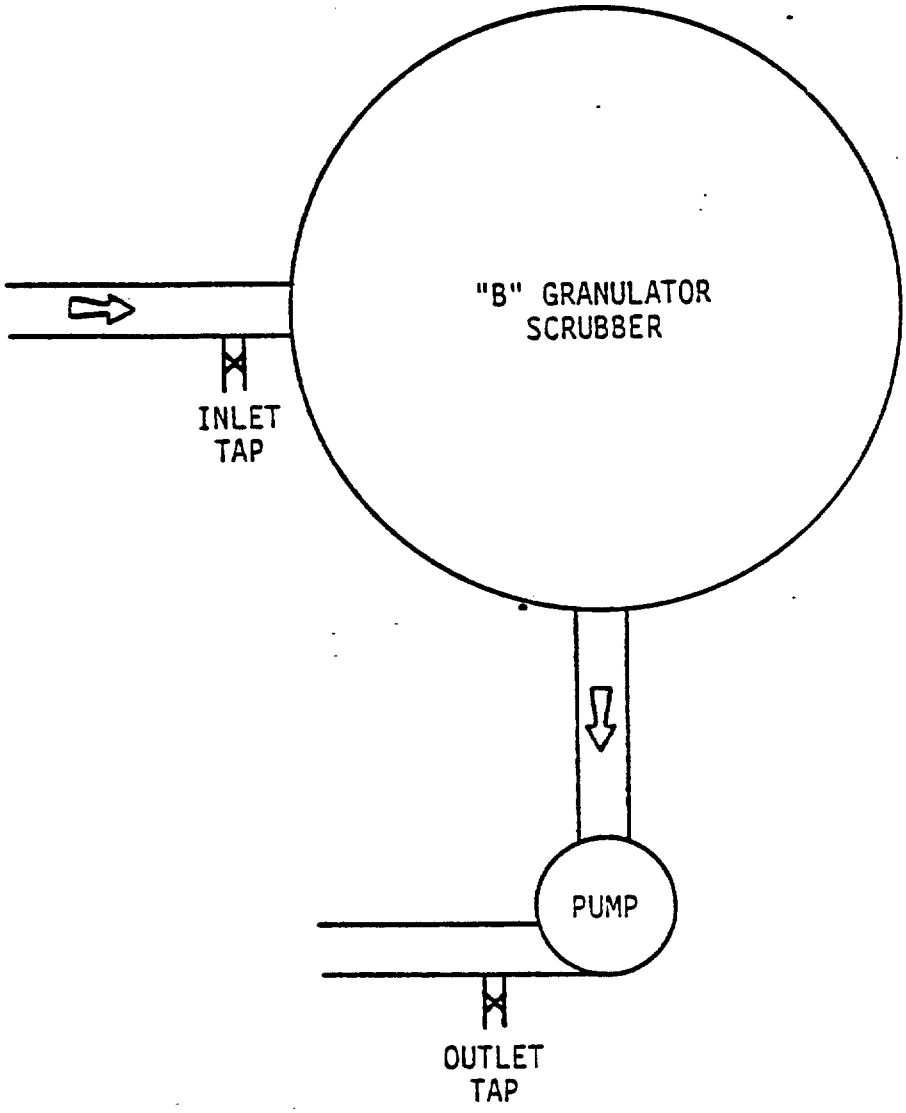


FIGURE 4-4: LOCATIONS OF SCRUBBER LIQUID COLLECTION TAPS FOR JANUARY 17 - 19, 1979 TESTS ON "B" GRANULATOR AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

UREA SYNTHESIS TOWER VENT LOCATION

The urea synthesis tower sampling site was located in a 14 inch I.D. vertical section of heavy gauge stainless steel pipe. A schematic of the sampling site is presented in Figure 4-5. One 6 inch I.D. pipe flange sampling port was positioned approximately 16 feet (13.7 stack diameters) upstream of a connecting exhaust vent. The distance between the sampling point and the stack vertex was approximately 30 feet (25.7 stack diameters). The port location met the EPA Method 1 criterion. The use of an in-stack orifice in the 14 inch I.D. stack restricted the sampling to a single point. The nozzle was positioned at its centroid of the stack for the three runs.

AMBIENT AIR TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENT LOCATION

The ambient air temperature and relative humidity measurements were made on the ground next to the CFI chemical laboratory, within 300 yards of the "B" Granulator.

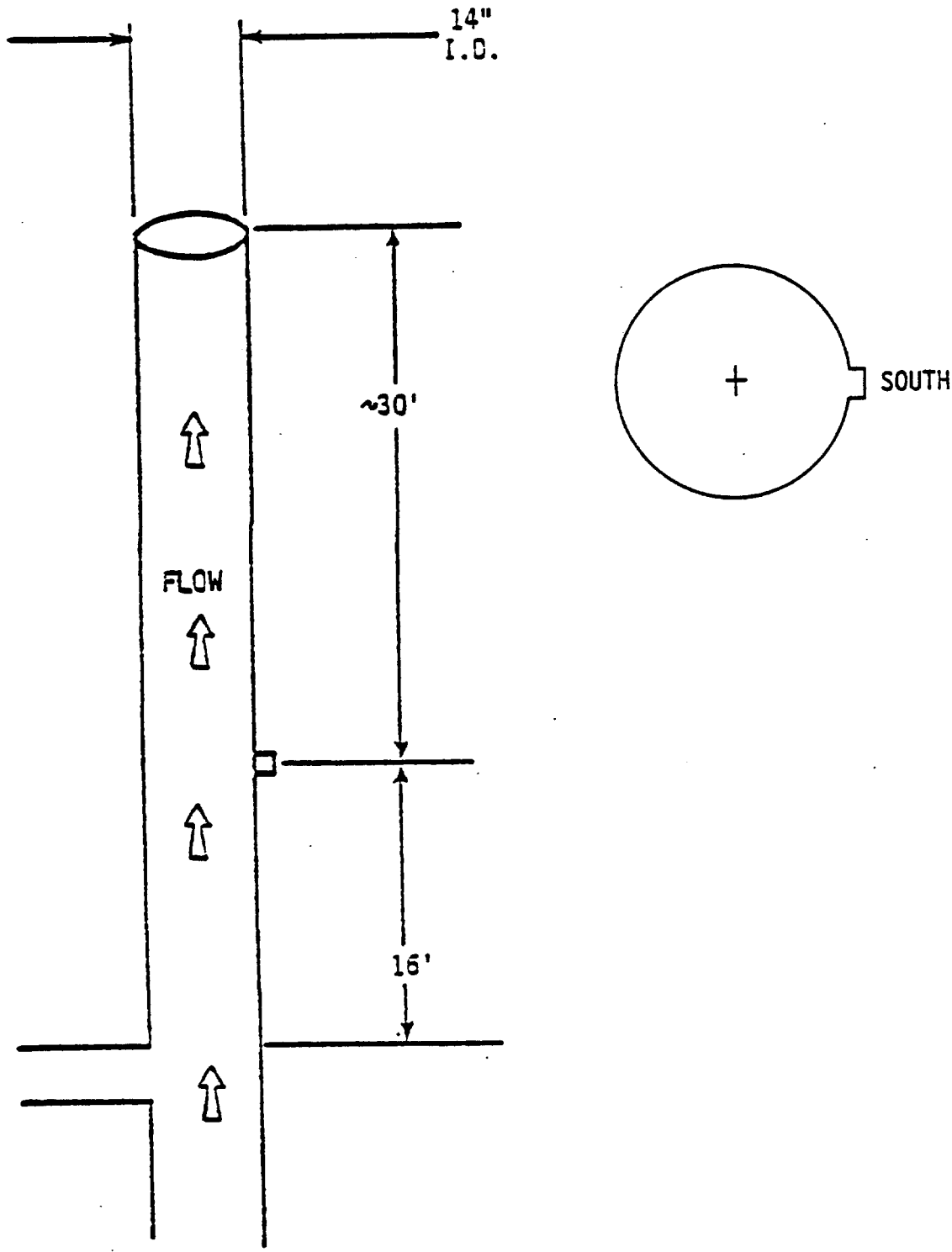


FIGURE 4-3: LOCATION OF SYNTHESIS TOWER SOLUTION VENT SAMPLING PORT AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

SECTION 5

SAMPLING AND ANALYSIS METHODOLOGIES

This section presents the description of the sampling and analysis methodologies employed at the CF Industries, Inc. urea manufacturing facility in Donaldsonville, Louisiana during January 15-19, 1979. Sampling and Analysis Methodologies are categorized as:

A - Urea, Formaldehyde, and Ammonia "B" Granulator Scrubber
B - Visible Emissions "B" Granulator Scrubber
C - Particle Size "B" Granulator System Inlet
D - Scrubber Liquid "B" Granulator
E - Process Samples "B" Granulator
F - Urea and Ammonia Synthesis Tower Main Vent

The EPA designated methods and any deviations from these methods are contained in Appendices J and K. This section presents general descriptions of the methods along with discussions of problems encountered during the test program.

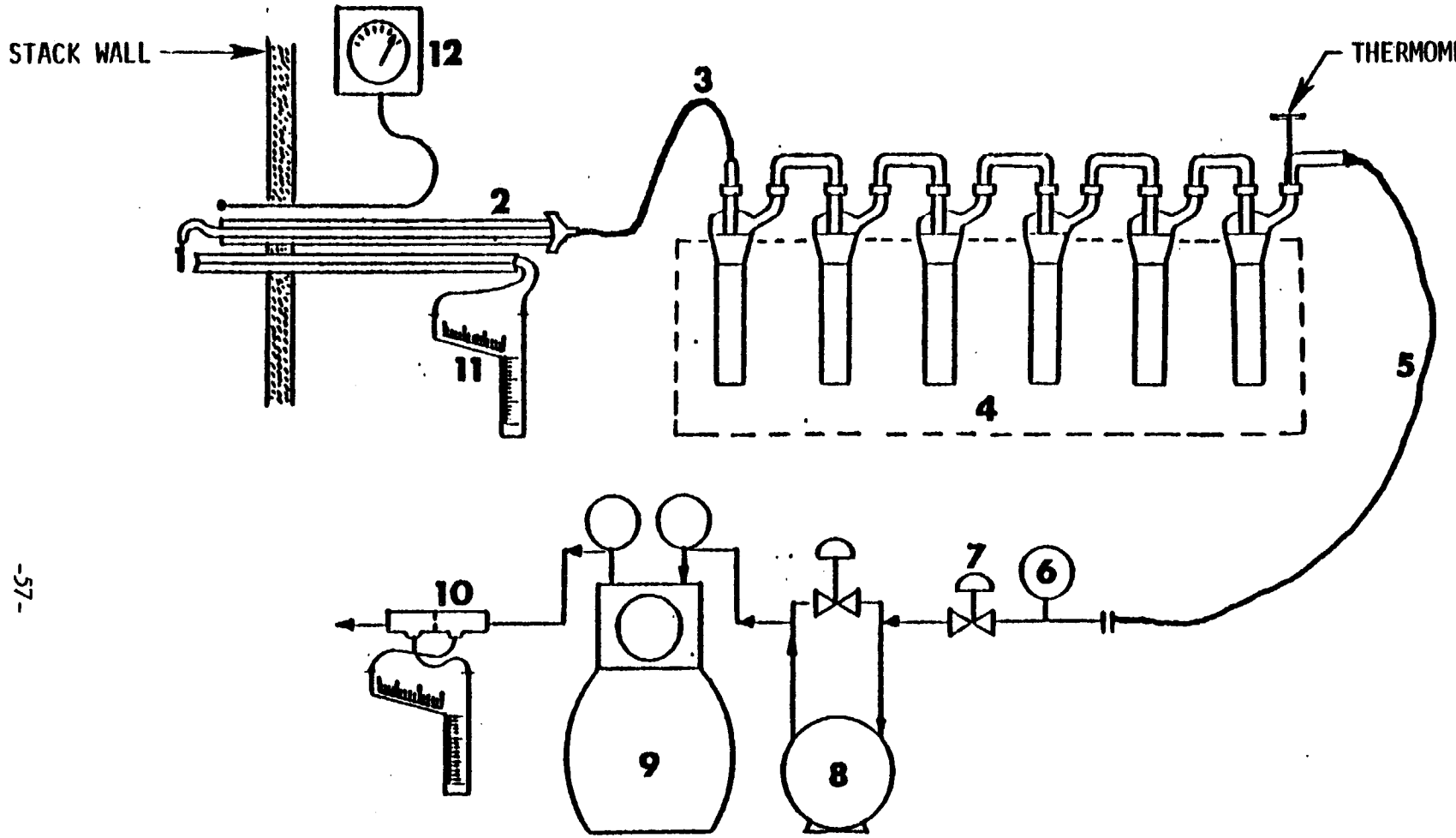
UREA, FORMALDEHYDE, AND AMMONIA METHODS USED ON "B" GRANULATOR SCRUBBER

Urea, formaldehyde, and ammonia in the "B" Granulator Scrubber inlet and outlet gas streams were sampled at points identified by EPA Method 1 in accordance with the relationship of the sampling ports to upstream and downstream flow disturbances. The velocity of the duct gas was measured using calibrated S-type pitot tubes in accordance with EPA Method 2. Construction and calibration of the S-type pitot tubes was consistent with EPA Method 2. The complete methods for sampling and analysis for urea, formaldehyde and ammonia are contained in Appendix K.

The sampling train is shown schematically in Figure 5-1 and consists of nozzle, probe, Teflon line, six impingers, vacuum pump, dry gas meter, and an orifice flow meter. The nozzle (1) is stainless steel and is of buttonhook shape. It was connected to a 5/8" stainless steel glass lined probe (2) that is wrapped with nichrome heating wire and jacketed. The probe temperature was maintained at approximately 190°F at the inlet and approximately 110°F at the outlet in order to prevent condensation of the sampled gas. Following the probe, the gas stream passed through a 3/8" I.D. Teflon line (3) into an ice bath/impinger system (4).

The first and second impingers in the ice bath contained deionized distilled water (100 ml), the third and fourth contained 100 ml of 1N H_2SO_4 each, the fifth was dry, and the sixth contained silica gel (200 grams) to remove any remaining moisture. Leaving the last impinger, the sample stream flowed through flexible tubing (5), a vacuum gauge (6), needle valve (7), pump (8), and a dry gas meter (9). A calibrated orifice and inclined manometer (10) complete the sampling train. The stack velocity pressure was measured using a pitot tube (11) and inclined manometer. Stack temperature was monitored by a thermocouple attached to the probe and connected to potentiometer (12). A nomograph was used to rapidly determine the orifice pressure drop required for any pitot velocity pressure and stack temperature in order to maintain isokinetic sampling conditions.

The recorded test data included test time, sampling duration at each traverse point, pitot pressure, stack temperature, meter volume, meter inlet-outlet temperature and orifice pressure drop. At completion of each run, the nozzle and probe contents were tripled washed and brushed into a glass sample jar. Next, the Teflon line between the probe and first impinger was also rinsed three times with distilled, deionized water into the same glass sample jar which was then sealed



LEGEND

1 - NOZZLE	7 - NEEDLE VALVE
2 - PROBE	8 - PUMP
3 - TEFLON LINE	9 - DRY GAS METER
4 - ICE BATH	10 - ORIFICE
5 - FLEXABLE LINE	11 - PITOT TUBE & INCLINED MANOMETER
6 - VACUUM GAGE	12 - POTENTIOMETER

FIGURE 5-1: MODIFIED EPA PARTICULATE SAMPLING TRAIN
AUGUST 18,1977, FEDERAL REGISTER

with a Teflon lined cap. The sample jars and impingers were returned to the sample train prep-and-clean-up room.

At the same prep-and-clean-up room, the contents of the impingers were transferred to tare-weighed sample jars. The sample jars were used as follows:

Jar #1 - contents of the first and second water impingers, the water wash of these impingers and their connecting glassware, and the nozzle, probe and teflon line washes.

Jar #2 - contents of third and fourth acid impingers, the water wash of these impingers, and their connecting glassware.

Jar #3 - silica gel from the sixth impinger.

The contents of jars 1 and 2 were analyzed by a TRC chemist, Ms. Margaret Fox, at the CF Industries laboratories and also at the TRC laboratories. Ammonia concentrations were determined by two methods: 1)direct Nesslerization (on-site) and 2) preliminary distillation (on-site) followed by Nesslerization (at TRC). Urea concentrations were determined by the Kjeldehl analysis method, as follows: the portion of sample remaining after the preliminary distillation was then digested and redistilled (on-site) and then brought to TRC for completion of the urea analysis. Urea and ammonia concentrations were in all cases determined colorimetrically with a spectrophotometer at a wave length of 405 nm.

The analysis for formaldehyde, done after transporting the samples "on-ice" back to the TRC laboratories, consisted of mixing an aliquot of the sample solution with the chromatropic-sulfuric acid reagent to form a purple chromogen. This colored solution was analyzed colorimetrically using a spectrophotometer at 580 nm.

In all these analyses, standard solutions were prepared and analyzed, and calibration curves of absorbance vs. concentration were drawn. These calibration curves were used to determine the urea, formaldehyde and ammonia concentrations of the samples. The sample concentration indicated by the calibration curve was multiplied by the sample volume to determine the total mass of urea, formaldehyde or ammonia collected.

The distillation-and-Nesslerization analysis method was done in addition to the direct-Nesslerization method for ammonia analysis because of potential interference from several species (including formaldehyde and urea) on ammonia concentrations determined by the direct Nesslerization method.[1] But there also exists evidence that about 7 percent of any urea in a sample is converted to ammonia during distillation.[1] Uncertainty in the exact mechanism and rate of urea conversion, however, leads to uncertainty in indicated ammonia concentrations, especially so in samples with high urea concentrations. This is evident in the analyses of the gases entering the "B" granulator scrubber (Table 2-2) and the liquid exiting this scrubber (Table 2-7). In these cases, the application of the standard 7 percent correction factor yielded negative "corrected" ammonia concentrations. Because of the uncertainty in the urea conversion factor, more confidence is placed in the direct-Nesslerization results.

The main sampling problem during these scrubber gas test runs occurred at the scrubber inlet. The large size and high concentration of the urea particles at this location caused plugging of the pitot, nozzle and probe. Plugs were removed from the pitot by pumping air via a purge line through the pitot tube side facing

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[1] Standard Methods for the Examination of Water and Wastewater, 14th Edition, APHA, AWWA, WPCF, 1975, p. 408.

upstream; this purge line would then be removed and the pitot reconnected to the manometer. The frequent nozzle and probe plugging required shutting down the sampling train and cleaning the nozzle and probe. Cleaning was quickly accomplished by squirting water into the nozzle to dissolve the plug, as recommended by the EPA Technical Manager. Plugging was minimized by inserting the probe into the duct with the nozzle facing downstream. The probe was then rotated 180 degrees into the flow stream immediately before the initiation of sampling. The probe was removed from the duct in reverse order. In addition, the largest possible nozzle was used as a precaution to minimize plugging problems.

The water used to clean the nozzle and probe did, however, contribute to the total volume of water collected by the impingers during the inlet test runs. For this reason and because of the large mass of urea collected at the inlet, a separate test run was performed at the scrubber inlet to determine the moisture content of the scrubber inlet gas stream. Details of this moisture run and calculations are contained in Appendix A.

VISIBLE EMISSIONS METHODS USED ON "B" GRANULATOR

The visible emissions measurements were conducted by a certified visible emission evaluator in accordance with EPA Reference Method 9. The readings were taken at 15 second intervals. Since the plume was white, it was necessary to read the emissions against a dark background. The dark background selected was the railroad tracks and the dark dirt and rock ground surface in that area.

PARTICLE SIZE METHODS USED ON "B" GRANULATOR INLET

A Sierra Model 266 multi-stage cascade impactor was operated in its in-stack mode. Sampling was performed isokinetically from a single point at the center of

the scrubber inlet duct. Prior to the initiation of sampling the impactor was leak tested and placed in the duct for 20 minutes to allow it to heat to duct temperature to prevent condensation. Sampling was initiated immediately upon rotation of the nozzle into the flow stream. The brief sampling time at the inlet necessitated presetting the sample valve so that when the nozzle was pointed into the flow stream and the pump started, only a minimal adjustment of the valve was necessary to achieve isokinetic flow.

The impactor was loaded before each run with preweighed glass fiber collection substrates. After sampling the impactor was removed to the clean up room and the substrates placed in plastic petri dishes and sealed. The cyclone contents were brushed into a sample jar and sealed. These samples were weighed on an analytical balance to 0.1 mg. Additional information on the particle sizing is presented in Appendix B.

SCRUBBER LIQUID SAMPLING METHODS USED ON "B" GRANULATOR

Half-liter samples of the scrubbing liquid streams entering and exiting the "B" granulator scrubber were collected at approximately 30 minute intervals during the granulator scrubber tests. Sample temperatures were recorded immediately upon collection. The pH of each sample was measured using a pH meter.

All the individual samples collected during a run were combined into one inlet and one outlet sample. The composite samples were analyzed for urea, ammonia, and formaldehyde concentration in accordance with the procedure described in Appendices J and K.

PROCESS SAMPLING AND PRODUCT ANALYSIS

Grab samples of the urea melt and unscreened product were collected at their respective locations in the process.

The urea melt and unscreened product samples were prepared for analysis by dissolving a known weight (approximately 1.0g) into 100 ml of distilled deionized water. The solution was then analyzed for urea, ammonia and formaldehyde using the procedures previously described above and delineated in Appendices J and K. A portion of each of the unscreened product samples were also subjected to bulk density and sieve analyses. Six sieve sizes were used in the sieve analysis, and the mass of material required to fill a 250 ml volume was measured for the bulk density analysis.

UREA AND AMMONIA SAMPLING METHODS USED ON SYNTHESIS TOWER MAIN VENT

Urea and ammonia in the Synthesis Tower Main Vent Stack were sampled and analyzed using the methodology and equipment described in the prior subsection entitled Urea and Ammonia "B" Granulator with the following modifications:

1. An in-stack orifice was used to permit isokinetic sampling of a stream with a moisture content greater than 50%. The orifice measures the sample stream at the same moisture conditions as exist in the stack and therefore changes in moisture will not affect isokinetic sampling.

2. A filter was not used in the sampling train.

3. Two extra impingers were added to achieve complete condensation of the moisture and collection of ammonia. Impingers one through three contained 100 ml each of distilled deionized water, impingers four through six each contained 100 ml of 10 N H_2SO_4, impinger seven was empty, and impinger eight contained silica gel. The 10 N H_2SO_4 was necessary because of the high ammonia concentration and served to trap ammonia by condensation and neutralization.

4. Only one sampling point (at center of stack) was used because of physical restrictions imposed by the in-stack orifice nozzle.

The total volume of water collected in these synthesis tower test runs consisted of water condensed from vapor and liquid water droplets that were extracted from the gas stream. The existence of liquid water in the gas stream was confirmed by observation and by the data shown in Appendix F. These data show that the total volume of water collected during each run exceeds the volume of water present in a saturated gas stream at the stack temperatures.

PRESSURE DROP MEASUREMENTS ACROSS "B" GRANULATOR SCRUBBER

The pressure drop measurements across the "B" granulator scrubber were made with a vertical U-tube water manometer which was connected to pressure taps at the scrubber inlet and outlet. The pressure drop across the scrubber was recorded at 5 to 15 minute intervals during the tests for urea, ammonia and formaldehyde at the B granulator scrubber.

AMBIENT AIR TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS

Ambient air temperature and relative humidity measurements were taken at the CFI chemical laboratory with a Bendix psychron at 15 to 30 minute intervals during each test run.

APPENDIX A

COMPUTER PRINTOUT TEST RESULTS WITH EQUATIONS AND EXAMPLE CALCULATIONS

APPENDIX A-1

COMPUTER PRINTOUT TEST RESULTS

1. Inlet to "B" Granulator Scrubber (TP-1)
2. Outlet from "B" Granulator Scrubber (TP-2)

INLET TO "B" GRANULATOR SCRUBBER (TP-1)

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 20988-20

UNIT TESTED	UREA GRANULATOR SCRUBBER B
DATE AND TIME OF TEST	JANUARY 17, 1979 1200-1423 HRS
SAMPLING LOCATION	INLET DUCT
NAME OF FIRM	C. F. INDUSTRIES
LOCATION OF FIRM	DONALDSONVILLE, LA
POLLUTANTS SAMPLED	UREA, FORMALDEHYDE, AMMONIA

VOLUME OF WATER IN IMPINGERS BACK CALCULATED FROM SEPARATE MOISTURE RUN DETERMINATION BECAUSE LAB UREA AND AMMONIA ANALYSIS DATA FOR THE TEST RUNS IS NOT APPLICABLE TO THE CORRECTION OF THE IMPINGER WEIGHT GAIN DATA FOR THESE TESTS.

BAROMETRIC PRESSURE, IN HG		30.39
DUCT AREA, SQ FT		13.36
NOZZLE DIAMETER, IN		0.188
PITOT CALIBRATION COEFFICIENTS	1	0.820
	2	0.834
	3	0.823
DRY GAS METER CALIBRATION FACTOR, Y		1.000
FINAL LEAK RATE, CFM		0.002
TONS PER HOUR, PRODUCT		0.000

COMPOSITION OF DUCT GAS, % BY VOLUME DRY BASIS

CARBON DIOXIDE	0.00
OXYGEN	20.50
CARBON MONOXIDE	0.00
NITROGEN	79.50

UREA, AMMONIA, FORMALDEHYDE COLLECTED, MG

	UREA	AMMONIA-DIR	AMMONIA-DIST	FORMALDEHYDE
420 IMPINGERS	0.2390E 05	0.3020E 03	0.7780E 03	0.2350E 01
42504 IMPINGERS	0.1500E 02	0.1090E 03	0.1100E 03	0.4260E 00
TOTAL	0.2392E 05	0.4100E 03	0.8880E 03	0.2476E 01

AMOUNT OF WATER COLLECTED, GRAMS

IMPINGERS	19.1
SILICA GEL	11.9

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82989-2C

POINT	TIME	VEL HEAD IN H20	ORIFICE PRESS IN H20	METER INLET DEG F	TEMPS EXIT DEG F	DUCT STAT PRESS IN H20	DUCT TEMP DEG F	INITIAL METER VOL CU FT	P R B	CYC AVG
1	3.0	0.3800	0.3900	72.	71.	-2.30	188.	120.64	1	0.
2	3.0	0.5400	0.5500	73.	71.	-2.30	189.	121.82	1	0.
3	3.0	0.5300	0.5400	72.	72.	-2.30	195.	123.05	1	0.
4	3.0	0.9800	0.9900	72.	73.	-2.30	180.	124.28	1	0.
5	3.0	1.0500	1.0800	71.	73.	-2.30	186.	126.35	1	0.
6	3.0	1.3000	1.3300	71.	73.	-2.30	196.	128.05	1	0.
7	3.0	1.3500	1.4000	71.	72.	-2.30	196.	129.92	1	0.
8	3.0	1.3500	1.4000	71.	73.	-2.30	196.	131.91	1	0.
9	3.0	1.4000	1.4200	71.	73.	-2.30	195.	133.87	1	0.
10	3.0	1.2500	1.2800	71.	73.	-2.30	196.	135.81	1	0.
11	3.0	1.1500	1.1800	72.	74.	-2.30	197.	137.69	1	0.
12	3.0	1.1000	1.1100	72.	72.	-2.30	197.	139.50	1	0.
13	3.0	1.1500	1.1800	72.	73.	-2.30	196.	141.22	1	0.
14	3.0	1.1500	1.1800	72.	74.	-2.30	197.	143.00	1	0.
15	3.0	1.1500	1.1800	72.	74.	-2.30	197.	144.77	1	0.
16	3.0	1.2000	1.2100	72.	74.	-2.30	197.	146.60	1	0.
17	3.0	1.1500	1.1800	72.	74.	-2.30	197.	148.37	1	0.
18	3.0	1.1000	1.1200	72.	74.	-2.30	196.	150.15	1	0.
1	3.0	0.5200	0.5300	72.	73.	-2.70	153.	151.92	1	0.
2	3.0	1.0000	1.0000	71.	73.	-2.70	153.	153.36	1	0.
3	3.0	1.1500	1.1800	71.	73.	-2.70	180.	155.04	1	0.
4	3.0	1.2000	1.2200	71.	73.	-2.70	195.	156.77	1	0.
5	3.0	1.2000	1.2200	71.	72.	-2.70	196.	158.58	1	0.
6	3.0	1.2000	1.2200	71.	72.	-2.70	196.	160.40	1	0.
7	3.0	1.2000	1.2200	71.	72.	-2.70	197.	162.22	1	0.
8	3.0	1.2500	1.2800	71.	73.	-2.70	196.	164.04	1	0.
9	3.0	1.2500	1.2800	71.	72.	-2.70	196.	165.91	1	0.
10	3.0	1.1000	1.1200	71.	73.	-2.70	196.	167.80	1	0.
11	3.0	1.1500	1.1800	71.	73.	-2.70	197.	169.55	1	0.
12	3.0	1.1000	1.1200	71.	73.	-2.70	196.	171.32	1	0.
13	3.0	1.1000	1.1200	71.	73.	-2.70	196.	173.07	1	0.
14	3.0	1.1000	1.1200	71.	73.	-2.70	196.	174.85	1	0.
15	3.0	1.0500	1.0800	71.	73.	-2.70	196.	176.56	1	0.
16	3.0	1.0500	1.0800	71.	73.	-2.70	196.	178.25	1	0.
17	3.0	0.9300	0.9500	71.	72.	-2.70	195.	179.94	1	0.
18	3.0	0.9300	0.9500	71.	73.	-2.70	195.	182.10	1	0.
FINAL METER VOLUME								183.17		

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82983-20

C. F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 INLET DUCT
JANUARY 17, 1979 1200-1423 HRS

STANDARD CONDITION TEMPERATURE, DEG F	0.6800E 02
STANDARD CONDITION PRESSURE, IN HG	0.2992E 02
TOTAL SAMPLING TIME, MINUTES	0.1080E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP .5	0.1030E 01
AVERAGE ORIFICE PRESSURE DROP, IN H2O	0.1100E 01
AVERAGE METER TEMPERATURE, DEG F	0.7217E 02
AVERAGE DUCT STATIC PRESSURE, IN H2O	-0.2500E 01
AVERAGE DUCT TEMPERATURE, DEG F	0.1921E 03
TOTAL SAMPLE VOLUME, DACF	0.6253E 02
TOTAL SAMPLE VOLUME, DSCF	0.6318E 02
WATER VAPOR VOLUME, DSCF	0.1459E 01
MOISTURE CONTENT OF DUCT GAS, PERCENT	0.2257E 01
MOLE FRACTION DRY GAS	0.9774E 00
MOLECULAR WEIGHT - DRY STACK GAS	0.2882E 02
MOLECULAR WEIGHT - STACK GAS	0.2858E 02
AVERAGE STACK PRESSURE, IN HG	0.3021E 02
DUCT VOLUMETRIC FLOW, ACFM	0.5020E 05
DUCT VOLUMETRIC FLOW, DSCFM	0.4018E 05
AVERAGE DUCT VELOCITY, FPM	0.3765E 04
EXCESS AIR, PERCENT	0.4201E 04
AVERAGE DUCT GAS DENSITY, LBS/ACF	0.6062E-01
ISOKINETIC FACTOR, PERCENT	0.1014E 03

EMISSION DATA

	GR/ ACF	GR/ DSCF	LBS/ HR
UREA IN H2O	0.4664E 01	0.5838E 01	0.2011E 04
UREA IN H2SO4	0.2927E-02	0.3663E-02	0.1262E 01
TOTAL UREA	0.4667E 01	0.5842E 01	0.2012E 04
AMMONIA-DIRECT-IN H2O	0.5893E-01	0.7375E-01	0.2540E 02
AMMONIA-DIRECT-IN H2SO4	0.2107E-01	0.2637E-01	0.9084E 01
TOTAL AMMONIA-DIRECT	0.8000E-01	0.1001E 00	0.3449E 02
AMMONIA-DISTILLED-IN H2O	0.1518E 00	0.1900E 00	0.6544E 02
AMMONIA-DISTILLED-IN H2SO4	0.2146E-01	0.2686E-01	0.9252E 01
TOTAL AMMONIA-DISTILLED	0.1733E 00	0.2169E 00	0.7469E 02
FORMALDEHYDE IN H2O	0.4000E-03	0.5006E-03	0.1724E 00
FORMALDEHYDE IN H2SO4	0.8312E-04	0.1040E-03	0.3583E-01
TOTAL FORMALDEHYDE	0.4831E-03	0.6047E-03	0.2083E 00

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82988-20

C. F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 INLET DUCT
JANUARY 17, 1979 1200-1422 HRS

STANDARD CONDITION TEMPERATURE, DEG C	0.2000E 02
STANDARD CONDITION PRESSURE, MM HG	0.7600E 03
TOTAL SAMPLING TIME, MINUTES	0.1080E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, MM H2O EXP.5	0.5190E 01
AVERAGE ORIFICE PRESSURE DROP, MM H2O	0.2793E 02
AVERAGE METER TEMPERATURE, DEG C	0.2231E 02
AVERAGE DUCT STATIC PRESSURE, MM H2O	-0.6350E 02
AVERAGE DUCT TEMPERATURE, DEG C	0.8995E 02
TOTAL SAMPLE VOLUME, DM3	0.1771E 01
TOTAL SAMPLE VOLUME, DNM3	0.1789E 01
WATER VAPOR VOLUME, DNM3	0.4132E-01
AVERAGE STACK GAS PRESSURE, MM HG	0.7672E 03
DUCT VOLUMETRIC FLOW, AM3/M	0.1424E 04
DUCT VOLUMETRIC FLOW, DNM3/M	0.1138E 04
AVERAGE DUCT VELOCITY, M/M	0.1147E 04
AVERAGE DUCT GAS DENSITY, KG/AM3	0.9710E 00

EMISSION DATA

	MG/AM3	MG/DNM3	KG/HR
UREA IN H2O	0.1067E 05	0.1336E 05	0.9129E 02
UREA IN H2SO4	0.6698E 01	0.8383E 01	0.5726E 00
TOTAL UREA	0.1068E 05	0.1337E 05	0.9134E 02
AMMONIA-DIRECT-IN H2O	0.1348E 03	0.1688E 03	0.1153E 02
AMMONIA-DIRECT-IN H2SO4	0.4822E 02	0.6036E 02	0.4124E 01
TOTAL AMMONIA-DIRECT	0.1831E 03	0.2291E 03	0.1566E 02
AMMONIA-DISTILLED-IN H2O	0.3474E 03	0.4348E 03	0.2971E 02
AMMONIA-DISTILLED-IN H2SO4	0.4912E 02	0.6147E 02	0.4201E 01
TOTAL AMMONIA-DISTILLED	0.3965E 03	0.4963E 03	0.3391E 02
FORMALDEHYDE IN H2O	0.9153E 00	0.1146E 01	0.7828E-01
FORMALDEHYDE IN H2SO4	0.1902E 00	0.2381E 00	0.1627E-01
TOTAL FORMALDEHYDE	0.1106E 01	0.1384E 01	0.9455E-01

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 82988-20

UNIT TESTED	UREA GRANULATOR SCRUBBER B
DATE AND TIME OF TEST	JANUARY 17, 1979 1548-1756 HRS
SAMPLING LOCATION	INLET DUCT
NAME OF FIRM	C. F. INDUSTRIES
LOCATION OF FIRM	DONALDSONVILLE, LA
POLLUTANTS SAMPLED	UREA, FORMALDEHYDE, AMMONIA

VOLUME OF WATER IN IMPINGERS BACK CALCULATED FROM SEPARATE MOISTURE RUN DETERMINATION BECAUSE LAB UREA AND AMMONIA ANALYSIS DATA FOR THE TEST RUNS IS NOT APPLICABLE TO THE CORRECTION OF THE IMPINGER WEIGHT GAIN DATA FOR THESE TESTS.

BAROMETRIC PRESSURE, IN HG		30.39
DUCT AREA, SQ FT		13.36
NOZZLE DIAMETER, IN		0.187
PITOT CALIBRATION COEFFICIENTS	1	0.820
	2	0.834
	3	0.823
DRY GAS METER CALIBRATION FACTOR, Y		1.000
FINAL LEAK RATE, CFM		0.003
TONS PER HOUR, PRODUCT		0.000

COMPOSITION OF DUCT GAS, % BY VOLUME DRY BASIS

CARBON DIOXIDE	0.00
OXYGEN	20.50
CARBON MONOXIDE	0.00
NITROGEN	79.50

UREA, AMMONIA, FORMALDEHYDE COLLECTED, MG

	UREA	AMMONIA-OIR	AMMONIA-DIST	FORMALDEHYDE
H2O IMPINGERS	0.2606E 05	0.3910E 03	0.3900E 03	0.1510E 01
H2SO4 IMPINGERS	0.2700E 02	0.5010E 02	0.5120E 02	0.3800E-01
TOTAL	0.2609E 05	0.4411E 03	0.9412E 03	0.1548E 01

AMOUNT OF WATER COLLECTED, GRAMS

IMPINGERS	18.5
SILICA GEL	13.8

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
IRC PROJECT 82988-20

POINT	TIME	VEL HEAD IN H20	ORIFICE PRESS IN H20	METER INLET DEG F	TEMPS EXIT DEG F	DUCT STAT PRESS IN H20	DUCT TEMP DEG F	INITIAL METER VOL CU FT	P R B	CYC ANG
1	3.0	1.0500	1.0800	70.	70.	-2.70	191.	183.33	3	0.
2	3.0	1.0500	1.0800	70.	70.	-2.70	193.	185.05	3	0.
3	3.0	1.0500	1.0800	70.	71.	-2.70	194.	186.77	3	0.
4	3.0	1.1500	1.1800	70.	71.	-2.70	194.	188.49	3	0.
5	3.0	1.1500	1.1800	70.	71.	-2.70	195.	190.30	3	0.
6	3.0	1.1500	1.1800	70.	71.	-2.70	194.	192.10	3	0.
7	3.0	1.2000	1.2200	70.	71.	-2.70	196.	193.98	3	0.
8	3.0	1.2000	1.2200	70.	71.	-2.70	196.	195.74	3	0.
9	3.0	1.2000	1.2200	70.	71.	-2.70	197.	197.60	3	0.
10	3.0	1.2000	1.2200	70.	71.	-2.70	196.	199.48	3	0.
11	3.0	1.2000	1.2200	70.	71.	-2.70	197.	201.28	3	0.
12	3.0	1.2000	1.2200	70.	71.	-2.70	197.	203.13	3	0.
13	3.0	1.2500	1.2900	70.	71.	-2.70	194.	204.96	3	0.
14	3.0	1.2500	1.2900	70.	71.	-2.70	195.	206.87	3	0.
15	3.0	1.1500	1.1800	70.	71.	-2.70	189.	208.75	3	0.
16	3.0	1.0500	1.0800	70.	71.	-2.70	185.	210.57	3	0.
17	3.0	0.7600	0.7800	70.	71.	-2.70	170.	212.30	3	0.
18	3.0	0.7600	0.7800	70.	71.	-2.70	130.	213.79	3	0.
1	3.0	1.1000	1.1200	69.	70.	-2.70	189.	215.33	3	0.
2	3.0	1.1500	1.1800	69.	70.	-2.70	196.	217.86	3	0.
3	3.0	1.2000	1.2200	69.	70.	-2.70	196.	219.66	3	0.
4	3.0	1.2000	1.2200	69.	70.	-2.70	196.	221.50	3	0.
5	3.0	1.1000	1.1200	69.	70.	-2.70	196.	223.32	3	0.
6	3.0	1.1500	1.1800	69.	69.	-2.70	197.	225.07	3	0.
7	3.0	1.1000	1.1200	68.	69.	-2.70	196.	226.87	3	0.
8	3.0	1.0500	1.0800	68.	69.	-2.70	196.	223.65	3	0.
9	3.0	1.2000	1.2200	68.	69.	-2.70	197.	230.42	3	0.
10	3.0	1.2500	1.2900	67.	69.	-2.70	197.	232.20	3	0.
11	3.0	1.2500	1.2900	67.	69.	-2.70	196.	234.20	3	0.
12	3.0	1.2500	1.2900	67.	69.	-2.70	197.	236.01	3	0.
13	3.0	1.1500	1.1800	68.	69.	-2.70	196.	237.91	3	0.
14	3.0	1.1000	1.1200	68.	69.	-2.70	193.	239.72	3	0.
15	3.0	1.0500	1.0800	68.	69.	-2.70	191.	241.53	3	0.
16	3.0	0.9800	1.0000	69.	70.	-2.70	192.	243.29	3	0.
17	3.0	0.9800	1.0000	70.	70.	-2.70	184.	245.00	3	0.
18	3.0	0.9800	1.0000	71.	72.	-2.70	140.	246.63	3	0.

FINAL METER VOLUME 248.31

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 82988-20

C. F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 INLET DUCT
JANUARY 17, 1979 1548-1756 HRS

STANDARD CONDITION TEMPERATURE, DEG F	0.6900E 02
STANDARD CONDITION PRESSURE, IN HG	0.2992E 02
TOTAL SAMPLING TIME, MINUTES	0.1080E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP .5	0.1056E 01
AVERAGE ORIFICE PRESSURE DROP, IN H2O	0.1145E 01
AVERAGE METER TEMPERATURE, DEG F	0.6974E 02
AVERAGE DUCT STATIC PRESSURE, IN H2O	-0.2700E 01
AVERAGE DUCT TEMPERATURE, DEG F	0.1902E 03
TOTAL SAMPLE VOLUME, DACF	0.6498E 02
TOTAL SAMPLE VOLUME, DSCF	0.6597E 02
WATER VAPOR VOLUME, DSCF	0.1520E 01
MOISTURE CONTENT OF DUCT GAS, PERCENT	0.2253E 01
MOLE FRACTION DRY GAS	0.9775E 00
MOLECULAR WEIGHT - DRY STACK GAS	0.2982E 02
MOLECULAR WEIGHT - STACK GAS	0.2958E 02
AVERAGE STACK PRESSURE, IN HG	0.3019E 02
DUCT VOLUMETRIC FLOW, ACFM	0.5170E 05
DUCT VOLUMETRIC FLOW, DSCFM	0.4141E 05
AVERAGE DUCT VELOCITY, FPM	0.3870E 04
EXCESS AIR, PERCENT	0.4201E 04
AVERAGE DUCT GAS DENSITY, LBS/ACF	0.6077E-01
ISOKINETIC FACTOR, PERCENT	0.1034E 03

EMISSION DATA

	GR/ ACF	GR/ DSCF	LBS/ HR
UREA IN H2O	0.4883E 01	0.6096E 01	0.2164E 04
UREA IN H2SO4	0.5058E-02	0.6315E-02	0.2241E 01
TOTAL UREA	0.4888E 01	0.6103E 01	0.2166E 04
AMMONIA-DIRECT-IN H2O	0.7325E-01	0.9146E-01	0.3246E 02
AMMONIA-DIRECT-IN H2SO4	0.9386E-02	0.1172E-01	0.4159E 01
TOTAL AMMONIA-DIRECT	0.8264E-01	0.1032E 00	0.3662E 02
AMMONIA-DISTILLED-IN H2O	0.1667E 00	0.2082E 00	0.7388E 02
AMMONIA-DISTILLED-IN H2SO4	0.9592E-02	0.1198E-01	0.4250E 01
TOTAL AMMONIA-DISTILLED	0.1763E 00	0.2202E 00	0.7813E 02
FORMALDEHYDE IN H2O	0.2829E-03	0.3532E-03	0.1254E 00
FORMALDEHYDE IN H2SO4	0.7119E-05	0.8888E-05	0.3155E-02
TOTAL FORMALDEHYDE	0.2900E-03	0.3621E-03	0.1285E 00

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 82988-20

C. F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 INLET DUCT
JANUARY 17, 1979 1546-1756 HRS

STANDARD CONDITION TEMPERATURE, DEG C	0.2000E 02
STANDARD CONDITION PRESSURE, MM HG	0.7600E 03
TOTAL SAMPLING TIME, MINUTES	0.1080E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, MM H2O EXP.5	0.5322E 01
AVERAGE ORIFICE PRESSURE DROP, MM H2O	0.2908E 02
AVERAGE METER TEMPERATURE, DEG C	0.2096E 02
AVERAGE DUCT STATIC PRESSURE, MM H2O	-0.6858E 02
AVERAGE DUCT TEMPERATURE, DEG C	0.8790E 02
TOTAL SAMPLE VOLUME, DM3	0.1840E 01
TOTAL SAMPLE VOLUME, DNM3	0.1868E 01
WATER VAPOR VOLUME, DNM3	0.4306E-01
AVERAGE STACK GAS PRESSURE, MM HG	0.7669E 03
DUCT VOLUMETRIC FLOW, AM3/M	0.1464E 04
DUCT VOLUMETRIC FLOW, DNM3/M	0.1173E 04
AVERAGE DUCT VELOCITY, M/M	0.1179E 04
AVERAGE DUCT GAS DENSITY, KG/AM3	0.9734E 00

EMISSION DATA

	MG/ AM3	MG/ DNM3	KG/ HR
UREA IN H2O	0.1117E 05	0.1395E 05	0.9823E 03
UREA IN H2SO4	0.1158E 02	0.1445E 02	0.1018E 01
TOTAL UREA	0.1119E 05	0.1397E 05	0.9833E 03
AMMONIA-DIRECT-IN H2O	0.1676E 03	0.2093E 03	0.1474E 02
AMMONIA-DIRECT-IN H2SO4	0.2148E 02	0.2682E 02	0.1888E 01
TOTAL AMMONIA-DIRECT	0.1891E 03	0.2361E 03	0.1662E 02
AMMONIA-DISTILLED-IN H2O	0.3816E 03	0.4764E 03	0.3354E 02
AMMONIA-DISTILLED-IN H2SO4	0.2195E 02	0.2741E 02	0.1930E 01
TOTAL AMMONIA-DISTILLED	0.4035E 03	0.5038E 03	0.3547E 02
FORMALDEHYDE IN H2O	0.6474E 00	0.8083E 00	0.3691E-01
FORMALDEHYDE IN H2SO4	0.1629E-01	0.2034E-01	0.1432E-02
TOTAL FORMALDEHYDE	0.6637E 00	0.8286E 00	0.3834E-01

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
IRC PROJECT 82988-20

UNIT TESTED	UREA GRANULATOR SCRUBBER B
DATE AND TIME OF TEST	JANUARY 18, 1979 0947-1210 HRS
SAMPLING LOCATION	INLET DUCT
NAME OF FIRM	C. F. INDUSTRIES
LOCATION OF FIRM	DONALDSONVILLE, LA
POLLUTANTS SAMPLED	UREA, FORMALDEHYDE, AMMONIA

VOLUME OF WATER IN IMPINGERS BACK CALCULATED FROM SEPARATE MOISTURE RUN DETERMINATION BECAUSE LAB UREA AND AMMONIA ANALYSIS DATA FOR THE TEST RUNS IS NOT APPLICABLE TO THE CORRECTION OF THE IMPINGER WEIGHT GAIN DATA FOR THESE TESTS.

BAROMETRIC PRESSURE, IN HG		30.27
DUCT AREA, SQ FT		13.36
NOZZLE DIAMETER, IN		0.187
PITOT CALIBRATION COEFFICIENTS	1	0.820
	2	0.834
	3	0.823
DRY GAS METER CALIBRATION FACTOR, Y		1.000
FINAL LEAK RATE, CFM		0.001
TONS PER HOUR, PRODUCT		0.000

COMPOSITION OF DUCT GAS, % BY VOLUME DRY BASIS

CARBON DIOXIDE	0.00
OXYGEN	20.50
CARBON MONOXIDE	0.00
NITROGEN	79.50

UREA, AMMONIA, FORMALDEHYDE COLLECTED, MG

	UREA	AMMONIA-DIR	AMMONIA-DIST	FORMALDEHYDE
H2O IMPINGERS	0.2622E 05	0.4980E 03	0.9260E 03	0.3000E 01
H2SO4 IMPINGERS	0.4050E 02	0.8200E 01	0.1780E 02	0.9100E-01
TOTAL	0.2626E 05	0.5362E 03	0.9438E 03	0.3091E 01

AMOUNT OF WATER COLLECTED, GRAMS

IMPINGERS	19.1
SILICA GEL	13.5

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
TRC PROJECT 82988-20

POINT	TIME	VEL HEAD IN H20	ORIFICE PRESS IN H20	METER INLET DEG F	TEMPS EXIT DEG F	DUCT STAT PRESS IN H20	DUCT TEMP DEG F	INITIAL METER VOL CU FT	P R B	CYC AVG
1	3.0	1.3000	1.3600	60.	61.	-2.30	182.	248.50	3	0.
2	3.0	1.2000	1.2400	61.	61.	-2.30	190.	250.30	3	0.
3	3.0	1.2000	1.2400	61.	62.	-2.30	190.	252.10	3	0.
4	3.0	1.2000	1.2400	61.	62.	-2.30	190.	254.12	3	0.
5	3.0	1.1000	1.1300	62.	62.	-2.30	191.	255.94	3	0.
6	3.0	1.2000	1.2400	62.	62.	-2.30	191.	257.73	3	0.
7	3.0	1.2000	1.2400	62.	63.	-2.30	191.	259.58	3	0.
8	3.0	1.0500	1.0900	62.	63.	-2.30	191.	261.42	3	0.
9	3.0	1.1000	1.1300	63.	63.	-2.30	191.	263.13	3	0.
10	3.0	1.0000	1.0200	63.	63.	-2.30	191.	264.91	3	0.
11	3.0	1.2500	1.3000	63.	63.	-2.30	184.	266.59	3	0.
12	3.0	1.3000	1.3700	64.	64.	-2.30	195.	268.54	3	0.
13	3.0	1.2000	1.2400	63.	64.	-2.30	189.	270.47	3	0.
14	3.0	1.2000	1.2400	64.	65.	-2.30	186.	272.34	3	0.
15	3.0	1.1000	1.1300	64.	65.	-2.30	176.	274.20	3	0.
16	3.0	1.0000	1.0200	64.	65.	-2.30	164.	275.92	3	0.
17	3.0	0.9000	0.9300	65.	66.	-2.30	164.	277.93	3	0.
18	3.0	0.9000	0.9300	65.	66.	-2.30	130.	279.55	3	0.
1	3.0	1.1000	1.1300	66.	66.	-2.50	170.	281.14	3	0.
2	3.0	1.1000	1.1300	66.	68.	-2.50	184.	283.10	3	0.
3	3.0	1.1500	1.2000	67.	68.	-2.50	189.	284.90	3	0.
4	3.0	1.1000	1.1300	67.	68.	-2.50	189.	286.70	3	0.
5	3.0	1.1000	1.1300	67.	68.	-2.50	189.	288.49	3	0.
6	3.0	1.2000	1.2400	67.	68.	-2.50	189.	290.28	3	0.
7	3.0	1.2000	1.2400	67.	68.	-2.50	190.	292.13	3	0.
8	3.0	1.2000	1.2400	67.	66.	-2.50	191.	294.00	3	0.
9	3.0	1.2000	1.2400	67.	68.	-2.50	191.	295.84	3	0.
10	3.0	1.2000	1.2400	67.	68.	-2.50	191.	297.70	3	0.
11	3.0	1.1500	1.2000	67.	68.	-2.50	191.	299.53	3	0.
12	3.0	1.1500	1.2000	68.	68.	-2.50	190.	301.33	3	0.
13	3.0	1.1000	1.1400	68.	69.	-2.50	189.	303.15	3	0.
14	3.0	1.1000	1.1400	68.	69.	-2.50	189.	304.95	3	0.
15	3.0	1.2000	1.2400	68.	70.	-2.50	184.	306.75	3	0.
16	3.0	1.1500	1.1900	68.	70.	-2.50	181.	308.58	3	0.
17	3.0	0.9000	0.9300	69.	70.	-2.50	160.	310.41	3	0.
18	3.0	0.9000	0.9300	69.	70.	-2.50	150.	312.10	3	0.
FINAL METER VOLUME								313.68		

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
TRC PROJECT 82988-20

C. F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 INLET DUCT
JANUARY 18, 1979 C947-1210 APS

STANDARD CONDITION TEMPERATURE, DEG F	0.6800E 02
STANDARD CONDITION PRESSURE, IN HG	0.2992E 02
TOTAL SAMPLING TIME, MINUTES	0.1080E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP .5	0.1061E 01
AVERAGE ORIFICE PRESSURE DROP, IN H2O	0.1166E 01
AVERAGE METER TEMPERATURE, DEG F	0.6547E 02
AVERAGE DUCT STATIC PRESSURE, IN H2O	-0.2400E 01
AVERAGE DUCT TEMPERATURE, DEG F	0.1931E 03
TOTAL SAMPLE VOLUME, DACF	0.6518E 02
TOTAL SAMPLE VOLUME, DSCF	0.6645E 02
WATER VAPOR VOLUME, DSCF	0.1534E 01
MOISTURE CONTENT OF DUCT GAS, PERCENT	0.2257E 01
MOLE FRACTION DRY GAS	0.9774E 00
MOLECULAR WEIGHT - DRY STACK GAS	0.2882E 02
MOLECULAR WEIGHT - STACK GAS	0.2858E 02
AVERAGE STACK PRESSURE, IN HG	0.3009E 02
DUCT VOLUMETRIC FLOW, ACFM	0.5174E 05
DUCT VOLUMETRIC FLOW, DSCFM	0.4176E 05
AVERAGE DUCT VELOCITY, FPM	0.3872E 04
EXCESS AIR, PERCENT	0.4201E 04
AVERAGE DUCT GAS DENSITY, LBS/ACF	0.6124E-01
ISOKINETIC FACTOR, PERCENT	0.1033E 03

EMISSION DATA

	GR/ ACF	GR/ DSCF	LBS/ HR
UREA IN H2O	0.4914E 01	0.6089E 01	0.2179E 04
UREA IN H2SO4	0.7591E-02	0.9405E-02	0.3366E 01
TOTAL UREA	0.4922E 01	0.6099E 01	0.2182E 04
AMMONIA-DIRECT-IN H2O	0.9334E-01	0.1156E 00	0.4139E 02
AMMONIA-DIRECT-IN H2SO4	0.1537E-02	0.1904E-02	0.6815E 00
TOTAL AMMONIA-DIRECT	0.9488E-01	0.1175E 00	0.4207E 02
AMMONIA-DISTILLED-IN H2O	0.1736E 00	0.2150E 00	0.7696E 02
AMMONIA-DISTILLED-IN H2SO4	0.3336E-02	0.4133E-02	0.1479E 01
TOTAL AMMONIA-DISTILLED	0.1769E 00	0.2192E 00	0.7844E 02
FORMALDEHYDE IN H2O	0.5623E-03	0.6966E-03	0.2493E 00
FORMALDEHYDE IN H2SO4	0.1706E-04	0.2113E-04	0.7563E-02
TOTAL FORMALDEHYDE	0.5793E-03	0.7178E-03	0.2569E 00

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
TRC PROJECT 82988-20

C. F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 INLET DUCT
JANUARY 18, 1979 0947-1210 HRS

STANDARD CONDITION TEMPERATURE, DEG C	0.2000E 02
STANDARD CONDITION PRESSURE, MM HG	0.7600E 03
TOTAL SAMPLING TIME, MINUTES	0.1080E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, MM H20 EXP.5	0.5346E 01
AVERAGE ORIFICE PRESSURE DROP, MM H20	0.2961E 02
AVERAGE METER TEMPERATURE, DEG C	0.1860E 02
AVERAGE DUCT STATIC PRESSURE, MM H20	-0.6096E 02
AVERAGE DUCT TEMPERATURE, DEG C	0.3395E 02
TOTAL SAMPLE VOLUME, DM3	0.1846E 01
TOTAL SAMPLE VOLUME, DNM3	0.1882E 01
WATER VAPOR VOLUME, DNM3	0.4346E-01
AVERAGE STACK GAS PRESSURE, MM HG	0.7644E 03
DUCT VOLUMETRIC FLOW, AM3/M	0.1465E 04
DUCT VOLUMETRIC FLOW, DNM3/M	0.1183E 04
AVERAGE DUCT VELOCITY, M/M	0.1180E 04
AVERAGE DUCT GAS DENSITY, KG/AM3	0.9809E 00

EMISSION DATA

	MG/AM3	MG/DNM3	KG/HR
UREA IN H2O	0.1125E 05	0.1393E 05	0.9893E 03
UREA IN H2SO4	0.1737E 02	0.2152E 02	0.1528E 01
TOTAL UREA	0.1126E 05	0.1395E 05	0.9908E 03
AMMONIA-DIRECT-IN H2O	0.2136E 03	0.2646E 03	0.1879E 02
AMMONIA-DIRECT-IN H2SO4	0.3517E 01	0.4357E 01	0.3094E 00
TOTAL AMMONIA-DIRECT	0.2171E 03	0.2690E 03	0.1910E 02
AMMONIA-DISTILLED-IN H2O	0.3972E 03	0.4921E 03	0.3494E 02
AMMONIA-DISTILLED-IN H2SO4	0.7635E 01	0.9459E 01	0.6716E 00
TOTAL AMMONIA-DISTILLED	0.4048E 03	0.5015E 03	0.3561E 02
FORMALDEHYDE IN H2O	0.1287E 01	0.1594E 01	0.1132E 00
FORMALDEHYDE IN H2SO4	0.3903E-01	0.4836E-01	0.3434E-02
TOTAL FORMALDEHYDE	0.1326E 01	0.1643E 01	0.1166E 00

OUTLET FROM "B" GRANULATOR SCRUBBER (TP-2)

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82988-20

UNIT TESTED	UREA GRANULATOR SCRUBBER B
DATE AND TIME OF TEST	JANUARY 17, 1979 1202-1416 HRS
SAMPLING LOCATION	OUTLET STACK
NAME OF FIRM	C.F. INDUSTRIES
LOCATION OF FIRM	DONALDSONVILLE, LA
POLLUTANTS SAMPLED	UREA, FORMALDEHYDE, AMMONIA

BAROMETRIC PRESSURE, IN HG		30.40
DUCT AREA, SQ FT		19.63
NOZZLE DIAMETER, IN		0.257
PITOT CALIBRATION COEFFICIENTS	1	0.820
	2	0.834
	3	0.823
DRY GAS METER CALIBRATION FACTOR, Y		1.000
FINAL LEAK RATE, CFM		0.000
TONS PER HOUR, PRODUCT		0.000

COMPOSITION OF DUCT GAS, % BY VOLUME DRY BASIS

CARBON DIOXIDE	0.00
OXYGEN	20.50
CARBON MONOXIDE	0.00
NITROGEN	79.50

UREA, AMMONIA, FORMALDEHYDE COLLECTED, MG

	UREA	AMMONIA-DIR	AMMONIA-DIST	FORMALDEHYDE
H2O IMPINGERS	0.6590E 02	0.2180E 03	0.2060E 03	0.2110E 01
H2SO4 IMPINGERS	0.4700E 01	0.2320E 03	0.2320E 03	0.4310E 00
TOTAL	0.7060E 02	0.4500E 03	0.4380E 03	0.2541E 01

AMOUNT OF WATER COLLECTED, GRAMS

IMPINGERS	105.3
SILICA GEL	22.0

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82988-20

POINT	TIME	VEL HEAD IN H20	ORIFICE PRESS IN H20	METER INLET DEG F	TEMPS EXIT DEG F	DUCT STAT PRESS IN H20	DUCT TEMP DEG F	INITIAL METER VOL CU FT	P R B	CYC AVG
1	5.0	0.6100	2.3000	69.	73.	-0.35	101.	48.91	2	0.
2	5.0	0.6000	2.2500	72.	73.	-0.35	99.	53.00	2	0.
3	5.0	0.6500	2.4500	72.	72.	-0.35	99.	57.12	2	0.
4	5.0	0.6500	2.4500	72.	72.	-0.35	99.	61.63	2	0.
5	5.0	0.6800	2.6000	71.	72.	-0.35	98.	65.93	2	0.
6	5.0	0.6800	2.6000	71.	72.	-0.35	101.	70.50	2	0.
7	5.0	0.6000	2.2500	72.	72.	-0.35	102.	75.05	2	0.
8	5.0	0.6100	2.3000	71.	71.	-0.35	103.	79.37	2	0.
9	5.0	0.4700	1.7900	71.	72.	-0.35	103.	83.70	2	0.
10	5.0	0.4800	1.8200	71.	71.	-0.35	103.	88.30	2	0.
11	5.0	0.4000	1.5100	71.	72.	-0.35	103.	91.90	2	0.
12	5.0	0.4200	1.6000	71.	72.	-0.35	103.	95.50	2	0.
1	5.0	0.5500	2.1000	72.	72.	-0.35	98.	99.23	2	0.
2	5.0	0.6000	2.2500	71.	72.	-0.35	98.	103.14	2	0.
3	5.0	0.6100	2.3000	71.	71.	-0.35	98.	107.60	2	0.
4	5.0	0.6300	2.3800	71.	71.	-0.35	100.	111.90	2	0.
5	5.0	0.6900	2.6200	71.	72.	-0.35	98.	116.30	2	0.
6	5.0	0.6700	2.5500	71.	72.	-0.35	98.	120.71	2	0.
7	5.0	0.6200	2.3200	71.	72.	-0.35	101.	125.45	2	0.
8	5.0	0.6200	2.3200	71.	72.	-0.35	103.	130.40	2	0.
9	5.0	0.5500	2.0800	71.	72.	-0.35	102.	134.20	2	0.
10	5.0	0.5500	2.0800	71.	72.	-0.35	102.	138.39	2	0.
11	5.0	0.4000	1.5100	71.	72.	-0.35	101.	142.54	2	0.
12	5.0	0.4000	1.5100	71.	72.	-0.35	99.	146.20	2	0.
FINAL METER VOLUME								149.95		

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82988-20

C.F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 OUTLET STACK
JANUARY 17, 1979 1202-1416 HRS

STANDARD CONDITION TEMPERATURE, DEG F	0.6800E 02
STANDARD CONDITION PRESSURE, IN HG	0.2992E 02
TOTAL SAMPLING TIME, MINUTES	0.1200E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP .5	0.7540E 00
AVERAGE ORIFICE PRESSURE DROP, IN H2O	0.2164E 01
AVERAGE METER TEMPERATURE, DEG F	0.7152E 02
AVERAGE DUCT STATIC PRESSURE, IN H2O	-0.3500E 00
AVERAGE DUCT TEMPERATURE, DEG F	0.1005E 03
TOTAL SAMPLE VOLUME, DACF	0.1010E 03
TOTAL SAMPLE VOLUME, DSCF	0.1025E 03
WATER VAPOR VOLUME, DSCF	0.5992E 01
MOISTURE CONTENT OF DUCT GAS, PERCENT	0.5522E 01
MOLE FRACTION DRY GAS	0.9448E 00
MOLECULAR WEIGHT - DRY STACK GAS	0.2882E 02
MOLECULAR WEIGHT - STACK GAS	0.2822E 02
AVERAGE STACK PRESSURE, IN HG	0.3037E 02
DUCT VOLUMETRIC FLOW, ACFM	0.5120E 05
DUCT VOLUMETRIC FLOW, DSCFM	0.4626E 05
AVERAGE DUCT VELOCITY, FPM	0.2608E 04
EXCESS AIR, PERCENT	0.4201E 04
AVERAGE DUCT GAS DENSITY, LBS/ACF	0.7005E-01
ISOKINETIC FACTOR, PERCENT	0.1007E 03

EMISSION DATA

	GR/ ACF	GR/ DSCF	LBS/ HR
UREA IN H2O	0.8962E-02	0.9919E-02	0.3932E 01
UREA IN H2SO4	0.6392E-03	0.7074E-03	0.2805E 00
TOTAL UREA	0.9601E-02	0.1063E-01	0.4213E 01
AMMONIA-DIRECT-IN H2O	0.2965E-01	0.3281E-01	0.1301E 02
AMMONIA-DIRECT-IN H2SO4	0.3155E-01	0.3492E-01	0.1384E 02
TOTAL AMMONIA-DIRECT	0.6120E-01	0.6773E-01	0.2685E 02
AMMONIA-DISTILLED-IN H2O	0.2801E-01	0.3101E-01	0.1229E 02
AMMONIA-DISTILLED-IN H2SO4	0.3155E-01	0.3492E-01	0.1384E 02
TOTAL AMMONIA-DISTILLED	0.5956E-01	0.6593E-01	0.2614E 02
FORMALDEHYDE IN H2O	0.2869E-03	0.3176E-03	0.1259E 00
FORMALDEHYDE IN H2SO4	0.5861E-04	0.6487E-04	0.2572E-01
TOTAL FORMALDEHYDE	0.3456E-03	0.3825E-03	0.1516E 00

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 1
TRC PROJECT 82988-20

C.F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 OUTLET STACK
JANUARY 17, 1979 1202-1416 HRS

STANDARD CONDITION TEMPERATURE, DEG C	0.2000E 02
STANDARD CONDITION PRESSURE, MM HG	0.7600E 03
TOTAL SAMPLING TIME, MINUTES	0.1200E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, MM H20 EXP.5	0.3800E 01
AVERAGE ORIFICE PRESSURE DROP, MM H20	0.5497E 02
AVERAGE METER TEMPERATURE, DEG C	0.2196E 02
AVERAGE DUCT STATIC PRESSURE, MM H20	-0.8890E 01
AVERAGE DUCT TEMPERATURE, DEG C	0.3906E 02
TOTAL SAMPLE VOLUME, DM3	0.2861E 01
TOTAL SAMPLE VOLUME, DNM3	0.2703E 01
WATER VAPOR VOLUME, DNM3	0.1697E 00
AVERAGE STACK GAS PRESSURE, MM HG	0.7715E 03
DUCT VOLUMETRIC FLOW, AM3/M	0.1450E 04
DUCT VOLUMETRIC FLOW, DNM3/M	0.1310E 04
AVERAGE DUCT VELOCITY, M/M	0.7949E 03
AVERAGE DUCT GAS DENSITY, KG/AM3	0.1122E 01

EMISSION DATA

	MG/ AM3	MG/ DNM3	KG/ HR
UREA IN H20	0.2051E 02	0.2270E 02	0.1785E 01
UREA IN H2SO4	0.1463E 01	0.1619E 01	0.1273E 00
TOTAL UREA	0.2197E 02	0.2432E 02	0.1913E 01
AMMONIA-DIRECT-IN H20	0.6784E 02	0.7509E 02	0.5906E 01
AMMONIA-DIRECT-IN H2SO4	0.7220E 02	0.7991E 02	0.6285E 01
TOTAL AMMONIA-DIRECT	0.1400E 03	0.1550E 03	0.1219E 02
AMMONIA-DISTILLED-IN H20	0.6411E 02	0.7095E 02	0.5581E 01
AMMONIA-DISTILLED-IN H2SO4	0.7220E 02	0.7991E 02	0.6285E 01
TOTAL AMMONIA-DISTILLED	0.1363E 03	0.1509E 03	0.1187E 02
FORMALDEHYDE IN H20	0.6566E 00	0.7268E 00	0.5716E-01
FORMALDEHYDE IN H2SO4	0.1341E 00	0.1485E 00	0.1168E-01
TOTAL FORMALDEHYDE	0.7908E 00	0.8752E 00	0.6884E-01

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 82988-20

UNIT TESTED	UREA GRANULATOR SCRUBBER B
DATE AND TIME OF TEST	JANUARY 17, 1979 1549-1753 HRS
SAMPLING LOCATION	OUTLET STACK
NAME OF FIRM	C.F. INDUSTRIES
LOCATION OF FIRM	DONALDSONVILLE, LA
POLLUTANTS SAMPLED	UREA, FORMALDEHYDE, AMMONIA

BAROMETRIC PRESSURE, IN HG		30.38
DUCT AREA, SQ FT		19.63
NOZZLE DIAMETER, IN		0.257
PITOT CALIBRATION COEFFICIENTS	1	0.820
	2	0.834
	3	0.823
DRY GAS METER CALIBRATION FACTOR, Y		1.000
FINAL LEAK RATE, CFM		0.000
TONS PER HOUR, PRODUCT		0.000

COMPOSITION OF DUCT GAS, % BY VOLUME DRY BASIS

CARBON DIOXIDE	0.00
OXYGEN	20.50
CARBON MONOXIDE	0.00
NITROGEN	79.50

UREA, AMMONIA, FORMALDEHYDE COLLECTED, MG

	UREA	AMMONIA-DIR	AMMONIA-DIST	FORMALDEHYDE
H2O IMPINGERS	0.6580E 02	0.3710E 03	0.1830E 03	0.1140E 01
H2SO4 IMPINGERS	0.7300E 01	0.3230E 03	0.2430E 03	0.3600E-01
TOTAL	0.7310E 02	0.6940E 03	0.4260E 03	0.1176E 01

AMOUNT OF WATER COLLECTED, GRAMS

IMPINGERS	112.1
SILICA GEL	20.6

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 82958-20

POINT	TIME	VEL HEAD IN H20	ORIFICE PRESS IN H20	METER INLET DEG F	TEMPS EXIT DEG F	DUCT STAT PRESS IN H20	DUCT TEMP DEG F	INITIAL METER VOL CU FT	P R B	CYC ANG
1	5.0	0.5800	2.2000	73.	74.	-0.31	100.	150.10	2	0.
2	5.0	0.5800	2.2000	71.	72.	-0.31	100.	154.20	2	0.
3	5.0	0.6500	2.4500	70.	72.	-0.31	102.	158.60	2	0.
4	5.0	0.6500	2.4500	70.	72.	-0.31	102.	162.90	2	0.
5	5.0	0.6700	2.5200	70.	72.	-0.31	101.	167.32	2	0.
6	5.0	0.6700	2.5200	70.	71.	-0.31	102.	171.89	2	0.
7	5.0	0.5600	2.1100	70.	71.	-0.31	103.	176.45	2	0.
8	5.0	0.5600	2.1100	69.	71.	-0.31	102.	180.77	2	0.
9	5.0	0.4800	1.8200	69.	70.	-0.31	103.	185.00	2	0.
10	5.0	0.4700	1.7900	68.	70.	-0.31	102.	189.00	2	0.
11	5.0	0.3500	1.3200	68.	69.	-0.31	100.	193.00	2	0.
12	5.0	0.3500	1.3200	68.	69.	-0.31	99.	196.35	2	0.
1	5.0	0.5600	2.1100	67.	68.	-0.38	100.	199.88	2	0.
2	5.0	0.5800	2.2000	67.	68.	-0.38	100.	203.93	2	0.
3	5.0	0.6200	2.3000	66.	68.	-0.38	101.	208.24	2	0.
4	5.0	0.6300	2.3500	66.	67.	-0.38	100.	212.70	2	0.
5	5.0	0.6700	2.5200	65.	67.	-0.38	97.	217.20	2	0.
6	5.0	0.6800	2.5900	66.	67.	-0.38	99.	221.52	2	0.
7	5.0	0.6200	2.3000	66.	67.	-0.38	100.	226.20	2	0.
8	5.0	0.6200	2.3000	65.	66.	-0.38	102.	230.63	2	0.
9	5.0	0.5400	2.0200	65.	66.	-0.38	100.	235.02	2	0.
10	5.0	0.5400	2.0200	66.	66.	-0.38	102.	239.21	2	0.
11	5.0	0.4000	1.5100	66.	67.	-0.38	99.	243.60	2	0.
12	5.0	0.4000	1.5100	66.	67.	-0.38	100.	247.09	2	0.
FINAL METER VOLUME								250.82		

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 32938-20

C.F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 OUTLET STACK
JANUARY 17, 1979 1549-1753 HRS

STANDARD CONDITION TEMPERATURE, DEG F	0.6800E 02
STANDARD CONDITION PRESSURE, IN HG	0.2992E 02
TOTAL SAMPLING TIME, MINUTES	0.1200E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP .5	0.7948E 00
AVERAGE ORIFICE PRESSURE DROP, IN H2O	0.2106E 01
AVERAGE METER TEMPERATURE, DEG F	0.6842E 02
AVERAGE DUCT STATIC PRESSURE, IN H2O	-0.3450E 00
AVERAGE DUCT TEMPERATURE, DEG F	0.1307E 03
TOTAL SAMPLE VOLUME, DACF	0.1307E 03
TOTAL SAMPLE VOLUME, DSCF	0.1027E 03
WATER VAPOR VOLUME, DSCF	0.6246E 01
MOISTURE CONTENT OF DUCT GAS, PERCENT	0.5733E 01
MOLE FRACTION DRY GAS	0.9427E 00
MOLECULAR WEIGHT - DRY STACK GAS	0.2882E 02
MOLECULAR WEIGHT - STACK GAS	0.2820E 02
AVERAGE STACK PRESSURE, IN HG	0.3035E 02
DUCT VOLUMETRIC FLOW, ACFM	0.5062E 05
DUCT VOLUMETRIC FLOW, DSCFM	0.4559E 05
AVERAGE DUCT VELOCITY, FPM	0.2579E 04
EXCESS AIR, PERCENT	0.4201E 04
AVERAGE DUCT GAS DENSITY, LBS/ACF	0.6992E-01
ISOKINETIC FACTOR, PERCENT	0.1024E 03

EMISSION DATA

	GR/ ACF	GR/ DSCF	LBS/ HR
UREA IN H2O	0.9903E-02	0.9385E-02	0.3862E 01
UREA IN H2SO4	0.9877E-03	0.1097E-02	0.4285E 00
TOTAL UREA	0.9891E-02	0.1098E-01	0.4291E 01
AMMONIA-DIRECT-IN H2O	0.5020E-01	0.5574E-01	0.2178E 02
AMMONIA-DIRECT-IN H2SO4	0.4370E-01	0.4852E-01	0.1896E 02
TOTAL AMMONIA-DIRECT	0.9390E-01	0.1043E 00	0.4074E 02
AMMONIA-DISTILLED-IN H2O	0.2476E-01	0.2749E-01	0.1074E 02
AMMONIA-DISTILLED-IN H2SO4	0.3288E-01	0.3651E-01	0.1426E 02
TOTAL AMMONIA-DISTILLED	0.5764E-01	0.6400E-01	0.2501E 02
FORMALDEHYDE IN H2O	0.1542E-03	0.1713E-03	0.6692E-01
FORMALDEHYDE IN H2SO4	0.4871E-05	0.5408E-05	0.2113E-02
TOTAL FORMALDEHYDE	0.1591E-03	0.1767E-03	0.6903E-01

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 2
TRC PROJECT 82988-20

C.F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 OUTLET STACK
JANUARY 17, 1979 1549-1753 HRS

STANDARD CONDITION TEMPERATURE, DEG C	0.2000E 02
STANDARD CONDITION PRESSURE, MM HG	0.7600E 03
TOTAL SAMPLING TIME, MINUTES	0.1200E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, MM H20 EXP.5	0.3754E 01
AVERAGE ORIFICE PRESSURE DROP, MM H20	0.5349E 02
AVERAGE METER TEMPERATURE, DEG C	0.2023E 02
AVERAGE DUCT STATIC PRESSURE, MM H20	-0.8763E 01
AVERAGE DUCT TEMPERATURE, DEG C	0.3915E 02
TOTAL SAMPLE VOLUME, DM3	0.2952E 01
TOTAL SAMPLE VOLUME, DNM3	0.2909E 01
WATER VAPOR VOLUME, DNM3	0.1769E 00
AVERAGE STACK GAS PRESSURE, MM HG	0.7710E 03
DUCT VOLUMETRIC FLOW, AM3/M	0.1433E 04
DUCT VOLUMETRIC FLOW, DNM3/M	0.1291E 04
AVERAGE DUCT VELOCITY, M/M	0.7859E 03
AVERAGE DUCT GAS DENSITY, KG/AM3	0.1120E 01

EMISSION DATA

	MG/ AM3	MG/ DNM3	KG/ HR
UREA IN H20	0.2037E 02	0.2262E 02	0.1754E 01
UREA IN H2SO4	0.2260E 01	0.2510E 01	0.1945E 00
TOTAL UREA	0.2263E 02	0.2513E 02	0.1948E 01
AMMONIA-DIRECT-IN H20	0.1149E 03	0.1275E 03	0.9887E 01
AMMONIA-DIRECT-IN H2SO4	0.1000E 03	0.1110E 03	0.8608E 01
TOTAL AMMONIA-DIRECT	0.2149E 03	0.2386E 03	0.1849E 02
AMMONIA-DISTILLED-IN H20	0.5666E 02	0.6291E 02	0.4877E 01
AMMONIA-DISTILLED-IN H2SO4	0.7524E 02	0.8354E 02	0.6476E 01
TOTAL AMMONIA-DISTILLED	0.1319E 03	0.1465E 03	0.1135E 02
FORMALDEHYDE IN H20	0.3530E 00	0.3919E 00	0.3038E-01
FORMALDEHYDE IN H2SO4	0.1115E-01	0.1239E-01	0.9594E-03
TOTAL FORMALDEHYDE	0.3641E 00	0.4043E 00	0.3134E-01

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
TRC PROJECT 82988-20

UNIT TESTED	UREA GRANULATOR SCRUBBER B
DATE AND TIME OF TEST	JANUARY 18, 1979 0946-1217 HRS
SAMPLING LOCATION	OUTLET STACK
NAME OF FIRM	C.F. INDUSTRIES
LOCATION OF FIRM	DONALDSONVILLE, LA
POLLUTANTS SAMPLED	UREA, FORMALDEHYDE, AMMONIA

BAROMETRIC PRESSURE, IN HG		30.27
DUCT AREA, SQ FT		19.63
NOZZLE DIAMETER, IN		0.257
PITOT CALIBRATION COEFFICIENTS	1	0.820
	2	0.834
	3	0.823
DRY GAS METER CALIBRATION FACTOR, Y		1.000
FINAL LEAK RATE, CFM		0.000
TONS PER HOUR, PRODUCT		0.000

COMPOSITION OF DUCT GAS, % BY VOLUME DRY BASIS

CARBON DIOXIDE	0.00
OXYGEN	20.50
CARBON MONOXIDE	0.00
NITROGEN	79.50

UREA, AMMONIA, FORMALDEHYDE COLLECTED, MG

	UREA	AMMONIA-DIR	AMMONIA-DIST	FORMALDEHYDE
420 IMPINGERS	0.5710E 02	0.1250E 03	0.1250E 03	0.1250E 01
42504 IMPINGERS	0.5200E 01	0.2620E 03	0.2630E 03	0.4600E-01
TOTAL	0.6230E 02	0.3870E 03	0.3880E 03	0.1296E 01

AMOUNT OF WATER COLLECTED, GRAMS

IMPINGERS	110.3
SILICA GEL	18.9

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
TRC PROJECT 82988-20

POINT	TIME	VEL HEAD IN H20	ORIFICE PRESS IN H20	METER INLET DEG F	TEMPS EXIT DEG F	DUCT STAT PRESS IN H20	DUCT TEMP DEG F	INITIAL METER VOL CU FT	P R B	CYC AVG
1	5.0	0.6200	2.3000	63.	63.	-0.33	103.	251.04	2	0.
2	5.0	0.5800	2.2000	63.	63.	-0.33	101.	253.50	2	0.
3	5.0	0.6500	2.4500	63.	63.	-0.33	102.	258.70	2	0.
4	5.0	0.6500	2.4500	63.	63.	-0.33	101.	263.19	2	0.
5	5.0	0.6700	2.5100	63.	63.	-0.33	103.	267.65	2	0.
6	5.0	0.6500	2.4500	63.	63.	-0.33	104.	272.20	2	0.
7	5.0	0.5600	2.1100	63.	63.	-0.33	104.	276.65	2	0.
8	5.0	0.5600	2.1100	63.	63.	-0.33	105.	280.93	2	0.
9	5.0	0.4900	1.8400	63.	63.	-0.33	103.	285.13	2	0.
10	5.0	0.5000	1.8800	63.	63.	-0.33	104.	289.09	2	0.
11	5.0	0.3700	1.4000	63.	63.	-0.33	102.	293.02	2	0.
12	5.0	0.3700	1.4000	64.	64.	-0.33	101.	296.55	2	0.
1	5.0	0.6000	2.2500	66.	66.	-0.30	102.	300.14	2	0.
2	5.0	0.5800	2.2000	66.	66.	-0.30	101.	304.24	2	0.
3	5.0	0.6400	2.4000	66.	66.	-0.30	101.	305.95	2	0.
4	5.0	0.6500	2.4500	66.	66.	-0.30	101.	312.96	2	0.
5	5.0	0.6800	2.5800	67.	67.	-0.30	102.	317.50	2	0.
6	5.0	0.6800	2.5800	66.	66.	-0.30	101.	322.07	2	0.
7	5.0	0.6000	2.2500	66.	67.	-0.30	103.	326.71	2	0.
8	5.0	0.6000	2.2500	67.	67.	-0.30	105.	331.08	2	0.
9	5.0	0.5200	1.9500	67.	67.	-0.30	104.	335.45	2	0.
10	5.0	0.5200	1.9500	67.	67.	-0.30	103.	339.54	2	0.
11	5.0	0.4200	1.5900	68.	68.	-0.30	102.	343.58	2	0.
12	5.0	0.4200	1.5900	68.	68.	-0.30	102.	347.27	2	0.
FINAL METER VOLUME								351.11		

C.F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 OUTLET STACK
JANUARY 18, 1979 0946-1217 HRS

STANDARD CONDITION TEMPERATURE, DEG F	0.6800E 02
STANDARD CONDITION PRESSURE, IN HG	0.2992E 02
TOTAL SAMPLING TIME, MINUTES	0.1200E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, IN H20 EXP .5	0.7494E 00
AVERAGE ORIFICE PRESSURE DROP, IN H20	0.2131E 01
AVERAGE METER TEMPERATURE, DEG F	0.6490E 02
AVERAGE DUCT STATIC PRESSURE, IN H20	-0.3150E 00
AVERAGE DUCT TEMPERATURE, DEG F	0.1025E 03
TOTAL SAMPLE VOLUME, DACF	0.1001E 03
TOTAL SAMPLE VOLUME, DSCF	0.1024E 03
WATER VAPOR VOLUME, DSCF	0.6081E 01
MOISTURE CONTENT OF DUCT GAS, PERCENT	0.5609E 01
MOLE FRACTION DRY GAS	0.9439E 00
MOLECULAR WEIGHT - DRY STACK GAS	0.2882E 02
MOLECULAR WEIGHT - STACK GAS	0.2921E 02
AVERAGE STACK PRESSURE, IN HG	0.3025E 02
DUCT VOLUMETRIC FLOW, ACFM	0.5109E 05
DUCT VOLUMETRIC FLOW, DSCFM	0.4576E 05
AVERAGE DUCT VELOCITY, FPM	0.2603E 04
EXCESS AIR, PERCENT	0.4201E 04
AVERAGE DUCT GAS DENSITY, LBS/ACF	0.6948E-01
ISOKINETIC FACTOR, PERCENT	0.1016E 03

EMISSION DATA

	GR/ ACF	GR/ DSCF	LBS/ HR
UREA IN H20	0.7709E-02	0.8607E-02	0.3376E 01
UREA IN H2SO4	0.7021E-03	0.7838E-03	0.3074E 00
TOTAL UREA	0.8411E-02	0.9391E-02	0.3683E 01
AMMONIA-DIRECT-IN H20	0.1688E-01	0.1884E-01	0.7391E 01
AMMONIA-DIRECT-IN H2SO4	0.3537E-01	0.3949E-01	0.1549E 02
TOTAL AMMONIA-DIRECT	0.5225E-01	0.5833E-01	0.2288E 02
AMMONIA-DISTILLED-IN H20	0.1688E-01	0.1884E-01	0.7391E 01
AMMONIA-DISTILLED-IN H2SO4	0.3551E-01	0.3964E-01	0.1555E 02
TOTAL AMMONIA-DISTILLED	0.5239E-01	0.5848E-01	0.2294E 02
FORMALDEHYDE IN H20	0.1688E-03	0.1884E-03	0.7391E-01
FORMALDEHYDE IN H2SO4	0.6211E-05	0.6934E-05	0.2720E-02
TOTAL FORMALDEHYDE	0.1750E-03	0.1954E-03	0.7663E-01

TEST DATA -- UREA, AMMONIA, FORMALDEHYDE -- TEST NO 3
TRC PROJECT 82998-2C

C.F. INDUSTRIES
UREA GRANULATOR SCRUBBER 3 OUTLET STACK
JANUARY 18, 1979 0946-1217 HRS

STANDARD CONDITION TEMPERATURE, DEG C	0.2000E 02
STANDARD CONDITION PRESSURE, MM HG	0.7600E 03
TOTAL SAMPLING TIME, MINUTES	0.1200E 03
AVERAGE SQUARE ROOT VELOCITY HEAD, MM H20 EXP.5	0.3777E 01
AVERAGE ORIFICE PRESSURE DROP, MM H2O	0.5412E 02
AVERAGE METER TEMPERATURE, DEG C	0.1328E 02
AVERAGE DUCT STATIC PRESSURE, MM H2O	-0.8001E 01
AVERAGE DUCT TEMPERATURE, DEG C	0.3917E 02
TOTAL SAMPLE VOLUME, DM3	0.2834E 01
TOTAL SAMPLE VOLUME, DNM3	0.2899E 01
WATER VAPOR VOLUME, DNM3	0.1722E 00
AVERAGE STACK GAS PRESSURE, MM HG	0.7683E 03
DUCT VOLUMETRIC FLOW, AM3/M	0.1447E 04
DUCT VOLUMETRIC FLOW, DNM3/M	0.1296E 04
AVERAGE DUCT VELOCITY, M/M	0.7933E 03
AVERAGE DUCT GAS DENSITY, KG/AM3	0.1113E 01

EMISSION DATA

	MG/ AM3	MG/ DNM3	KG/ HR
UREA IN H2O	0.1764E 02	0.1970E 02	0.1533E 01
UREA IN H2SO4	0.1607E 01	0.1794E 01	0.1396E 00
TOTAL UREA	0.1925E 02	0.2149E 02	0.1672E 01
AMMONIA-DIRECT-IN H2O	0.3862E 02	0.4312E 02	0.3355E 01
AMMONIA-DIRECT-IN H2SO4	0.8095E 02	0.9037E 02	0.7033E 01
TOTAL AMMONIA-DIRECT	0.1196E 03	0.1335E 03	0.1039E 02
AMMONIA-DISTILLED-IN H2O	0.3862E 02	0.4312E 02	0.3355E 01
AMMONIA-DISTILLED-IN H2SO4	0.8126E 02	0.9072E 02	0.7060E 01
TOTAL AMMONIA-DISTILLED	0.1199E 03	0.1338E 03	0.1041E 02
FORMALDEHYDE IN H2O	0.3862E 00	0.4312E 00	0.3355E-01
FORMALDEHYDE IN H2SO4	0.1421E-01	0.1587E-01	0.1235E-02
TOTAL FORMALDEHYDE	0.4004E 00	0.4470E 00	0.3479E-01

APPENDIX A-2

SAMPLE EQUATIONS AND EXAMPLE CALCUALTIONS

EMISSION CALCULATION SYMBOLS

La - Allowable leak rate, cfm

Vm_{total} - Total meter sample volume, ft^3

T_{total} - Total sampling time, min

L_p - Final leak rate of sampling train, cfm

Vmc_{total} - Total volume sampled corrected for excessive leakage, ft^3

Y - Dry gas meter calibration factor, dimensionless

T_{std} - Standard temperature, ^oF

$Tm_{avg.}$ - Average dry gas meter temperature, ^oF

P_{bar} - Barometric pressure, "Hg

$\Delta H_{avg.}$ - Average orifice pressure drop, "H_2O

P_{std} - Standard pressure, "Hg

V_I - Volume of liquid collected in impingers, ml

V_{SG} - Volume of liquid collected in silica gel, grams

M_S - Molecular weight of stack gas, lb/lb-mole

$\%CO_2$ - Percent CO_2 by volume (dry basis), %

%CO - Percent CO by volume (dry basis), %

$\%N_2$ - Percent N_2 by volume (dry basis), %

$\%O_2$ - Percent O_2 by volume (dry basis), %

D_{st} - Average duct gas density, lbs/ft^3

Ps_{avg} - Average duct static pressure, "H_2O

Ts_{avg} - Average duct temperature, ^oF

EA - Excess air, %

V_s - Average duct velocity, ft/min

C_p - Pitot tube coefficient, dimensionless

$(\sqrt{\Delta P})avg$ - Average square root of velocity head, $\sqrt{"H_2O}$

A_s - Cross-sectional area of duct, ft^2

Q - Duct volumetric flow rate, acfm

Q_{std} - Duct volumetric flow rate, corrected to dry standard conditions, dscfm

D_n - Nozzle diameter, inches

F - F factor, DSCF/MM BTU

%H - Percent by weight of hydrogen in fuel

%C - Percent by weight of carbon in fuel

%S - Percent by weight of sulfur in fuel

%N - Percent by weight of nitrogen in fuel

%O - Percent by weight of oxygen in fuel

GCV - Gross calorific value of fuel, BTU/lb.

C - Actual particulate concentration, grains/acf

C_s - Particulate concentration, grains/dscf

ER - Particulate emission rate, lbs/hr

E - Particulate emissions, lbs/MM BTU

C_s @ 12% CO_2 - Particulate concentration, grains/dscf @ 12% CO_2

C_s @ 50% EA - Particulate concentration, grains/dscf @ 50% EA

C_{Lb} - Particulate concentration, lbs/1000 duct gas

C_{Lb} @ 12% CO_2 - Particulate concentration, lbs/1000 lbs @ 12% CO_2

C_{Lb} @ 50% EA - Particulate concentration, lbs/1000 lbs @ 50% EA

M_n - Total particulate collected, mg

Sample Equations and Example Calculations For
Test No. 1 Scrubber "B" Outlet

1. Allowable Leak Rate

$$La = 0.02 \text{ cfm or } 0.04 \frac{V_{m\ total}}{T_{total}} \quad \text{which ever is less.}$$

$$\frac{0.04\ V_{m\ total}}{T_{total}} = \frac{0.04 \times 102.5}{120} = 0.03$$

$$La = 0.02 \text{ cfm}$$

2. Correction for Excessive Leak Rate

$$Lp = 0.00 \text{ cfm}$$

if Lp > La use $V_{mc\ total}$ in place of $V_{m\ total}$ in all subsequent equations.

$$V_{mc\ total} = V_{m\ total} - (Lp - La)\ T_{total}$$

$$V_{mc\ total} = \quad -(\quad - \quad) \quad = \quad ft^3$$

---

3. Volume of Sample Measured by Dry Gas Meter, Corrected to Standard Conditions

$$V_{m\ total\ (std)} = V_{m\ total}\ Y \left(\frac{T_{std} + 460}{T_{m\ avg} + 460}\right) \left[\frac{P_{bar} + \frac{\Delta H\ avg}{13.6}}{P_{std}}\right]$$

$$V_{m\ total\ (std)} = 101.0 \times 1.00 \left(\frac{68 + 460}{71.5 + 460}\right) \left[\frac{30.40 + \frac{2.16}{13.6}}{29.92}\right]$$

$$V_{m\ total\ (std)} = 102.5 \text{ dscf}$$

4. Moisture Content of Duct Gas

$$\% H_2O = \frac{0.04707\ (V_I + V_{SG})}{V_{m\ total\ (std)} + 0.04707\ (V_I + V_{SG})} \times 100$$

$$\% H_2O = \frac{0.04707\ (105.3 + 22.0)}{102.5 + 0.04707\ (105.3 + 22.0)} \times 100$$

$$\% H_2O = 55 \%$$

5. Molecular Weight of Stack Gas

$$M_s = \left[(0.44 \times \%\ CO_2)+(0.28 \times \%\ CO)+(0.28 \times \%\ N_2)+(0.32 \times \%\ O_2)\right]\left(1-\frac{\%\ H_2O}{100}\right)+0.18\ (\%\ H_2O)$$

$$M_s = \left[(0.44 \times 0.0)+(0.28 \times 0.0)+(0.28 \times 79.5)+(0.32 \times 20.5)\right]\left(1-\frac{5.5}{100}\right)+0.18\ (5.5)$$

$$M_s = 28.59 \text{ lb/lb-mole}$$

6. Average Duct Gas Density

$$D_{st} = 0.0458 \times M_s \left(\frac{P_{bar} + \frac{P_{s\ avg}}{13.6}}{T_{s\ avg} + 460}\right)$$

$$D_{st} = 0.0458 \times 28.59 \left(\frac{30.40 + \frac{-0.35}{13.6}}{100.5 + 460}\right)$$

$$D_{st} = 0.0710 \text{ lbs/ft}^3$$

7. Excess Air NOT APPLICABLE

$$EA = 100\left[\frac{\%\ O_2 - 0.5\ \%\ CO}{0.264\ \%\ N_2 - (\%\ O_2 - 0.5\%\ CO)}\right]$$

$$EA = 100\left[\frac{-0.5 \times}{0.264 \times \quad - (\quad - 0.5 \times)}\right]$$

$$EA = \quad \%$$

8. Average Duct Velocity

$$V_s = 5129.4\ C_p\ (\sqrt{\Delta P})_{avg} \sqrt{\frac{T_{s\ avg} + 460}{\left(P_{bar} + \frac{P_{s\ avg}}{13.6}\right) M_s}}$$

$$V_s = 5129.4 \times 0.834 \times 0.754 \sqrt{\frac{100.5 + 460}{\left(30.40 + \frac{-0.35}{13.6}\right) 28.59}}$$

$$V_s = 2591. \text{ ft/min}$$

9. Duct Volumetric Flow Rate

$$Q = V_s \times A_s$$

$$Q = 2591. \times 19.63$$

$$Q = 50861.\ \text{acfm}$$

10. Duct Volumetric Flow Rate, Corrected to Dry Standard Conditions

$$Q_{std} = Q \left(1 - \frac{\%\ H_2O}{100}\right) \left(\frac{T_{std} + 460}{T_{s\ avg} + 460}\right) \left(\frac{P_{bar} + \frac{P_{s\ avg}}{13.6}}{P_{std}}\right)$$

$$Q_{std} = 50861. \left(1 - \frac{5.5}{100}\right) \left(\frac{68 + 460}{100.5 + 460}\right) \left(\frac{30.40 + \frac{-0.35}{13.6}}{29.92}\right)$$

$$Q_{std} = 45964.\ \text{dscfm}$$

11. Isokinetic Factor

$$I = \frac{5.67\ (T_{s\ avg} + 460)(V_{m\ std})}{\left(P_{bar} + \frac{P_{s\ avg}}{13.6}\right) V_s \times T_{total} \left(1 - \frac{\%\ H_2O}{100}\right) \left(\frac{(Dn)^2 \times 0.7854}{144}\right)}$$

$$I = \frac{5.67\ (100.5 + 460)(102.5)}{\left(30.40 + \frac{-0.35}{13.6}\right) 2591 \times 120 \left(1 - \frac{5.5}{100}\right) \left(\frac{(0.257)^2 \times 0.7854}{144}\right)}$$

$$I = 101.\ \%$$

12. F - Factor NOT APPLICABLE

$$F = \frac{10^6(3.64\%\ H + 1.53\%\ C + 0.57\%\ S + 0.14\%\ N - 0.46\%\ O)}{GCV}$$

$$F = \frac{10^6(3.64 \times \quad +1.53 \times \quad +0.57 \times \quad +0.14 \times \quad -0.46 \times \quad)}{}$$

$$F = \quad \text{DSCF/MM BTU}$$

13. Actual Particulate Concentration

$$C = \frac{0.01543 \times Mn \left(T_{std} + 460\right)\left(P_{bar} + \frac{P_{s\,avg}}{13.6}\right)\left(1 - \frac{\%H_2O}{100}\right)}{Vm_{std}\left(T_{s\,avg} + 460\right) P_{std}}$$

(UREA AMMONIA FORMALDEHYDE)

$$C = \frac{0.01543 \times \begin{pmatrix} 70.6 \\ 450.0 \\ 2.5 \end{pmatrix} (68 + 460)\left(30.40 + \frac{-0.35}{13.6}\right)\left(1 - \frac{5.5}{100}\right)}{102.5 \quad (100.5 + 460) \quad (29.92)}$$

$$C = \begin{pmatrix} 0.0096 \\ 0.0012 \\ 0.00034 \end{pmatrix} \text{grains/acf}$$

14. Particulate Concentration, Corrected to Dry Standard Conditions

$$C_s = 0.01543 \times \frac{Mn}{V_{m\,std}}$$

(UREA AMMONIA FORMALDEHYDE)

$$C_s = 0.01543 \times \frac{\begin{pmatrix} 70.6 \\ 450.0 \\ 2.5 \end{pmatrix}}{102.5}$$

$$C_s = \begin{pmatrix} 0.0106 \\ 0.0677 \\ 0.00038 \end{pmatrix} \text{grains/dscf}$$

15. Particulate Emission Rate

$$ER = 0.008571 \times C_s \times Q_{std}$$

(UREA AMMONIA FORMALDEHYDE)

$$ER = 0.008571 \times \begin{pmatrix} 0.0106 \\ 0.0677 \\ 0.00038 \end{pmatrix} \times 45964.$$

$$ER = \begin{pmatrix} 4.18 \\ 26.7 \\ 0.15 \end{pmatrix} \text{ lbs/hr.}$$

16. Particulate Emission NOT APPLICABLE

$$E = 0.0001429\ C_s \times F \left(\frac{20.9}{20.9 - \%O_2}\right)$$

$$E = 0.0001429 \times \quad \times \quad \left(\frac{20.9}{20.9 -}\right)$$

$$E = \quad \text{lbs/MM BTU}$$

17. Particulate Concentration Corrected to Dry Standard Conditions and 12% CO_2
NOT APPLICABLE

$$C_s\ @\ 12\%\ CO_2 = \frac{12}{\%\ CO_2} \times C_s$$

$$C_s\ @\ 12\%\ CO_2 = \frac{12}{\quad} \times$$

$$C_s\ @\ 12\%\ CO_2 = \quad \text{grains/dscf @ 12\% } CO_2$$

18. Particulate Concentration Corrected to Dry Standard Conditions and 50% Excess Air NOT APPLICABLE

$$C_s \text{ @ 50\% EA} = \frac{\%\text{ EA} + 100}{150} \times C_s$$

$$C_s \text{ @ 50\% EA} = \frac{+ 100}{150} \times$$

C_s @ 50% EA = grains/dscf @ 50% EA

19. Particulate Concentration Based on Duct Gas Weight

$$C_{Lb} = 0.1429 \times \frac{C}{D_{st\ avg}}$$

(UREA, AMMONIA, FORMALDEHYDE)

$$C_{Lb} = 0.1429 \times \frac{\begin{pmatrix} 0.0096 \\ 0.0612 \\ 0.00034 \end{pmatrix}}{0.0710}$$

C_{Lb} = $\begin{pmatrix} 0.019 \\ 0.123 \\ 0.00068 \end{pmatrix}$ lbs/1000 lbs duct gas (uncorrected)

20. Particulate Concentration Based on Duct Gas Weight Corrected to 12% CO_2 NOT APPLICABLE

$$C_{Lb} \text{ @ 12\% } CO_2 = \frac{C_s \text{ @ 12\% } CO_2 \times 0.104\ (T_{std} + 460)}{(0.44 \times \%\ CO_2) + (0.28(\%\ CO + \%N_2)) + (0.32 \times \%O_2)}$$

$$C_{Lb} \text{ @ 12\% } CO_2 = \frac{\times\ 0.104\ (528)}{(0.44 \times\ \ ) + (0.28(\ \ +\ \ )) + (0.32 \times\ \ )}$$

C_{Lb} @ 12% CO_2 = lbs/1000 lbs dry corrected to 12% CO_2

21. Particulate Concentration Based on Duct Gas Weight Corrected to 50% Excess Air NOT APPLICABLE

$$C_{Lb} \text{ @ 50\% EA} = \frac{C_s \text{ @ 50\% EA} \times 0.104\ (T_{std} + 460)}{(0.44 \times \%CO_2) + (0.28(\%CO + \%N_2)) + (0.32 \times \%O_2)}$$

$$C_{Lb} \text{ @ 50\% EA} = \frac{\times\ 0.104\ (528)}{(0.44 \times\ \ ) + (0.28(\ \ +\ \ .)) + (0.32 \times\ \ )}$$

C_{Lb} @ 50% EA = lbs/1000 lbs dry @ 50% EA

APPENDIX B

PARTICLE SIZE TESTS RESULTS

INCLUDES:

B-1. DISCUSSION OF PARTICLE SIZE TESTING
B-2. PARTICLE SIZE FIELD DATA SHEETS
B-3. LAB WEIGHING DATA

APPENDIX B-1

DISCUSSION OF PARTICLE SIZE TESTING

DISCUSSION OF PARTICLE SIZE TESTING

The problem of probe plugging during the particle sizing scrubber inlet tests dictated use of a 1/8" I.D. sampling nozzle. The nozzle size, therefore, governed the sampling rate through the impactor necessary to maintain isokinetic sampling conditions. If the plugging was not a problem at the scrubber inlet, it would have been preferable to use a smaller nozzle; this would have allowed a longer sampling time and a larger range of measured particle sizes.

It was not possible to plot cumulative size distribution curves because 99.9% of the particulate matter was collected in the cyclone preseparator. Therefore, it is only possible to conclude that essentially all of the particulate matter collected had diameters greater than the size cutoff of the impactor.

A Sierra Model 226 multi-stage cascade impactor was operated in its instack mode and attached directly to the front end of a standard EPA Method 5 train. Sampling was performed isokinetically, and data was recorded in much the same manner as for the EPA Method 5 train with the exception that sampling was performed at only one point (center of the inlet duct).

The impactor unit consists of a cyclone preseparator and six impactor stages followed by a built-in backup filter stage. All parts are constructed of stainless steel. The unit is designed to hold seven preweighed radially slotted glass fiber filters and one glass fiber backup filter.

An impactor with particle collector filters on each stage was used because it offered low tare weights and caused minimal particle reentrainment (compared to steel plate collection). The sampled air stream accelerates through four radial

slots on every stage. A particle will pass through each stage until it acquires sufficient momentum to impact on one of the collector filters. The backup filter is designed to capture all particulates which do not deposit on a stage filter.

The particle size cutoff for the preseparator is calculated from the manufacturer's calibration data. The cutoffs of each impactor stage depend on the operating conditions during a test. The equations used to calculate these impactor stage cutoffs are as follows:

$$D_{p,50} = (D_{p,50})r \frac{MC_r P_{pr} Q_r ½}{m_r C P_p Q}$$

Where

$D_{p,50}$ = measured particle dia, μm

r = calibration values from impactor manual

η = gas viscosity, micropoise

C = Cunningham slip correction factor, dimensionless

ρ_p = particle mass density, gm/cc

Q = volumetric flow rate, acfm

and

$$\mu = \frac{BT^{3/2}}{T + S}$$

where

B = 14.58 μg $sec^{-1} cm^{-1} (°K)^{-½}$

S = 110.4° K

T = °K

and

$$C = 1 + \frac{2\lambda}{d}(\{.257 + 0.400 \exp \{-1.10d/2\lambda\})$$

Where

d = particle diam, μm

λ = mean free path, μm

and

$$\lambda = 112.96 \frac{n}{p} \frac{T}{m}^{1/2}$$

where

T = gas temp, °K = °C + 273

P = pressure, atmospheres

m = gas molecular wt (wet), g/g-mole.

Note that graviational constant, gc, is not shown

and

$$Q = \frac{Vm}{DGF} \frac{Ts}{Ps} \frac{Pm}{Tm} \frac{1}{5}$$

where

Q = volumetric flow rate through impactor, acfm

Vm = dry gas meter volume, ft^3

DGF = dry gas fraction

Ts = stack temp, °R

Ps = stack pressure, "Hg

Tm = meter temp, °R

Pm = meter press., "Hg

t = time, min.

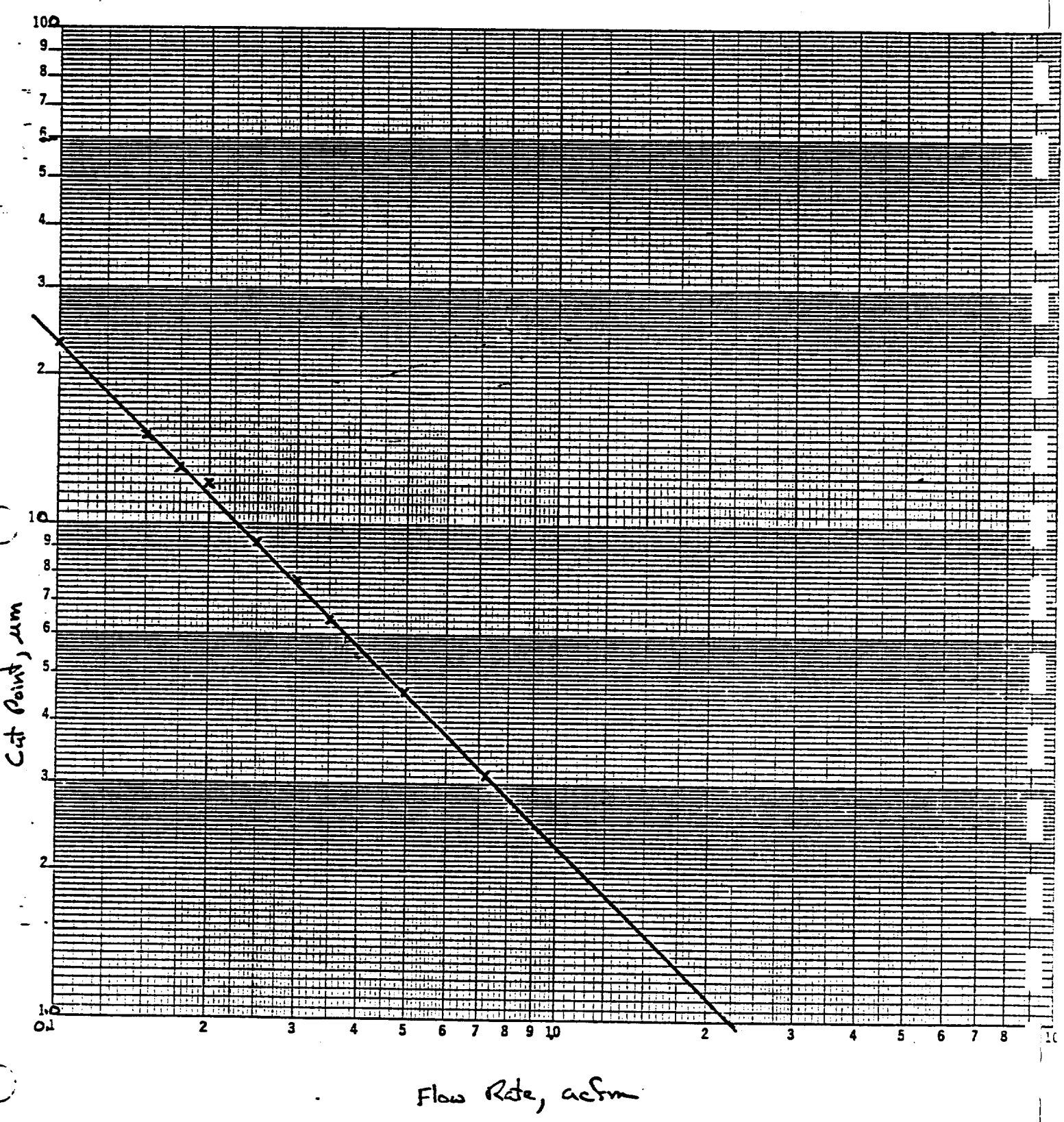
and

DSF = $1 - \%H_2O/100$

The cutoff size for the cyclone preseparator was determined from Figure B1-1. The actual stack flow rate, Q_{acfm}, used to determine the cutoff size, was

figure B1-1

Sierra 220 Cyclone Preseparator cut points as a function of flow rate*



* data from Sierra Bulletin No. 678-220 and Sierra Series 210 Cascade Impactor Cut Points sheet dated April 1, 1978.

Logarithmic, 2 x 2 Cycles

calculated by a computer program, whose results are presented in Table B1-1.

The cascade impactor determines aerodynamic particle size distribution. Aerodynamic particle sizing differs from geometric sizing in that a mass of particles containing various shapes and densities is fractionated and collected according to each particles aerodynamic characteristics. A particle collected on a given stage is aerodynamically equivalent in size to the unit density sphere (1g/cc) collected on that stage during calibration.

Particle size distributions are normally plotted cumulatively on log-normal graph paper. In this format, the mass of particulate collected on a given stage and all stages of smaller Dp is plotted against the Dp of that stage as a percent of the total mass of particulate collected on all stages (including the backup filter). The size is typically represented as an "Equivalent Aerodynamic Diameter": the size of a spherical particle of density 1 g/cc which has the same terminal settling velocity as the sampled particle.

Each of the eight filters was placed in a petri dish and transferred to the laboratory for analysis. Each filter was dessicated and weighed repeatedly until a constant weight was obtained. The contents of the cyclone preseparator sample container were collected in a glass jar, transferred to a pre-weighed beaker, dessicated, and weighed to a constant weight. Results are reported to the neareest 0.01 mg.

While standard procedures were followed in these tests, a more detailed sampling method would be required in order to obtain a meaningful particle size distribution. For example, several points across the duct should be sampled in light of evidence from the scrubber gas sampling traverses that the particle distribution across the duct was not uniform. In addition, larger particle size cutoffs would be needed.

CASCADE IMPACTOR

Table B1-1 : DATA REDUCTION INPUTS/OUTPUTS

Inputs	Test #1	Test #2	Test #3
M_T, mg	1321.99	1118.42	271.26
Vm, ft^3	4.59	4.61	4.50
P_{bar}, "Hg	30.27	30.17	30.14
Δh, "H_2O	0.28	0.27	0.262
Tm, °F	80.7	67	72.7
DGF	0.997	0.997	0.997
Ts, °F	197	201	203.3
Ps, "H_2O	-2.5	-2.5	-2.5
Time, min	15	15	15
m, g/g-mole	28.6	28.6	28.6
ρ, g/cc	1.0	1.0	1.0
ρ, g/cc			
Outputs			
Vm, dscf	4.521	4.643	4.479
C, gr/dscf	4.486	3.695	0.929
Q, acfm	0.3755	0.3972	0.3850
η, micropoise	214.2	215.1	215.7
λ, μm	0.0870	0.0876	0.0880
Cyclone μm	6.09	5.70	5.85
Cutoff Stage 1 (ρ=1.0) μm	15.4	15.0	15.3
Cutoff Stage 2 (ρ=1.0) μm	9.4	9.2	9.4
Cutoff Stage 3 (ρ=1.0) μm	3.7	3.6	3.7
CUtoff Stage 4 (ρ=1.0) μm	2.3	2.2	2.2
Cutoff Stage 5 (ρ=1.0) μm	1.4	1.4	1.4
Cutoff Stage 6 (ρ=1.0) μm	0.8	0.7	0.8
Cyclone	1321.2 mg	1117.65 mg	270.67 mg
Stage 0	n.d.	0.20 mg	0.12 mg
Stage 1	0.43 mg	0.34 mg	n.d.
Stage 2	0.17 mg	0.05 mg	0.24 mg
Stage 3	n.d.	n.d.	n.d.
Stage 4	n.d.	n.d.	n.d.
Stage 5	n.d.	n.d.	n.d.
Stage 6	n.d.	n.d.	n.d.
Filter	0.19 mg	0.18 mg	0.23 mg
mg, Total wt	1321.99	1118.42	271.26
gr, Total wt	20.40	17.26	4.11
gr/DSCF, Concentration	4.512	3.717	0.935

APPENDIX B-2

PARTICLE SIZE FIELD DATA SHEETS

FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 12 | Nozzle No. & Dia. 0.125 in. | Nomograph C Factor 100

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.829

Test No. #1 Cascade Impactor | Ambient Temp 75 °F | Test Duration 15 min. | Orifice ΔH_A 1.88

Sampling Location scrubber inlet | Bar Press 30.27 "Hg | Traverse Point Interval 15 min. | Test Start Time 3:28 PM

TRC Project No. 82988-20 | Probe Ident. No. 35 | Probe Heater Setting NA amps | Test End Time 3:43

Date 1/18/79 | Filter Ident. No. 300/700-706 | Filter Temp. Setting NA | Leak Test Start 0.01 CFM @ 15 "Hg

Tester DEK DAK | Duct Area (49½" dia) ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.001 CFM @ 5 "Hg

Low with impactor still hot

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	Mid	50	140	028	80	81	-250	197	313913	5		—	68	1	—	
	Mid	50	140	028	80	81	-250	192	315548	5		—	70	1	—	
	Mid	50	140	028	79	80	-250	197	316991	5		—	70	1	—	
									318500	5						

B-19

Probe Wash | Cleaning Patch

Silica Gel | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

Horizontal port

6

FIELD DATA SHEETS

Firm Name CF Jnd | Pump No. 12 | Nozzle No. & Dia. 0.1276 in. | Nomograph C Factor 1.000.98

Plant Location Donaldsville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.823

Test No. 2 - Cascade Impactor | Ambient Temp 65 °F | Test Duration 15 min. | Orifice ΔH_A 1.68

Sampling Location Sonobee inlet | Bar Press 30.17 "Hg | Traverse Point Interval 15 min. | Test Start Time 10:00 AM

IRC Project No. 8898-20 | Probe Ident. No. 35 | Probe Heater Setting NA amps | Test End Time 10:15 AM

Date 1/19/79 | Filter Ident. No. 30C-707 F13 | Filter Temp. Setting NA | Leak Test Start 0.001 CFM @ 8 "Hg

Tester JEK DAK | Duct Area (4'6"dia) ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.001 CFM @ 5 "Hg

Horizontal port

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle °	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	mid	5 0	1 4 0	0 2 8	6 6	6 7	- 2 5 0	1 9 9	3 4 9 9 4	5		NA	68	1	NA	
	mid	5 0	1 3 0	0 2 6 5	6 6	6 7	- 2 5 0	2 0 2	3 5 1 5 1	5		↓	68	1	↓	
	mid	5 0	1 3 0	0 2 6 5	6 7	6 7	- 2 5 0	2 0 2	3 5 2 0 2	5			70	1		
									3 5 4 5 5	5		↓			↓	

B-11

Probe Wash | Cleaning Patch

Silica Gel | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

Horizontal port
Preheated impactor
10 minutes in stack

FIELD DATA SHEETS

Firm Name CF Ind. | Pump No. 12 | Nozzle No. & Dia. I-6 (0.1276) in. | Nomograph C Factor 0.98

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.823

Test No. 3-Cascade Impactor | Ambient Temp 65 °F | Test Duration 15 min. | Orifice ΔH_A 1.88

Sampling Location Scrubber Inlet | Bar Press 30.14 "Hg | Traverse Point Interval 15 min. | Test Start Time 11:25 AM

TRC Project No. 82988-20 | Probe Ident. No. 35 | Probe Heater Setting NA amps | Test End Time 11:40 AM

Date 11/19/79 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.006 CFM @ 8 "Hg

Tester JEF DAK | Duct Area (49½" dia) ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.001 CFM @ 5 "Hg

horizontal duct

Port	Point	Time Min (3-5)	Velocity ΔP in H_2O (6-10)	ΔH in H_2O (12-15)	T_M in °F (18-20)	T_M Out °F (23-25)	P_{STACK} in H_2O (26-30)	T_{STACK} °F (32-35)	Initial Meter Volume cu. ft. (40-45)	PROBE (50)	Cyc. Angle (52-53)	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	mid	50	130	0265	71	72	-250	201	354621	5		NA	72	1	NA	
	mid	50	130	0265	71	73	-250	204	356155	5		↓	↓	↓	↓	
	mid	50	125	0255	72	73	-250	205	357655	5						
									359125	5						

BL-12

Probe Wash _____ Cleaning Patch _____

Silica Gel _____ H_2O Collected _____

Silica Gel Cond. _____ H_2O Condition _____

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

horizontal duct
Impactor preheated in stack
10 minutes & returned

APPENDIX B-3

LAB WEIGHING DATA

CASCADE IMPACTOR SUBSTRATES

TEST #	CI-1	CI-2	CI-3
STAGE 0 filter #	706	713	720
1 "	705	712	719
2 "	704	711	718
3 "	703	710	717
4 "	702	709	716
5 "	701	708	715
6 "	700	707	714
backup "	300	301	302

√ used EMS 2/79

FILTER WEIGHTS

Type Filter Slotted cascades

Filter Number	Initial Weight (g)	Initials	Date Weighed
700	.06690	EMS	1-9-79
701	.06819		
702	.06954		
703	.06707		
704	.06821		
705	.06791		
706	.06844		
707	.06789		
708	.06930		
709	.06769		
710	.06938		
711	.06808		
712	.06788		
713	.06690		
714	.06775		
715	.06929		
716	.06862		
717	.06742		
718	.06701		
719	.06834		
720	.06971		
721	.06930		
722	.06754	✓	✓

FILTER WEIGHTS

Back-up's

Type Filter plain cascade

Back-ups

Filter Number	Initial Weight (g)	Initials	Date Weighed
300	.08341	EMS	1-9-79
301	.08536		
302	.08383		
303	.08172		
304	.08148		
305	.08221		
306	.08188		
307	.08309		
308	.08619		
309	.08016		
310	.08690		
311	.08690	EMS	1-23-79
312	.08425		
313	.08214		
314	.08186		
315	.08270		
316	.08650		
317	.08617		
318	.08276		
319	.08379		
320	.08236		

used EMS 2/79

Client: EPA - CF Industries

Contract No: 82988-20

Reviewed by: JMmanchese

Report to: RWC

Laboratory No: 48-79(1)

Date Received: 1-23-79

Date Reported: 2-15-79

Type Sample: Filter Impactor Fuel Oil _____ Sediment _____ Impinger _____ Other _____

Sample Number	Location	Analysis No. 1 total mg	Analysis No. 2	Analysis No. 3	Analysis No. 4	Analysis No. 6	TLV
CT-1	Probe + Nozzle	1.3212 grams	1321.2 mg				
filter 300		0.19 mg					
700		n.d. ↓					
701		n.d.					
702		n.d.					
703		n.d.					
704		0.17					
705		0.43					
706		n.d.					
CT-2	Probe + Nozzle	1.1176 5 grams					
filter 301		0.18 mg					
707		n.d.					
708		n.d.					
709		n.d.					

B-14

Analyzed by: EMS

Form CL-0012

Client: Ef. -CF Industries

Contract No: 8295-8-20

Reviewed by: J. M. Manchese

Report to: RWC

Laboratory No: 48-79 (1)

Date Received: 1-23-79

Date Reported: 2-15-79

Type Sample: Filter Impaction Fuel Oil _____ Sediment _____ Impinger _____ Other _____

Sample Number	Location	Analysis No. 1 total mg	Analysis No. 2	Analysis No. 3	Analysis No. 4	Analysis No. 6	TLV
filter 710		n.d.					
711		0.05 mg					
712		0.34					
713		0.20					
C-I-3	Probe + Nozzle	270.67					
filter 302		0.23					
714		n.d.					
715		n.d.					
716		n.d.					
717		n.d.					
718		0.24					
719		n.d.					
720		0.12					

Analyzed by: EMS

Form CL 0012

APPENDIX C

VISIBLE EMISSIONS RESULTS

INCLUDES:

C-1 Visible Emissions Summary Tables for Outlet Stack "B" Granulator
C-2 Visual Emission Recertification Certificate
C-3 Visible Emission Field Data Sheets
C-4 Guidelines for EPA Method 9

APPENDIX C-1

VISIBLE EMISSIONS SUMMARY TABLES

FOR

OUTLET STACK "B" GRANULATOR

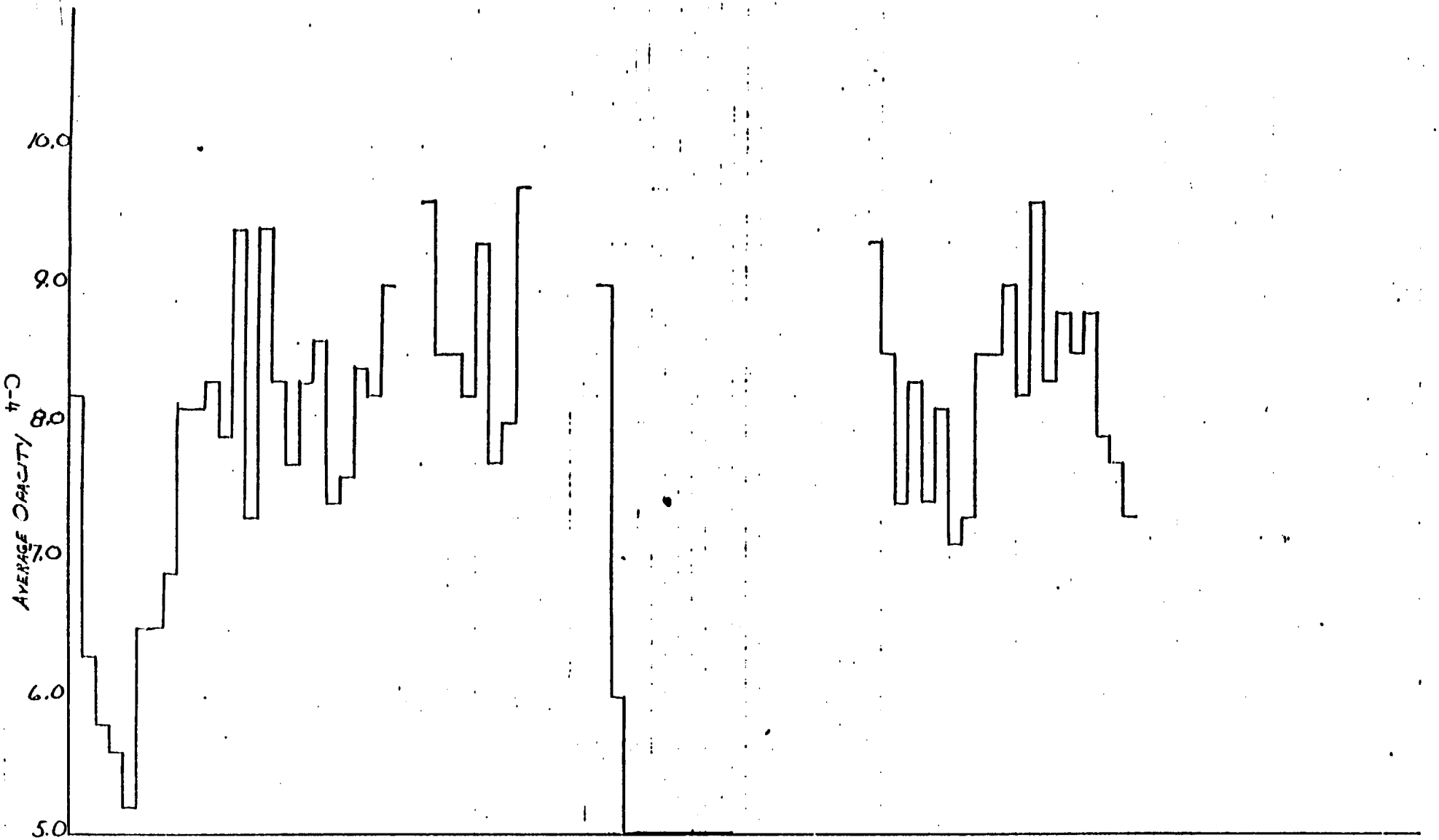
SIX MINUTE ARITHMETRIC AVERAGES OF JANUARY 17, 18 AND 19, 1979
OPACITY READINGS ON "B" GRANULATOR SCRUBBER STACK AT CF INDUSTRIES, INC.,
IN DONALDSONVILLE, LOUISIANA

TIME	AVG. OPACITY FOR 6 MIN.	DATE
12:02 - 12:07	8.2	1-17-79
12:08 - 12:13	6.3	
12:14 - 12:19	5.8	
12:20 - 12:25	5.6	
12:26 - 12:31	5.2	
12:32 - 12:37	6.5	
12:38 - 12:43	6.5	
12:44 - 12:49	6.9	
12:50 - 12:55	8.1	
12:56 - 13:01	8.1	
13:02 - 13:07	8.3	
13:08 - 13:13	7.9	
13:14 - 13:19	9.4	
13:20 - 13:25	7.3	
13:26 - 13:31	9.4	
13:32 - 13:37	8.3	
13:38 - 13:43	7.7	
13:44 - 13:49	8.3	
13:50 - 14:55	8.6	
13:56 - 14:01	7.4	
14:02 - 14:07	7.6	
14:08 - 14:13	8.4	
14:14 - 14:19	8.8	
14:20 - 14:22*	9.0	
15:50 - 15:55	9.6	
15:56 - 16:01	8.5	
16:02 - 16:07	8.5	
16:08 - 16:13	8.2	
16:14 - 16:19	9.3	
16:20 - 16:25	7.7	
16:26 - 16:31	8.0	
16:32 - 16:36*	9.7	
12:44 - 12:49	9.0	1-18-79
12:50 - 12:55	6.0	

TIME	AVG. OPACITY FOR 6 MIN.	DATE
12:56 - 13:01	5.0	1-18-79
13:02 - 13:07	5.0	
13:08 - 13:13	5.0	
13:14 - 13:19	5.0	
13:20 - 13:25	5.0	
13;26 - 13:31	5.0	
13:32 - 13:37	5.0	
13:38 - 13:43	5.0	
09:53 - 09:58	9.3	1-19-79
09:59 - 10:04	8.5	
10:05 - 10:10	7.4	
10:11 - 10:16	8.3	
10:17 - 10:22	7.4	
10:23 - 10:28	8.1	
10:29 - 10:34	7.1	
10:35 - 10:40	7.3	
10:41 - 10:46	8.5	
10:47 - 10:52	8.5	
10:53 - 10:58	9.0	
10:59 - 11:04	8.2	
11:05 - 11:10	9.6	
11:11 - 11:16	8.3	
11:17 - 11:22	8.8	
11:23 - 11:28	8.5	
11:29 - 11:34	8.8	
11:35 - 11:40	7.9	
11:41 - 11:46	7.7	
11:47 - 11:52	7.3	

* Less than 6 min average

Six Minute Arithmetic Averages of January 17, 18 and 19, 1979 Opacity Readings on "B" Granulator Scrubber Stack at CF Industries, Inc in Donaldsonville, Louisiana



APPENDIX C-2

VISUAL EMISSION RECERTIFICATION CERTIFICATE

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

COOK COLLEGE

New Brunswick, New Jersey

C-6

THIS IS TO CERTIFY THAT

CARL EKROTH

HAS COMPLETED THE SHORT COURSE

VISUSAL EMISSIONS EVALUATION RECERTIFICATION

SEPTEMBER 28, 1978

COOK COLLEGE

Grant E. Walton

Dean

APPENDIX C-3

VISIBLE EMISSIONS FIELD DATA SHEETS

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant UREA Date 1-17-79

Company Name CF INDUSTRIES Hours of Observation 1202 - 1423

Plant Address DONALDSONVILLE, LA Observer CSE

Type of Discharge (STACK) OTHER _____

Discharge Location N

Height of Point of Discharge ~80'

Observer's Location:

Distance to Discharge Point 150'

Height of Observation Point ~~160~~ 90'

Direction from Discharge Point S

Background Description RAIL BED, GROUND

Weather: Clear (Overcast) Partly Cloudy Other _____ Color _____

Wind Direction S Wind Velocity 10 mi/hr

Plume Description:

Detached: Yes (No)

Color: Black (White) Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible 10'

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

RECORD OF VISIBLE EMISSIONS

(1)

Company Name CF INDUSTRIES Date 1-17-79

Plant Address DONALDSONVILLE, LA. Observer C S E

Stack Location N Observer's Location SOUT

Weather Conditions MC, HZ, WIND-10 MPH

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1202	00	10	15	15	10	Plume from cooling towers sometimes obscures stack plume. in this case I will use a clear ~~to~~ to indicate this. Periodically the sky becomes more overcast blocking out the sun altogether, at these times it is nearly impossible to get an accurate reading.
	01	10	10	5	5	
	02	10	10	5	—	
	03	—	5	5	5	
1206	04	5	10	10	10	
	05	5	10	5	5	
	06	5	5	10	10	
	07	5	5	10	10	
1210	08	5	5	5	5	
	09	5	5	10	5	
	10	5	5	5	5	
	11	5	10	5	5	
	12	5	5	5	10	
	13	10	5	5	5	
1216	14	5	5	10	5	sky was heavy overcast for last 6 minutes.
	15	5	5	5	5	
	16	5	5	5	5	
	17	5	10	5	5	
	18	5	10	10	5	
	19	5	10	5	5	
1222	20	5	5	5	5	
	21	5	5	5	5	
	22	5	5	5	5	
	23	5	5	5	5	
1226	24	5	5	5	5	
	25	5	5	5	5	
	26	5	5	5	5	
	27	10	5	5	5	
	28	5	5	5	5	
1231	29	5	5	5	5	

(2)

RECORD OF VISIBLE EMISSIONS

Company Name C E INDUSTRIES
Plant Address DONALDSONVILLE, LA
Stack Location N
Weather Conditions HVY OVRCST

Date 1-17-79
Observer CSE
Observer's Location S

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1232	30	5	5	5	5	sky still heavily overcast. wind is
	31	5	10	10	5	steady but the same direction & speed
	32	5	10	5	5	
	33	5	5	5	5	
1236	34	10	10	10	5	
	35	5	10	5	5	
	36	5	5	10	10	
1239	37	10	10	10	10	
	38	10	5	5	5	
	39	5	5	5	5	
	40	5	5	5	5	
1243	41	5	5	5	5	
	42	10	5	10	5	
	43	5	10	5	10	
1246	44	5	5	10	10	
	45	5	5	5	10	
	46	10	5	5	5	
1249	47	5	5	5	10	
	48	10	5	10	10	
	49	5	5	5	10	
1252	50	10	10	10	10	
	51	5	10	10	5	
	52	10	10	5	5	wind beginning to shift & wind more from
1255	53	5	10	10	10	SSW now
	54	10	5	5	5	sky is now brightening a little
	55	10	10	5	10	
1258	56	10	10	10	5	
	57	5	10	10	10	
1300	58	5	10	10	10	
	59	10	10	5	5	

RECORD OF VISIBLE EMISSIONS

(3)

Company Name _____ Date _____

Plant Address DONALDSONVILLE, LA Observer CST

Stack Location N Observer's Location S

Weather Conditions HOT & DRY ST

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1302	00	5	5	5	5	
	01	5	10	10	5	
	02	5	10	10	10	
1305	03	5	10	10	10	
	04	10	10	10	10	
	05	10	10	10	10	
1308	06	10	10	5	10	
	07	5	10	10	10	
	08	10	10	10	10	
1311	09	5	5	5	5	shy getting back again
	10	5	10	10	5	
	11	5	10	10	5	
1314	12	5	10	10	10	
	13	10	15	10	10	
	14	10	10	10	10	plume seems to be swirling around
	15	15	10	10	10	mouth of stack
1318	16	10	10	5	5	
	17	10	5	5	10	
	18	10	10	10	10	
	19	10	10	10	10	
1322	20	5	10	5	5	
	21	5	5	5	10	
	22	5	5	5	5	
1325	23	5	5	5	10	
	24	10	10	10	10	
	25	10	10	10	10	
	26	5	10	5	10	
	27	10	10	10	10	
1330	28	10	5	10	10	
	29	10	10	10	10	

(4)

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-17-79

Plant Address DONALDSONVILLE, LA. — Observer CSE

Stack Location N — Observer's Location S.

Weather Conditions OVERCAST

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1332	30	10	10	5	10	
	31	5	10	5	10	
	32	10	10	5	10	wind appears to have swung around to the SSE.
1335	33	10	10	10	5	
	34	10	10	10	5	
	35	10	10	5	5	
	36	5	5	5	5	
1339	37	5	10	10	10	am trying to breathe through
	38	5	5	10	10	
	39	10	5	5	10	
	40	10	5	10	10	
	41	10	5	10	10	
	42	5	5	5	10	
1345	43	5	5	5	5	
	44	10	10	10	10	
	45	10	10	10	10	
	46	10	10	10	10	
	47	10	10	5	—	
1350	48	10	10	5	10	
	49	10	10	10	10	
	50	10	10	10	10	
	51	5	10	—	10	
	52	—	5	5	5	
1355	53	5	—	10	10	
	54	5	10	5	5	
	55	5	10	5	5	
	56	5	5	5	5	
	57	5	5	5	10	
1400	58	5	5	—	—	
	59	—	5	10	10	

(5)

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-17-79

Plant Address DONALDSONVILLE, LA. — Observer CSE

Stack Location N — Observer's Location S

Weather Conditions OVRCST

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1402	00	10	10	10	—	
	01	5	10	10	10	
	02	10	5	—	5	
1405	03	10	5	—	—	
	04	—	—	5	5	
	05	10	—	5	5	
	06	10	10	10	10	
	07	10	5	5	5	
	08	5	—	—	—	
	09	5	10	10	10	
	10	—	—	—	—	
	11	10	10	—	10	
	12	5	—	10	10	
1415	13	10	10	5	—	
	14	—	—	—	10	
	15	10	10	—	—	
	16	5	10	5	10	
	17	10	5	10	5	
1420	18	—	10	10	10	
	19	10	—	10	10	
	20	10	10	5	5	end of test
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant UREA Date 1-17-79

Company Name CF INDUSTRIES Hours of Observation 1550-1635

Plant Address DONALDSONVILLE, LA. Observer CSE

Type of Discharge (STACK) OTHER _____

Discharge Location NORTH

Height of Point of Discharge 80'

Observer's Location:

Distance to Discharge Point 150'

Height of Observation Point 90'

Direction from Discharge Point South

Background Description RAIL BED, GROUND

Weather: Clear (Overcast) Partly Cloudy Other _____ Color _____

Wind Direction ESE Wind Velocity 5 mi/hr

Plume Description:

Detached: Yes No

Color: Black (White) Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible _____

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-17-79

Plant Address DONALDSONVILLE, LA. — Observer CSE

Stack Location N — Observer's Location S

Weather Conditions HVY OVERCST, HAZY

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1550	00	10	10	10	10	Sky is heavy overcast and due to the
	01	10	10	10	10	lateness of the hour, the light is failing,
	02	10	10	10	10	making it difficult to obtain any
	03	10	10	10	10	real accurate readings.
	04	10	10	10	10	
1555	05	5	5	10	—	The plume from cooling towers periodically
	06	5	10	10	10	obscures stack plume, these readings
	07	5	10	10	10	indicated by slash.
	08	5	10	10	10	
	09	10	10	10	10	
1600	10	5	5	5	10	
	11	10	10	10	5	
	12	10	10	10	10	
	13	5	10	10	10	
	14	10	10	10	5	
1605	15	10	10	5	5	
	16	5	5	5	—	
	17	10	10	10	10	
	18	5	10	5	—	
	19	10	5	—	10	
1610	20	10	10	10	10	
	21	10	—	—	10	
	22	5	5	—	5	
	23	5	10	10	10	
	24	—	10	10	10	
1615	25	10	5	10	10	
	26	10	5	5	—	
	27	10	10	10	10	
	28	10	—	10	10	
	29	10	10	—	10	

(2)

RECORD OF VISIBLE EMISSIONS

Company Name C F INDUSTRIES — Date _____

Plant Address DONALDSONVILLE, LA — Observer CSE

Stack Location N — Observer's Location S

Weather Conditions HVY OVRCST, ~~[illegible]~~ HAZY

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1620	30	—	10	10	—	
	31	—	—	10	10	
	32	5	5	—	—	
	33	10	5	—	5	
	34	5	5	—	—	
1625	35	5	10	10	10	
	36	—	10	5	5	
	37	10	5	10	10	
	38	10	10	5	5	
	39	10	10	5	10	
1630	40	5	5	10	10	
	41	10	5	10	10	
	42	10	10	10	10	
	43	10	10	5	—	
	44	10	10	10	10	
1635	45	10	10	10	10	
	46	10	10	10	10	too dark to get any more readings
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant UREA — Date 1-18-79

Company Name CF INDUSTRIES — Hours of Observation 1244-1344

Plant Address DONALDSONVILLE, LA — Observer C.S. Ekroth

Type of Discharge (STACK) OTHER _____

Discharge Location N

Height of Point of Discharge 80'

Observer's Location:

Distance to Discharge Point 150'

Height of Observation Point 90'

Direction from Discharge Point S

Background Description Rail Bed / grounds

Weather: Clear (Overcast) Partly Cloudy Other _____ Color Light

Wind Direction N NE Wind Velocity 0-5 mi/hr

Plume Description:

Detached: Yes (No)

Color: Black (White) Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible 10'

Summary of Observations:

Opacity	Aggregate Time @ Opacity		Opacity	Aggregate Time @ Opacity
	min.	sec.		
0			55	
5			60	
10			65	
15			70	
20			75	
25			80	
30			85	
35			90	
40			95	
45			100	
50				

(1)

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-18-79

Plant Address DONALDSONVILLE, LA — Observer CSE

Stack Location N — Observer's Location S

Weather Conditions

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1244	00	10	10	10	10	Sky is high overcast, with large clouds
1245	01	10	10	10	10	are beginning to build up. Sun is trying
	02	10	5	10	10	to come out. Sky is very bright. Wind is
	03	10	10	5	10	calm
	04	5	5	10	10	
	05	10	10	5	10	
1250	06	5	5	10	10	
	07	10	10	5	10	
	08	5	5	5	5	
	09	5	5	5	5	Sun is brighter now. Background is
	10	5	5	5	5	hazy which accounts for lower
1255	11	5	5	5	5	readings
	12	5	5	5	5	
	13	5	5	5	5	
	14	5	5	5	5	
	15	5	5	5	5	
1300	16	5	5	5	5	
	17	5	5	5	5	
	18	5	5	5	5	
	19	5	5	5	5	
	20	5	5	5	5	
1305	21	5	5	5	5	
	22	5	5	5	5	
	23	5	5	5	5	
	24	5	5	5	5	
	25	5	5	5	5	
1310	26	5	5	5	5	
	27	5	5	5	5	
	28	5	5	5	5	
	29	5	5	5	5	

(2)

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-18-79

Plant Address DONALDSONVILLE, LA — Observer CSE

Stack Location N — Observer's Location S.

Weather Conditions

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1314	30	5	5	5	5	Sky conditions still the same, nothing
1315	31	5	5	5	5	to difficulty in getting readings
	32	5	5	5	5	
	33	5	5	5	5	
	34	5	5	5	5	
	35	5	5	5	5	
1320	36	5	5	5	5	
	37	5	5	5	5	
	38	5	5	5	5	
	39	5	5	5	5	
	40	5	5	5	5	Brightness has diminished slightly
1325	41	5	5	5	5	
	42	5	5	5	5	
	43	5	5	5	5	
	44	5	5	5	5	
	45	5	5	5	5	
1330	46	5	5	5	5	
	47	5	5	5	5	
	48	5	5	5	5	What little ~~wi~~ breeze there is now is
1333	49	5	5	5	5	coming out of the NE.
	50	5	5	5	5	
1335	51	5	5	5	5	
	52	5	5	5	5	
	53	5	5	5	5	
	54	5	5	5	5	
	55	5	5	5	5	
1340	56	5	5	5	5	
	57	5	5	5	5	
	58	5	5	5	5	
1343	59	5	5	5	5	

RECORD OF VISIBLE EMISSIONS

(1)

Company Name C F INDUSTRIES Date 1-19-79

Plant Address DONALDSONVILLE, LA Observer CSE

Stack Location N Observer's Location S

Weather Conditions See Below

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
0953	00	10	10	10	5	heavy overcast, wind from west 12-15 mph
	01	10	10	10	10	High humidity and ~~foggy~~ hazy.
0955	02	10	5	10	10	
	03	10	10	10	10	
	04	10	10	10	—	Plume from cooling tower periodically obscures
	05	10	10	10	5	stack plume, these instances are indicated
	06	5	5	10	10	by slash.
1000	07	10	—	10	10	
	08	10	10	10	10	
	09	10	5	10	5	
	10	—	10	10	10	
	11	10	5	10	5	
1005	12	5	5	5	10	
	13	5	10	5	10	
	14	5	10	10	10	
	15	10	—	5	5	
	16	5	10	10	10	
1010	17	5	5	10	5	
	18	5	10	10	10	
	19	5	5	5	10	
	20	10	5	5	5	
	21	10	10	10	10	
1015	22	—	5	5	10	
	23	10	5	10	10	
	24	5	10	10	5	
	25	—	10	5	10	
	26	10	5	10	5	
1020	27	5	5	10	10	
	28	5	5	5	10	
	29	10	5	5	5	

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-19-79

Plant Address DONALDSONVILLE, LA. — Observer CS &

Stack Location North — Observer's Location South

Weather Conditions OVRCST. HAZY

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
	00	10	10	10	5	
	01	5	10	5	10	
1025	02	10	5	10	10	
	03	5	5	10	10	
	04	10	5	10	5	
	05	5	10	10	10	
	06	5	5	5	10	
1030	07	5	5	10	10	
	08	10	5	5	10	
	09	5	10	5	5	
	10	5	10	10	10	
	11	10	5	5	5	
1035	12	5	10	10	5	
	13	10	10	10	5	
	14	5	5	10	10	
	15	—	10	5	5	
	16	10	10	5	5	
1040	17	10	10	5	5	
	18	5	10	10	10	
	19	10	10	5	5	
	20	5	10	10	5	
	21	10	5	5	10	
1045	22	10	10	10	10	
	23	10	10	10	10	
	24	5	10	5	5	
	25	10	10	10	5	
	26	10	10	10	10	
1050	27	5	5	10	5	
	28	10	—	10	10	
	29	10	10	10	10	

(3)

RECORD OF VISIBLE EMISSIONS

Company Name CF INDUSTRIES — Date 1-19-79

Plant Address DONALDSONVILLE, LA — Observer CSE

Stack Location N — Observer's Location S

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	30	10	10	5	5	
	31	10	5	10	10	
1055	32	10	10	10	10	
	33	10	10	10	10	
	34	10	10	10	5	
	35	10	10	5	10	
1059	36	10	10	10		heavy steam plume coming from stack some men doing something to fan.
1100	37					
	38	5	10	5	10	
	39	5	10	10	5	
	40	10	10	10	10	
	41	10	10	10	5	
1105	42	10	10	10	10	
	43	10	10	10	10	
	44	10	10	10	10	
	45	5	10	10	5	
	46	10	10	10	10	
1110	47	10	10	10	10	
	48	10	10	5	5	
	49	10	10	5	10	
	50	10	10	5	10	
	51	10	10	10	10	
1115	52	10	5	5	5	
	53	10	5	10	10	
	54	5	10	10	10	
	55	10	5	10	10	
	56	10	10	10	10	
1120	57	10	10	10	5	
	58	10	5	10	5	
	59	10	5	10	10	

RECORD OF VISIBLE EMISSIONS

(4)

Company Name CF INDUSTRIES — Date 1-19-79

Plant Address DONALDSONVILLE, LA — Observer CSE

Stack Location N — Observer's Location S

Weather Conditions HUY OVR CST

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
	00	10	10	5	10	
	01	10	10	5	5	
1125	02	10	10	10	10	
	03	10	5	5	10	
	04	10	10	10	5	
	05	10	5	10	10	
	06	10	10	10	5	Sky is becoming a little brighter.
1130	07	5	10	10	10	
	08	10	5	5	—	
	09	10	10	10	10	
	10	10	10	10	10	
	11	10	10	10	10	sun is trying to breakthrough
1135	12	5	10	5	5	
	13	5	10	10	10	
	14	10	10	10	5	
	15	5	10	10	5	
	16	5	5	10	5	
1140	17	10	10	10	10	
	18	10	10	10	5	
	19	10	10	10	5	
	20	5	10	5	5	
	21	5	5	5	5	
1145	22	5	10	10	10	
	23	10	10	10	5	
	24	10	5	10	10	
	25	5	5	5	5	
	26	5	10	10	5	
1150	27	5	10	10	10	
	28	10	5	10	5	
1152	29	10	5	5	5	

APPENDIX C-4

GUIDELINES FOR EPA METHOD 9

DRAFT COPY

SEP 6 1974

GUIDELINES FOR USE OF METHOD 9 FOR DETERMINATION OF NSPS

DRAFT COPY

I. Purpose

To establish basic procedures for visually determining the opacity of emissions for the purpose of attaining baseline opacity data for NSPS. These general guidelines are to aid the observer in ensuring representative data is collected.

II. Observer Qualification

Prior to performing work for Emission Standards and Engineering Division, the observer must meet the following qualifications:

1. He must have a current certification from a smoke school conducted by either the Environmental Protection Agency, State air pollution agency or local air pollution agency.

2. He must have attended, at one time, the classroom portion of the smoke school.

Certificates indicating the above requirements have been met, will be submitted to the Emission Measurement Branch and filed.

III. General

1. The procedures set forth in Method 9 shall be followed.

2. The data should be recorded on the attached forms. Note that observations are made and recorded at 15 second intervals. It is suggested a digital clock be used for timekeeping. Use of a stopwatch is helpful for exactly timing short periods of peak emissions such as during rapping, soot-blowing, bag cleaning, etc.

3. Each observer should monitor only one emission source at a time.

DRAFT COPY

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME						COMMENTS
HR	MIN	SECONDS				
		00	15	30	45	
	00					
	01					
	02					
	03					
	04					
	05					
	06					
	07					
	08					
	09					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME						COMMENTS
HR	MIN	SECONDS				
		00	15	30	45	
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date _____

Company Name _____ Hours of Observation _____

Plant Address _____ Observer _____

Type of Discharge STACK OTHER _____

Discharge Location _____

Height of Point of Discharge _____

Observer's Location:

Distance to Discharge Point _____

Height of Observation Point _____

Direction from Discharge Point _____

Background Description _____

Weather: Clear Overcast Partly Cloudy Other _____ Color _____

Wind Direction _____ Wind Velocity _____ mi/hr

Plume Description:

Detached: Yes No

Color: Black White Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible _____

Summary of Observations:

Opacity	Aggregate Time @ Opacity	Opacity	Aggregate Time @ Opacity
0	min. sec.	55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			

RECORD OF VISUAL DETERMINATION OF OPAC

...Y _____ HOURS OF OBSERVATION _____

...ON _____ OBSERVER _____

...UMBER _____ OBSERVER CERTIFICATION DATE _____

_____ OBSERVER AFFILIATION _____

FACILITY _____ Point of Emissions _____

...L DEVICE _____ Height of Discharge Point _____

...cord the following information prior to and upon completion of observations at each source; if observations ...are made over an extended period of time, additional recordings should be made as applicable.

	Initial	Final
TIME		
...ER LOCATION:		
...tance To Discharge		
...ection From Discharge		
...ht of Observation Point		
...OUND DESCRIPTION:		
...R CONDITIONS:		
... Direction		
... Speed		
...ient Temperature		
...DITIONS:		
...ar, overcast, % cloud)		
...DESCRIPTION:		
...		
...tance Visible		
... DATA:		
...ses of ... compliance		

APPENDIX D

FIELD DATA SHEETS FOR "B" GRANULATOR TESTING

INCLUDES:

Field Data Sheets for:

D-1 Scrubber Inlet Location (TP-1)
D-2 Scrubber Outlet Location (TP-2)

APPENDIX D-1

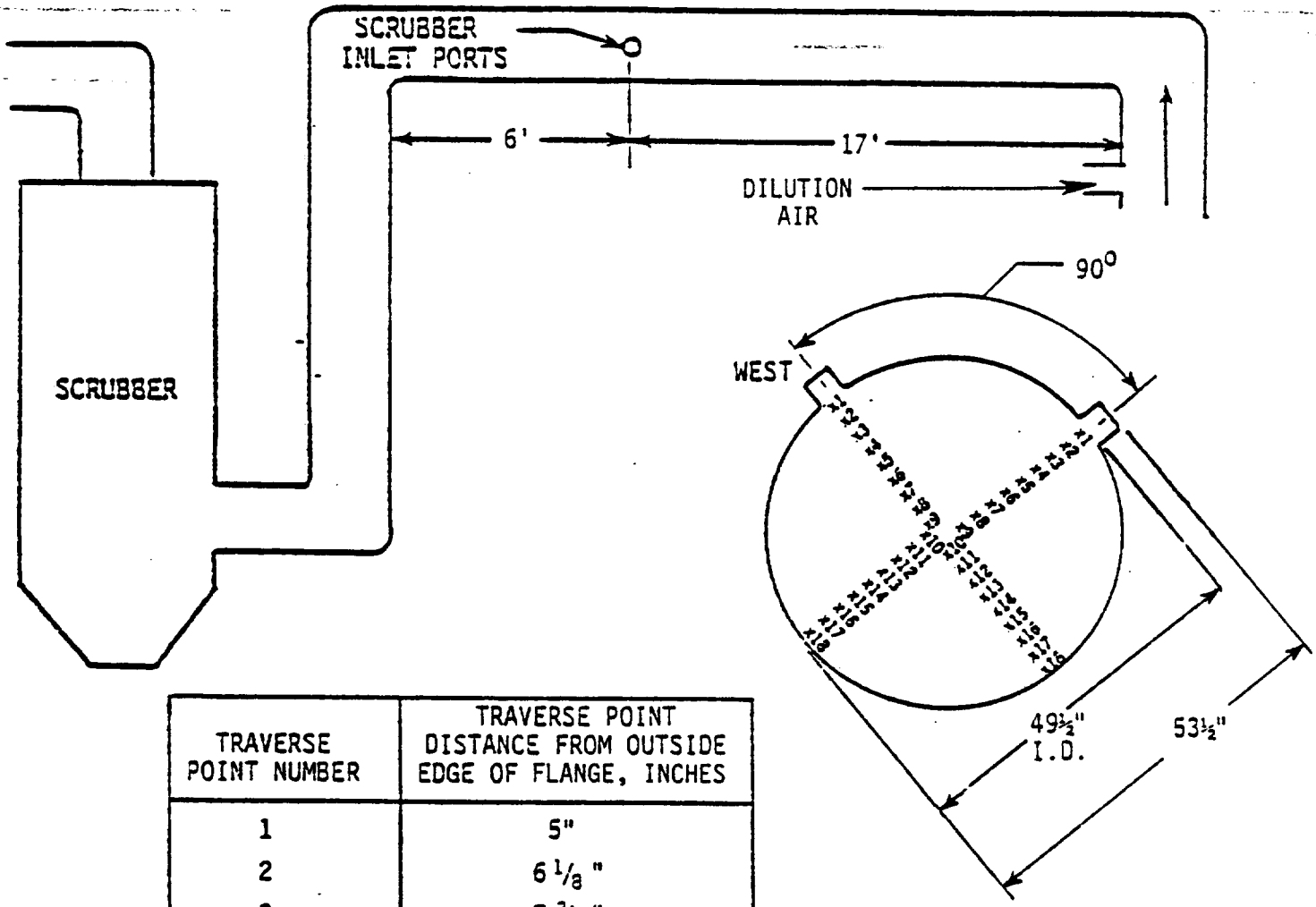
SCRUBBER INLET LOCATION (TP-1)
FIELD DATA SHEETS

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT CF Industries Inc., Donaldsonville, Louisiana
DATE 1/17/79
SAMPLING LOCATION Granulator "B" scrubber inlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 53½"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 4"
STACK I.D., (DISTANCE A - DISTANCE B) 49½"
NEAREST UPSTREAM DISTURBANCE 17'
NEAREST DOWNSTREAM DISTURBANCE 6'
CALCULATOR J. KIRZEC, TRC

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.014	49½"	1"	4"	5"
2	0.044	↓	2⅛"	↓	6⅛"
3	0.075		3¾"		7¾"
4	0.109		5⅜"		9⅜"
5	0.146		7¼"		11¼"
6	0.188		9¼"		13¼"
7	0.236		11⅝"		15⅝"
8	0.296		14⅝"		18⅝"
9	0.382		18⅞"		22⅞"
10	0.618		30⅝"		34⅝"
11	0.704		34⅞"		38⅞"
12	0.764		37⅞"		41⅞"
13	0.812		40¼"		44¼"
14	0.854		42¼"		46¼"
15	0.891		44⅛"		48⅛"
16	0.925		45¾"		49¾"
17	0.956		47⅜"		51⅜"
18	0.986	↓	48½"	↓	52½"



TRAVERSE POINT NUMBER	TRAVERSE POINT DISTANCE FROM OUTSIDE EDGE OF FLANGE, INCHES
1	5"
2	6 1/8 "
3	7 3/4 "
4	9 3/8 "
5	11 1/4 "
6	13 1/4 "
7	15 5/8 "
8	18 5/8 "
9	22 7/8 "
10	34 5/8 "
11	38 7/8 "
12	41 7/8 "
13	44 1/4 "
14	46 1/4 "
15	48 1/8 "
16	49 3/4 "
17	51 3/8 "
18	52 1/2 "

LOCATIONS OF "B" GRANULATOR SCRUBBER INLET TEST PORTS AND POINTS AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

NOMOGRAPH DATA

PLANT CF Industries Inc, Donaldsonville, Louisiana

DATE 1/17/79

SAMPLING LOCATION Granulator "B" scrubber inlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.88
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	~70°F
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	~4%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.39
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	30.21
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.994
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	~195
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	~1.15
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	~1.30
C FACTOR		0.97
CALCULATED NOZZLE DIAMETER, in.		0.21"
ACTUAL NOZZLE DIAMETER, in.		0.1876"
REFERENCE Δp, in. H_2O		1.80

VELOCITY TRAVERSE
DATA FORM

Client CF Industries Stack Ident. No. scrub. inlet Stack I.D. 4 Ft. 1½

Location Donaldsonville LA Pitot Ident. No. 44 Stack O.D. _____ Ft. _____

Date 11/6/79 Test by JEK Pitot Cal. No., F_s _____

Barometric Pressure, P_B 30.30 "Hg

Run 1 Run 1 cyclone ftc

Port	Point	VP "H_2O	SP "H_2O	T_F °F	T_R °F	$\sqrt{VP*T_R}$	Port	Point	VP "H_2O	SP "H_2O	T_F °F	T_R °F	$\sqrt{VP}$
1	1	0.78		70			R	1	0.47		164		— *
	2	0.95		160				2	0.58		164		—
	3	1.05		166				3	0.64		168		0
	4	1.30		171				4	0.84		172		5
	5	1.40		173				5	1.05		174		15
	6	1.30		174				6	1.10		174		25
	7	1.35		175				7	1.30		175		0
	8	1.45		175				8	1.40		176		0
	9	1.55		175				9	1.50		176		0
	10	1.60		175				10	1.60		176		0
	11	1.65		175				11	1.70	-2.8	176		0
	12	1.70		175				12	1.75		176		0
	13	1.70		175				13	1.70		176		0
	14	1.70		176				14	1.70		176		5
	15	1.65		175				15	1.45		175		5
	16	1.60		174				16	1.40		174		0
	17	1.55		175				17	1.40		176		0
	18	1.50		176				18	1.40		176		0
	Total							Total					
	Average							Average					
								Overall Average					

* unmeasurable due to entrainment leaking in.

Absolute Stack Pressure, P_s

$P_s = P_B + \overline{SP}/13.6 =$ _____ + _____ = _____

Velocity, V_s

$V_s = 2.90 * F_s * \sqrt{VP*T_R} * \sqrt{\frac{29.92}{P_s} * \frac{28.84}{M_s}}$

M_s = molecular weight of stack gas (wet basis)

V_s = _____ FPS

Volume, standard conditions T_{std} = _____ °R

$Q = V_s * A * 60 * T_{std}/T_R * P_s/29.92 =$ _____ * _____ * 60 * _____ * _____

= _____ SCFM

FIELD DATA SHEET

Firm Name	Ct Ind.	Pump No.	12	Nozzle No. & Dia.	5-2 0.876 in.	Nomograph C Factor	0.91
Plant Location	Donaldsonville LA	Orifice No.	D-6	Assumed Moisture	4 %	Pitot Coefficient	0.820 (rev)
Test No.	1	Ambient Temp	70 °F	Test Duration	108 min.	Orifice ΔH_A	1.88
Sampling Location	before scrubber	Bar Press	30.39 "Hg	Traverse Point Interval	3 min.	Test Start Time	12 NOON
TRC Project No.	82988-20	Probe Ident. No.	44	Probe Heater Setting	170°F amps	Test End Time	2:23
Date	1/17/79	Filter Ident. No.	NA	Filter Temp. Setting	NA	Leak Test Start	0.01 CFM@ 15 "Hg
Tester	JEK DAK	Duct Area	(49.5" Dia) 13.36 ft^2	Dry Gas Meter Y	1.00	Leak Test Final	0.002 CFM@ 5 "Hg

0.80 ft^3 air used to campaign 1 of 3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R (end side wall)	1	3.0	0.38	0.39	~~7~~ 72	71	-2.30	188	1206.4	1		NA	60	1	161	
	2	3.0	0.54	0.55	73	71	↓	189	1218.2	1		↓	↓	2	164	
	3	3.0	0.53	0.54	72	73		195	1230.5	1				2	170	
	4	3.0	0.98	0.99	72	73		180	12[illegible]2.8	1	4			3	171	
	5	3.0	1.05	1.08	71	73		186	1263.5	1				3	171	
	6	3.0	1.30	1.33	71	73		196	1280.5	1				4	169	
	7	3.0	1.35	1.40	71	73		196	1299.2	1				4	166	
	8	3.0	1.35	1.40	71	73		196	1319.1	1				4	169	
	9	3.0	1.40	1.42	71	73		195	1338.7	1				4	173	
	10	3.0	1.25	1.28	71	73		196	1358.1	1				4	173	
	11	3.0	1.15	1.18	72	74		197	1376.9	1				3	163	
	12	3.0	1.10	1.11	72	73		197	1395.0	1				3	173	
	13	3.0	1.15	1.18	72	73		196	1412.2	1				3	173	
	14	3.0	1.15	1.18	72	74		197	1430.0	1				3	171	
	15	3.0	1.15	1.18	72	74		197	1447.7	1				3	171	
	16	3.0	1.20	1.21	72	74		197	1466.0	1				3	172	

D-7

Probe Wash	1-PW-I		Cleaning Patch	N/A
Silica Gel	1-S-I		H_2O Collected	
Silica Gel Cond			H_2O Condition	

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

12:10 stop to ck pitots
1" pipe
returned 1:..

FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 12 | Nozzle No. & Dia. 5-2 (0.1876) in. | Nomograph C Factor 0.97

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.820 (rev)

Test No. 1 | Ambient Temp 70 °F | Test Duration 108 min. | Orifice ΔH_A 1.88

Sampling Location Scrubber inlet | Bar Press 30.39 "Hg | Traverse Point Interval 3 min. | Test Start Time 12 Noon

TRC Project No. 82988-20 | Probe Ident. No. 44 | Probe Heater Setting 170°F | Test End Time 2:23 P.M

Date 11/17/79 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.01 CFM @ 15 "Hg

Tester DEK DAK | Duct Area (49.5" DIA) 13.36 ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.00 CFM @ 5 "Hg

80 ft³ air used to unplug probe

2 of 3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	Probe	Cyc. Angle	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	17	3 0	1 1 5	1 1 8	172	74	-2 3 0	197	148 3 7	1		NA	60	3	172	
in stack	18	3 0	1 1 0	1 1 2	72	74	-2 3 0	196	150 1 5	1		↓	60	3	171	
									151 9 2	1						
L	1	3 0	0 5 2	0 5 3	72	73	-2 7 0	153	151 9 2	1		NA	60	2	168	
out of inlet	2		1 0 0	1 0 0	71	73		153	153 3 6	1			60	3	169	
	3		1 1 5	1 1 8	71	73		180	155 5 0 4	1				3	169	
	4		1 2 0	1 2 2	71	73		195	156 7 7	1				3	169	
	5		1 2 0	1 2 2	71	72		196	158 5 8	1				3	168	
	6		1 2 0	1 2 2	71	72		196	160 4 0	1				3	168	
	7		1 2 0	1 2 2	71	72		197	162 2 2	1				3½	167	
	8		1 2 5	1 2 8	71	73		196	164 0 4	1				3½	170	
	9		1 2 5	1 2 8	71	72		196	165 9 1	1				3½	168	
	10		1 1 0	1 1 2	71	73		196	167 8 0	1				3	169	
	11		1 1 5	1 1 8	71	73		197	169 9 5	1				3	169	
	12		1 1 0	1 1 2	71	73		196	171 1 3 2	1		↓	↓	3	169	

D-8

Probe Wash 1-PW-I | Cleaning Patch N/A

Silica Gel 1-S-I | H_2O Collected

Silica Gel C/ | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 12 | Nozzle No. & Dia. S-2 0.1896 in. | Nomograph C Factor 097

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.820 (rev)

Test No. 1 | Ambient Temp 70 °F | Test Duration 108 min. | Orifice ΔH_A 1.88

Sampling Location Scrubber Inlet | Bar Press 30.39 "Hg | Traverse Point Interval 3 min. | Test Start Time 12 NOON

TRC Project No. 8988-20 | Probe Ident. No. H | Probe Heater Setting 170°F amps | Test End Time 2:23

Date 11/17/89 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.01 CFM @ 15 "Hg

Tester JEF DAK | Duct Area (49.5" dia) 13.36 ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.005 CFM @ 5 "Hg

0.80 ft³ on used to purge probe

3-f3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
L	13	3.0	1.10	1.12	71	73	-2.70	196	173.07	1		NA	60	3	170	
	14	3.0	1.10	1.12	71	73		196	174.85	1				3	171	
	15	3.0	1.05	1.08	71	73		196	176.56	1				3	170	
	16	3.0	1.05	1.08	71	73		196	178.25	1				3	170	
	17	3.0	0.93	0.95	71	73		195	179.94	1				3	169	
w Stuck	18	3.0	0.93	0.95	71	73		195	182.10	1				3	169	
END OF TEST									183.17	L						

D-9

Probe Wash 1-PW-I | Cleaning Patch N/A

Silica Gel 1-S-I | H_2O Collected

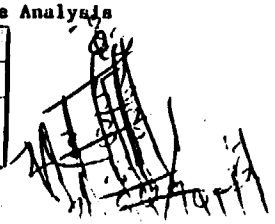
Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2



FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 12 | Nozzle No. & Dia. 5-2 (0.1876) in. | Nomograph C Factor 0.97

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.83 (rev)

Test No. 2 | Ambient Temp 70 °F | Test Duration 108 min. | Orifice ΔH_A 1.88

Sampling Location scrubber inlet | Bar Press 30.39 "Hg | Traverse Point Interval 3 min. | Test Start Time 3:48 PM

TRC Project No. 82988.20 | Probe Ident. No. HK37 | Probe Heater Setting ~~300°F~~ 15 amps | Test End Time 5:56 PM

Date 11/29 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.01 CFM @ 15 "Hg

Tester JEK DAK | Duct Area (49.5" DIA) 13.36 ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.003 CFM @ 5 "Hg

0.71 ft³ on each sampling probe

1 of 3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
Bk	1	30	1.05	1.08	70	70	-.270	191	183.30	3		NA	60	2½	170	
	2		1.05	1.08	70	70		193	185.05	3				2½		
	3		1.05	1.08	70	71		194	186.77	3				2½		
	4		1.15	1.18	70	71		194	188.49	3				2½		
	5		1.15	1.18	70	71		195	190.30	3				2½		
	6		1.15	1.18	70	71		194	192.10	3				2½		
	7		1.20	1.22	70	71		196	193.88	3				3		
	8		1.20	1.22	70	71		196	195.74	3				3		
	9		1.20	1.22	70	71		197	197.60	3				3		
	10		1.20	1.22	70	71		196	199.48	3				3		
	11		1.20	1.22	70	71		197	201.28	3				3		
	12		1.20	1.22	70	71		197	203.13	3				3		
	13		1.25	1.29	70	71		194	204.96	3				3		
	14		1.25	1.29	70	71		195	206.87	3				3		
	15		1.15	1.18	70	71		189	208.75	3				3		
	16		1.05	1.08	70	71		185	210.57	3				3		

D-10

Probe Wash 2-PW-I | Cleaning Patch N/A

Silica Gel 2-B-I | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 12 | Nozzle No. & Dia. 5-2 (0.1876) in. | Nomograph C Factor 0.97

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.83 (rev)

Test No. 2 | Ambient Temp 70 °F | Test Duration 108 min. | Orifice ΔH@ 1.88

Sampling Location Scrubber Inlet | Bar Press 30.39 "Hg | Traverse Point Interval 3 min. | Test Start Time 3:48PM

TRC Project No. 82988.20 | Probe Ident. No. 4F37 | Probe Heater Setting 170F (1'/2a) amps | Test End Time 5:56PM

Date 11/17/99 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.01 CFM@ 15 "Hg

Tester JEK DAK | Duct Area (49.5"dia) 13.36 ft² | Dry Gas Meter Y 1.00 | Leak Test Final 0.003 CFM@ 5 "Hg

0.71 ft³ air used to purge probe.

2 of 3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	17	3.0	0.76	0.78	70	71	-2.70	170	21.230	3		NA	60	2	170	
outside wall	18	3.0	0.86	0.78	70	71		130	21.379	3		↓	↓	2	170	
									21.533	3						
inside wall																
R	1	3.0	1.10	1.12	69	70	-2.70	189	21.533	3		NA	60	3	170	
	2		1.15	1.18	69	70		196	21.786	3				3		
	3		1.20	1.22	69	70		196	21.966	3				3		
	4		1.20	1.22	69	70		196	22.150	3				3		
	5		1.10	1.12	69	70		196	22.332	3				3		
	6		1.15	1.18	69	69		197	22.507	3				3		
	7		1.10	1.12	68	69		196	22.687	3				3		
	8		1.05	1.08	68	69		196	22.865	3				3		
	9		1.20	1.22	68	69		197	23.042	3				3		
	10		1.25	1.29	67	69		197	23.220	3				3		
	11		1.25	1.29	67	69		196	23.420	3				3		
	12	↓	1.25	1.29	67	69		197	23.601	3		↓	↓	3	↓	

D-11

Probe Wash 2-PW-I | Cleaning Patch N/A

Silica Gel 2-S-I | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

20 ml used to purge probe 20 sec R-1 pre leak test

FIELD DATA SHEETS

Firm Name: CF Ind
Plant Location: Donaldsonville LA
Test No.: 2
Sampling Location: Scrubber outlet
TRC Project No.: 82988-20
Date: 1/12/79
Tester: JEK

Pump No.: 12
Orifice No.: D-6
Ambient Temp: 70 °F
Bar Press: 30.39 "Hg
Probe Ident. No.: 44-37
Filter Ident. No.: NA
Duct Area: (49.5" dia) 13.36 ft^2

Nozzle No. & Dia.: 5.2 (0.1876) in.
Assumed Moisture: 4 %
Test Duration: 108 min.
Traverse Point Interval: 3 min.
Probe Heater Setting: 170°F (1.5a) amps
Filter Temp. Setting: NA
Dry Gas Meter Y: 1.00

Nomograph C Factor: 0.97
Pitot Coefficient: 0.823 (RJ)
Orifice ΔH_A: 1.88
Test Start Time: 3:48 PM
Test End Time: 6:56 PM
Leak Test Start: 0.01 CFM@ 15 "Hg
Leak Test Final: 0.003 CFM@ 5 "Hg

0.71 ft³ air used to unplug probe

3 of 3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ∅	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
B	13	30	1.15	1.18	68	69	-2.70	196	237.91	3		NA	50	3	170	
	14		1.10	1.12	68	69		193	239.72	3				3		
	15		1.05	1.08	68	69		191	241.53	3				3		
	16		0.98	1.00	69	70		192	243.28	3				3		
	17		0.98	1.00	70	70		184	245.00	3				3		
outside wall	18		0.98	1.00	71	72		140	246.63	3				3		
end of test									248.31	3						

Probe Wash: 2-PW-I
Silica Gel: 2-S-I
Silica Gel Cond.:

Cleaning Patch: N/A
H_2O Collected:
H_2O Condition:

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF Ind	Pump No. 12	Nozzle No. & Dia. 5-2 (0.1876) in.	Nomograph C Factor 0.97
Plant Location Donaldsonville LA	Orifice No. D-6	Assumed Moisture 4 %	Pitot Coefficient 0.823 (rev)
Test No. 3	Ambient Temp 63 °F	Test Duration 108 min.	Orifice ΔH$_A$ 1.88
Sampling Location Scrubber inlet	Bar Press 30.27 "Hg	Traverse Point Interval 3 min.	Test Start Time 9:47 AM
TRC Project No. 82988-20	Probe Ident. No. 37	Probe Heater Setting 1.5 amps	Test End Time 12:10 PM
Date 1/18/79	Filter Ident. No. NA	Filter Temp. Setting NA	Leak Test Start 0.01 CFM@ 18 "Hg
Tester JEK DAK	Duct Area (49½" dia) ft²	Dry Gas Meter Y 1.00	Leak Test Final 0.001 CFM@ 5 "Hg

rotor for airweed to sampling probe

1 of 3

Port	Point	Time Min (3–5)	Velocity ΔP in H_2O (6–10)	ΔH in H_2O (12–15)	T_M in °F (18–20)	T_M Out °F (23–25)	P_{STACK} in H_2O (26–30)	T_{STACK} °F (32–35)	Initial Meter Volume cu. ft. (40–45)	Probe (50)	Cyc. Angle ϕ (52–53)	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	1	30	1.30	1.36	60	61	-2.30	182	248.50	3		NA	50	3½	170	
	2	30	1.20	1.24	61	61		190	250.30	3				3½		
	3	30	1.20	1.24	61	62		190	252.10	3				3½		
	4	30	1.20	1.24	61	62		190	254.12	3				3½		
	5	30	1.10	1.13	62	62		191	255.94	3				3½		
	6	30	1.20	1.24	62	62		191	257.73	3				3½		
	7	30	1.20	1.24	62	63		191	259.58	3				3½		
	8	30	1.05	1.09	62	63		191	261.42	3				3		
	9	30	1.10	1.13	63	63		191	263.13	3				3		
	10	30	1.00	1.02	63	63		191	264.91	3				3		
	11	30	1.25	1.30	63	63		184	266.57	3				3		
	12	30	1.30	1.37	64	64		195	268.54	3				3½		
	13	30	1.20	1.24	63	64		188	270.47	3				3½		
	14	30	1.20	1.24	64	65		186	272.34	3				3½		
	15	30	1.10	1.13	64	65		176	274.20	3				3½		
	16	30	1.00	1.02	64	65		164	275.92	3						

Probe Wash 3-PW-I

Silica Gel 3-S-I

Silica Gel Cond.

Cleaning Patch N/A

H_2O Collected

H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF Inds.

Plant Location Donaldsonville LA

Test No. 3

Sampling Location Scrubber inlet

TRC Project No. 82988-20

Date 1/18/79

Tester JEK DAK

Pump No. 12

Orifice No. D-6

Ambient Temp 63 °F

Bar Press 30.27 "Hg

Probe Ident. No. 37

Filter Ident. No. NA

Duct Area (49½" dia) ft²

Nozzle No. & Dia. S-2 (.01876) in.

Assumed Moisture 4 %

Test Duration 108 min.

Traverse Point Interval 3 min.

Probe Heater Setting 1.5 amps

Filter Temp. Setting NA

Dry Gas Meter Y 1.00

Nomograph C Factor 0.97

Pitot Coefficient 0.823 (VPJ)

Orifice ΔH_A 1.88

Test Start Time 9:47 AM

Test End Time 12:10 PM

Leak Test Start 0.01 CFM @ 18 "Hg

Leak Test Final 0.001 CFM @ 5 "Hg

not corr for air used to sampling probe.

2 of 3

Port	Point	Time Min (3-5)	Velocity ΔP in H_2O (6-10)	ΔH in H_2O (12-15)	T_M in °F (18-20)	T_M Out °F (23-25)	P_{STACK} in H_2O (26-30)	T_{STACK} °F (32-35)	Initial Meter Volume cu. ft. (40-45)	PROBE (50)	Cyc. Angle ø (52-53)	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
R	17	30	090	093	65	66	-250	164	27793	3		NA	50	3	170	
	18	30	090	093	65	66	↓	130	27955	3				5		
									28114	3						
										3						
L	1	30	110	113	66	66	-250	170	28114	3						
	2	30	110	113	66	68		184	28310	3				3		
	3	30	115	120	67	68		189	28490	3				3		
	4	30	110	113	67	68		189	28670	3				3		
	5	30	110	113	67	68		189	28849	3				3		
	6	30	120	124	67	68		189	29028	3				3		
	7	30	120	124	67	68		190	29213	3				3		
	8	30	120	124	67	68		191	29400	3				3		
	9	30	120	124	67	68		191	29584	3				3½		
	10	30	120	124	67	68		191	29770	3				3½		
	11	30	115	120	67	68		191	29953	3				3½		
	12	30	115	120	68	68	↓	190	30133	3		↓	↓	3½	↓	
														3½		

Probe Wash 3-PW-I

Silica Gel 3-S-I

Silica Gel Cond.

Cleaning Patch N/A

H_2O Collected

H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 12 | Nozzle No. & Dia. 5-2 (0.1876) in. | Nomograph C Factor 0.97

Plant Location Donaldsonville LA | Orifice No. D-6 | Assumed Moisture 4 % | Pitot Coefficient 0.823 (rev)

Test No. 3 | Ambient Temp 63 °F | Test Duration 108 min. | Orifice ΔH_A 1.88

Sampling Location Scrubber inlet | Bar Press 30.27 "Hg | Traverse Point Interval 3 min. | Test Start Time 9:47AM

TRC Project No. 82988-20 | Probe Ident. No. 37 | Probe Heater Setting 1.5 amps | Test End Time 12:10PM

Date 11/18/19 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.01 CFM @ 18 "Hg

Tester AK DAL | Duct Area (4ft 1/2in) ft^2 | Dry Gas Meter Y 1.08 | Leak Test Final 0.001 CFM @ 5 "Hg

hot can for ambient to sampling probe

3 of 3

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
L	13	30	1.10	1.14	68	69	-2.30	189	303.15			NA	50	3½	170	
	14		1.10	1.14	68	69		189	304.95					3½		
	15		1.20	1.24	68	70		184	306.75					3½		
	16		1.15	1.18	68	70		181	308.58					3½		
	17		0.90	0.93	69	70		160	310.41					3		
	18		0.90	0.93	69	70		150	312.10					3		
out of hol				~~1.09~~					313.68							
			1.06	1.17	69	70	-2.30	183	313.68							

Probe Wash 3-PW-I | Cleaning Patch NA

Silica Gel 3-S-I | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

D-15

APPENDIX D-2

SCRUBER OUTLET LOCATION TP-2
FIELD DATA SHEETS

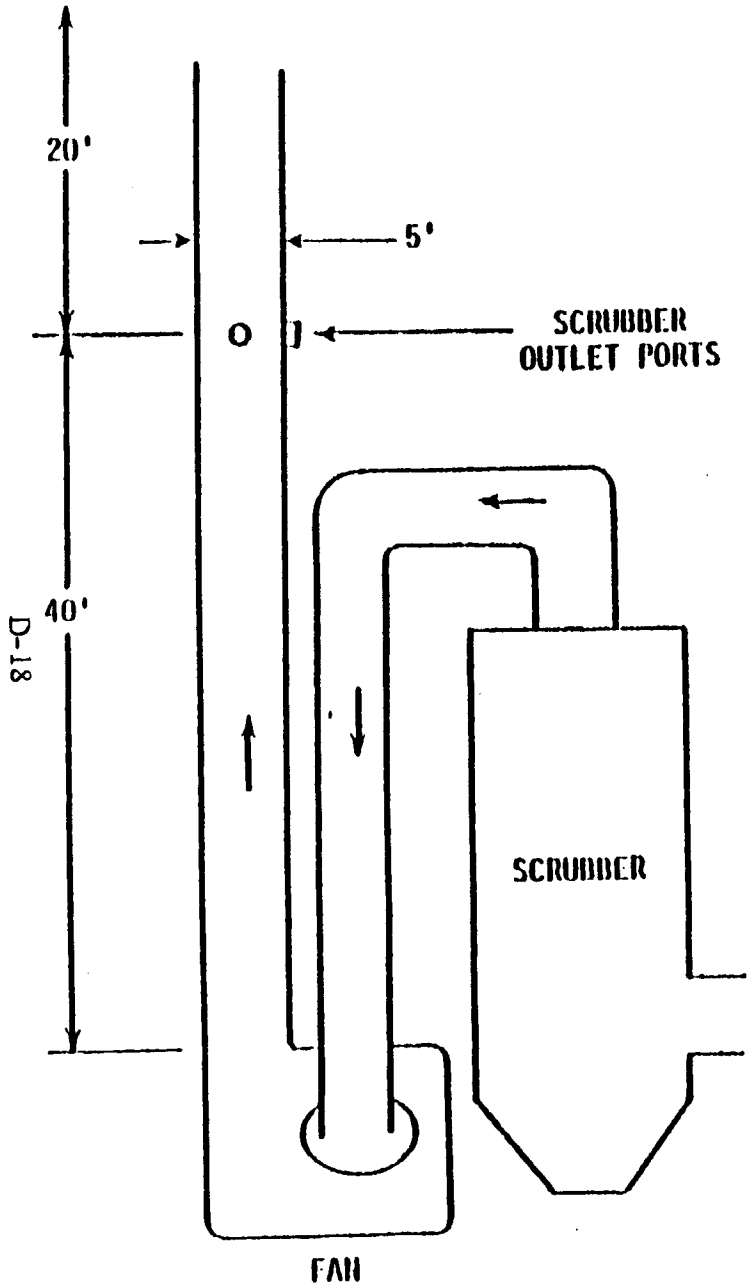
TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

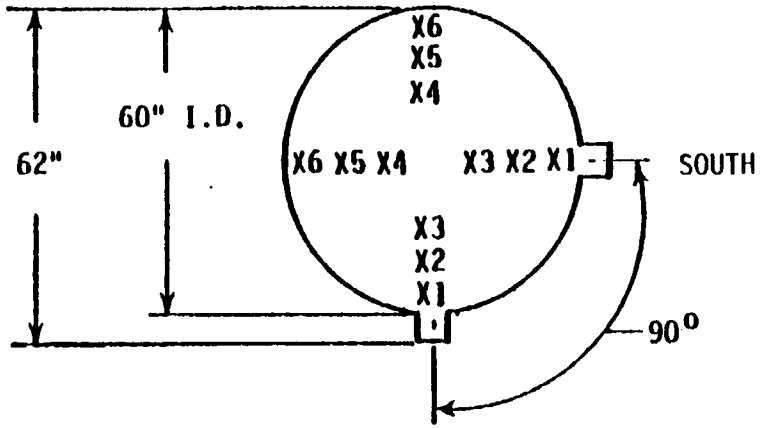
PLANT CF Industries Inc., Donaldsonville, Louisiana
DATE 1/17/79
SAMPLING LOCATION Granulator "B" scrubber outlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 62"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 2"
STACK I.D., (DISTANCE A - DISTANCE B) 60"
NEAREST UPSTREAM DISTURBANCE 40'
NEAREST DOWNSTREAM DISTURBANCE 10'
CALCULATOR S. Richardson

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.044	60"	2 5/8"	2"	4 5/8"
2	0.146	↓	8 3/4"	↓	10 3/4"
3	0.296	↓	17 3/4"	↓	19 3/4"
4	0.704	↓	42 1/4"	↓	44 1/4"
5	0.854	↓	51 1/4"	↓	53 1/4"
6	0.956	↓	57 3/8"	↓	59 3/8"

EPA (Dur) 232
4/72





TRAVERSE POINT NO.	TRAVERSE POINT DISTANCE FROM OUTSIDE EDGE OF NIPPLE (INCHES)
1	4 5/8"
2	10 3/4"
3	19 3/4"
4	44 1/4"
5	53 1/4"
6	59 3/8"

LOCATIONS OF "B" GRANULATOR SCRUBBER OUTLET TEST PORTS AND POINTS AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

NOMOGRAPH DATA

PLANT CF Industries Inc., Donaldsonville, Louisiana

DATE 1/17/79

SAMPLING LOCATION Granulator "B" scrubber outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.68
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	~70°F
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	~4%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.4
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	30.37
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.999
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	~100°F
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	~0.57
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	~0.69
C FACTOR	0.88	
CALCULATED NOZZLE DIAMETER, in.	0.246	
ACTUAL NOZZLE DIAMETER, in.	0.2575	
REFERENCE Δp, in. H_2O	0.48	

EPA (Dur) 234
4/72

Velocity Check

FIELD DATA SHEETS

Firm Name C F | Pump No. | Nozzle No. & Dia. | in. | Nomograph C Factor

Plant Location Donaldsonville | Orifice No. | Assumed Moisture | % | Pitot Coefficient

Test No. V | Ambient Temp | °F | Test Duration | min. | Orifice ΔH_A

Sampling Location Scrubber Out | Bar Press | "Hg | Traverse Point Interval | min. | Test Start Time

TRC Project No. | Probe Ident. No. | Probe Heater Setting | amps | Test End Time

Date 4/16/78 | Filter Ident. No. | Filter Temp. Setting | Leak Test Start | CFM@ | "Hg

Tester SFR DR | Duct Area | ft^2 | Dry Gas Meter Y | Leak Test Final | CFM@ | "Hg

Port	Point	3 4 5 Time Min	6 7 8 9 10 Velocity ΔP in H_2O	12 13 14 15 ΔH in H_2O	18 19 20 T_M in °F	23 24 25 T_M Out °F	26 27 28 29 30 P_{STACK} in H_2O	32 33 34 35 T_{STACK} °F	40 41 42 43 44 45 Initial Meter Volume cu. ft.	50 PROBE	52 53 Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
			390					96			00					
			470					97			00					
			580				-46	98			00					
			590					98			00					
			700					98			00					
			640					97			00					
			460					96			00					
			530					96			00					
			650					97			00					
			710				-46	97			00					
			670					97			00					
			600					97			00					

~~Avg = 597~~ Avg 597

Probe Wash | Cleaning Patch

Silica Gel | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CE | Pump No. 24 | Nozzle No. & Dia. .2575 #4-2 in. | Nomograph C Factor .883 | Tm 80°

Plant Location Donaldsonville | Orifice No. 05 | Assumed Moisture 4 % | Pitot Coefficient .834

Test No. 1 | Ambient Temp 68 °F | Test Duration 120 min. | Orifice ΔH_A 1.68

Sampling Location Scrubber Out | Bar Press 30.4 "Hg | Traverse Point Interval 10 min. | Test Start Time 1202

TRC Project No. 82988-20 | Probe Ident. No. 38 | Probe Heater Setting 120° amps | Test End Time 1416

Date 1/17/88 | Filter Ident. No. N/A | Filter Temp. Setting N/A | Leak Test Start 0.002 CFM@ 10" "Hg

Tester SER DR | Duct Area 12.635 ft² | Dry Gas Meter Y | Leak Test Final CFM@ "Hg

Port	Point	3 4 5 Time Min	6 7 8 9 10 Velocity ΔP in H_2O	12 13 14 15 ΔH in H_2O	18 19 20 T_M in °F	23 24 25 T_M Out °F	26 27 28 29 30 P_{STACK} in H_2O	32 33 34 35 T_{STACK} °F	40 41 42 43 44 45 Initial Meter Volume cu. ft.	50 PROBE	52 Cyc. Angle	53	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	Scrubber ΔP / O_2 Conc. %
1	1	5 0	6 1 0	2 3 0 0	6 9	7 3		1 0 1	4 8 9 1	2	N/A		N/A	51	3.2	113	
	1	5 0	6 0 0	2 2 5 0	7 2	7 3		9 9	5 3 0 0	2				53	3.2	119	21.8
	2	5 0	6 5 0	2 4 5 0	7 2	7 2		9 9	5 7 1 2	2				58	3.7	118	21.6
	2	5 0	6 5 0	2 4 5 0	7 2	7 2		9 9	6 1 6 3	2				58	3.7	118	21.5
	3	5 0	6 8 0	2 6 0 0	7 1	7 2		9 8	6 5 9 3	2				58	4.5	125	20.9
	3	5 0	6 8 0	2 6 0 0	7 1	7 2		1 0 1	7 0 5 0	2				58	4.5	122	20.7
	4	5 0	6 0 0	2 2 5 0	7 2	7 2	- 3 5	1 0 2	7 5 0 5	2				59	3.5	122	20.7
	4	5 0	6 1 0	2 3 0 0	7 1	7 1		1 0 3	7 9 3 7	2				60	3.9	121	20.7
	5	5 0	4 7 0	1 7 9 0	7 1	7 2		1 0 3	8 3 7 0	2				60	3.0	122	21.1
	5	5 0	4 8 0	1 8 2 0	7 1	7 1		1 0 3	8 8 3 0	2				60	3.0	121	21.1
	6	5 0	4 0 0	1 5 1 0	7 1	7 2		1 0 3	9 1 9 0	2				60	2.0	121	20.7
	6	5 0	4 2 0	1 6 0 0	7 1	7 2		1 0 3	9 5 5 0	2				60	2.0	121	20.5
									9 9 2 3	2							

D-21

Probe Wash 1-PW-0 | Cleaning Patch N/A

Silica Gel 1-S-0 | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

Firm Name CT — Pump No. 11 — FIELD DATA SHEETS — Nozzle No. & Dia. .2575 4-2 in. — Nomograph C Factor .88

Plant Location Donaldsonville — Orifice No. D-5 — Assumed Moisture 7 % — Pitot Coefficient .834

Test No. 1 — Ambient Temp 68 °F — Test Duration 120 min. — Orifice ΔH_A 1.68

Sampling Location Scrubber Out — Bar Press 30.39 "Hg — Traverse Point Interval 10 min. — Test Start Time 1201

TRC Project No. 8295 — Probe Ident. No. 38 — Probe Heater Setting 120 °F amps — Test End Time 1416

Date 4/17/78 — Filter Ident. No. N/A — Filter Temp. Setting N/A — Leak Test Start 0.002 CFM @ 10 "Hg

Tester SPR DR — Duct Area 19.635 ft² — Dry Gas Meter Y — Leak Test Final 0.000 CFM @ 5 "Hg

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	Scrubber O_2 Conc. %
2	1	5.0	5.5	2.1	72	72		98	992.3	2	N/A	N/A	58	3.8	123	20.5
	1	5.0	6.0	2.2	72	72		98	1031.7	2			58	3.5	123	20.7
	2	5.0	6.1	2.3	71	72		98	1076.0	2			68	3.7	123	20.9
	2	5.0	6.3	2.3	71	71		98	1118.0	2			60	3.9	123	20.9
	3	5.0	6.9	2.6	71	72		100	1161.8	2			60	4.5	118	20.7
	3	5.0	6.7	2.5	71	72		98	1206.3	2			55	4.5	123	20.7
	4	5.0	6.2	2.3	71	72	-.35	98	1250.1	2			55	3.9	123	20.7
	4	5.0	6.2	2.3	71	72		98	1293.5	2			55	3.9	123	20.9
	5	5.0	5.5	2.0	71	72		101	1330.4	2			55	3.2	122	20.7
	5	5.0	5.5	2.0	71	72		103	1384.2	2			55	3.2	122	20.5
	6	5.0	4.0	1.5	71	72		102	1423.9	2			55	2.0	122	20.5
	6	5.0	4.0	1.5	71	72		101	1462.0	2			55	2.0	122	20.5
		6.754	2.164		71.5		-0.35	100.5	1499.5	2						
									1501.4							

D-22

Probe Wash 1N-0 — Cleaning Patch N/A

Silica Gel 1-5-0 — H_2O Collected

Silica Gel Cond. B P — H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

1.52

FIELD DATA SHEETS

Firm Name C-E | Pump No. 11 | Nozzle No. & Dia. .1575 4-2 in. | Nomograph C Factor .88

Plant Location Donaldsonville | Orifice No. D-5 | Assumed Moisture 4 % | Pitot Coefficient .834

Test No. 2 | Ambient Temp 68 °F | Test Duration 120 min. | Orifice ΔH_A 1.68

Sampling Location Scrubber Out | Bar Press 30.38 "Hg | Traverse Point Interval 10 min. | Test Start Time 1549

TRC Project No. 82988-20 | Probe Ident. No. 38 | Probe Heater Setting 120°F amps | Test End Time ~~1644~~ 1753

Date 1/12/78 | Filter Ident. No. N/A | Filter Temp. Setting N/A | Leak Test Start .002 CFM@ 6 "Hg

Tester SFR DR | Duct Area 19.635 ft^2 | Dry Gas Meter Y | Leak Test Final .000 CFM@ 5 "Hg

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_H in °F	T_H Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	~~O_2~~ Conc. %
1	1	5.0	.580	2.200	~~193~~	74		100	150.10	2	N/A	N/A	49	2.7	122	20.2
	1	5.0	.580	2.200	~~171~~	72		100	154.20	2			49.	2.7	121	20.2
	2	5.0	.650	2.450	~~190~~	72		102	158.60	2			~~49~~	3.3	123	20.2
	2	5.0	.650	2.450	170	72		102	162.80	2			58	3.3	122	20.8
	3	5.0	.670	2.520	170	72		101	167.32	2			58	3.5	122	20.9
	3	5.0	.670	2.520	170	71		102	171.89	2			58	3.5	122	20.9
	4	5.0	.560	2.110	170	71	-.31	103	176.45	2			59	3.0	122	20.7
	4	5.0	.560	2.110	169	71		102	180.77	2			59	3.0	122	20.8
	5	5.0	.480	1.820	169	70		103	185.00	2			55	2.4	122	20.9
	5	5.0	.470	1.790	168	70		102	189.00	2			53	2.3	121	21.0
	6	5.0	.350	1.320	168	69		100	193.00	2			51	1.5	122	21.0
	6	5.0	.350	1.320	168	69		99	196.35	2			51	1.5	122	20.2
									199.88	2						

Probe Wash 2-PW-0 | Cleaning Patch N/A

Silica Gel 2-S-0 | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

Pt-02

FIELD DATA SHEETS

Firm Name CF | Pump No. 11 | Nozzle No. & Dia. .2575 4-2 in. | Nomograph C Factor .88

Plant Location Donaldsonville | Orifice No. 05 | Assumed Moisture 4 % | Pitot Coefficient .834

Test No. 2 | Ambient Temp 68 °F | Test Duration 120 min. | Orifice ΔH_A 1.68

Sampling Location Scrubber Out | Bar Press 30.38 "Hg | Traverse Point Interval 10 min. | Test Start Time 1549

TRC Project No. 82988-20 | Probe Ident. No. 38 | Probe Heater Setting 120°F amps | Test End Time 1753

Date 1/17/78 | Filter Ident. No. N/A | Filter Temp. Setting N/A | Leak Test Start 0.002 CFM @ 6 "Hg

Tester SFR DR | Duct Area 19.635 ft² | Dry Gas Meter Y | Leak Test Final 0.000 CFM @ 5 "Hg

Port	Point	3 4 5 Time Min	6 7 8 9 10 Velocity ΔP in H_2O	12 13 14 15 ΔH in H_2O	18 19 20 T_H in °F	23 24 25 T_M Out °F	26 27 28 29 30 P_{STACK} in H_2O	32 33 34 35 T_{STACK} °F	40 41 42 43 44 45 Initial Meter Volume cu. ft.	50 PROBE	52 Cyc. Angle ϕ	53 Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
2	1	5 0	5 6 0	2 1 1 0	6 7	6 8		1 0 0	1 9 9 8 8	2	N/A	N/A	48	3.3	120	20.4
	1	5 0	5 8 0	2 2 0 0	6 7	6 8		1 0 0	2 0 3 9 3	2			49	3.3	124	20.4
	2	5 0	6 2 0	2 3 0 0	6 6	6 8		1 0 1	2 0 8 2 4	2			49	3.5	123	20.4
	2	5 0	6 3 0	2 3 5 0	6 6	6 7		1 0 0	2 1 2 7 0	2			50	3.5	123	20.2
	3	5 0	6 7 0	2 5 2 0	6 5	6 7		9 9	2 1 7 2 0	2			50	4.5	122	20.3
	3	5 0	6 8 0	2 5 9 0	6 6	6 7	-.38	9 9	2 2 1 5 2	2			52	4.5	123	20.4
	4	5 0	6 2 0	2 3 0 0	6 6	6 7		1 0 0	2 2 6 2 0	2			52	3.5	124	20.6
	4	5 0	6 2 0	2 3 0 0	6 5	6 6		1 0 2	2 3 0 6 3	2			52	3.5	124	20.6
	5	5 0	5 4 0	2 0 2 0	6 5	6 6		1 0 0	2 3 5 0 2	2			52	3.0	124	20.6
	5	5 0	5 9 0	2 0 2 0	6 6	6 6		1 0 2	2 3 9 2 1	2			52	3.0	124	20.4
	6	5 0	4 0 0	1 5 1 0	6 6	6 7		9 9	2 4 3 6 0	2			53	1.5	124	20.4
	6	5 0	4 0 0	1 5 1 0	6 6	6 7		1 0 0	2 4 7 0 8	2			53	1.5	124	20.2
									2 5 0 8 2	2						
		0 7 5 0	2 1 0 6			6 8.4	-0345	1 0 0.7								
									1 0 0 7 2							

D-24

Probe Wash 2-P,W-0 | Cleaning Patch N/A

Silica Gel 2-S-0 | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF | Pump No. 11 | Nozzle No. & Dia. .2575 4-2 in. | Nomograph C Factor .86

Plant Location Donaldsonville | Orifice No. D-5 | Assumed Moisture 5 % | Pitot Coefficient .834

Test No. 3 | Ambient Temp 58 °F | Test Duration 120 min. | Orifice ΔH_A 1.68

Sampling Location Scrubber Out | Bar Press ____ "Hg | Traverse Point Interval 10 min. | Test Start Time 0946

TRC Project No. 82988-20 | Probe Ident. No. 38 | Probe Heater Setting 120°F amps | Test End Time 1217

Date 1/18/79 | Filter Ident. No. N/A | Filter Temp. Setting N/A | Leak Test Start 0.000 CFM 5 "Hg

Tester SFR DR | Duct Area 19.635 ft^2 | Dry Gas Meter Y ____ | Leak Test Final 0.000 CFM 5 "Hg

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	Scrubber ΔP Dry Gas Conc. %
1	1	5.0	.62	2.30	63	63		103	251.04	2	N/A	N/A	52	3.0	119	21.6
	1	5.0	.58	2.20	63	63		101	253.50	2			47	3.0	119	21.2
	2	5.0	.65	2.45	63	63		102	258.70	2			52	3.5	119	21.0
	2	5.0	.65	2.45	63	63		101	263.19	2			54	3.5	118	21.1
	3	5.0	.67	2.51	63	63		103	267.65	2			54	3.8	119	21.0
	3	5.0	.65	2.45	63	63	-.33	104	272.20	2			54	3.5	118	21.2
	4	5.0	.56	2.11	63	63		104	276.65	2			54	3.0	121	21.0
	4	5.0	.56	2.10	63	63		105	280.93	2			55	3.0	121	20.7
	5	5.0	.49	1.84	63	63		103	285.13	2			55	2.4	120	20.5
	5	5.0	.50	1.88	63	63		104	289.09	2			56	2.4	120	20.7
	6	5.0	.37	1.40	63	63		102	293.02	2			55	1.5	120	20.6
	6	5.0	.37	1.40	64	64		101	296.55	2			55	1.5	120	20.7
									300.14	2						
										2						
										2						
										2						

D-25

Probe Wash 3-PW-0 | Cleaning Patch N/A

Silica Gel 3-S-0 | H_2O Collected ____

Silica Gel Cond ____ | H_2O Condition ____

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF | Pump No. 11 | Nozzle No. & Dia. .2575 9-2 in. | Nomograph C Factor .86

Plant Location Donaldsonville | Orifice No. D-5 | Assumed Moisture 5 % | Pitot Coefficient .834

Test No. 3 | Ambient Temp 58 °F | Test Duration 120 min. | Orifice ΔH_A 1.68

Sampling Location Scrubber Out | Bar Press ____ "Hg | Traverse Point Interval 10 min. | Test Start Time 0846

TRC Project No. 82988-20 | Probe Ident. No. 38 | Probe Heater Setting 120°F amps | Test End Time 1217

Date 1/18/78 | Filter Ident. No. N/A | Filter Temp. Setting N/A | Leak Test Start 0.000 CFM@ 5 "Hg

Tester SFR DR | Duct Area 19.634 ft^2 | Dry Gas Meter Y ____ | Leak Test Final 0.000 CFM@ 5 "Hg

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	Probe	Cyc. Angle °	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	Scrubber O_2 or CO_2 Conc. %
2	1	5.0	6.00	2.250	66	66		102	300.174	2	N/A	N/A	45	3.4	121	20.5
	1	5.0	5.80	2.200	66	66		101	304.224	2			46	3.3	121	20.5
	2	5.0	6.40	2.400	66	66		101	309.585	2			52	3.7	120	20.4
	2	5.0	6.80	2.550	66	66		101	312.986	2			54	3.7	120	20.6
	3	5.0	6.80	2.580	67	69		102	317.550	2			55	4.0	120	20.3
	3	5.0	6.80	2.580	66	66		101	322.207	2			55	4.0	120	20.3
	4	5.0	6.00	2.250	66	67	-.30	103	326.711	2			55	3.5	120	20.2
	4	5.0	6.00	2.250	67	67		105	331.108	2			57	3.5	120	20.1
	5	5.0	5.20	1.950	67	69		104	335.445	2			57	2.6	119	19.8
	5	5.0	5.20	1.950	67	67		103	339.754	2			57	2.6	120	20.0
	6	5.0	4.20	1.590	68	68		102	343.588	2			58	2.0	120	19.7
	6	5.0	4.20	1.590	68	68		102	347.227	2			58	2.0	120	19.5
									351.111	2						
		0.75	2.13	6	4.9		-.30	102.5								
									100.07							

Probe Wash 3-PW-0 | Cleaning Patch N/A

Silica Gel 3-S-0 | H_2O Collected ____

Silica Gel Con ____ | H_2O Condition ____

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name C-7 IND | Pump No. | Nozzle No. & Dia. | in. | Nomograph C Factor

Plant Location Donaldsonville, La | Orifice No. | Assumed Moisture | % | Pitot Coefficient

Test No. MOISTURE DET CO2/O2 | Ambient Temp | °F | Test Duration 34 | min. | Orifice ΔH_A

Sampling Location INLET | Bar Press | "Hg | Traverse Point Interval | min. | Test Start Time 1615

TRC Project No. 82988-20 | Probe Ident. No. | Probe Heater Setting | amps | Test End Time 1649

Date 1/18/76 | Filter Ident. No. | Filter Temp. Setting | Leak Test Start 0.00 CFM @ 15 "Hg

Tester DAK | Duct Area | ft^2 | Dry Gas Meter Y | Leak Test Final 0.00 CFM @ 15 "Hg

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ϕ	Heater Box Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
		5.0		2.5	80	80		197	31943				60	10		
		5.0		2.5	80	81		197	32387.5				60	10		
		5.0		2.5	80	81		197	32825				60	16		
		5.0		2.5	80	81		197	33264				60	10		
		5.0		2.5	80	81		197	33714				60	10		
		5.0		2.5	80	81		197	34160				66	10		
		4.0		2.5	80	81		197	34605				65	10		
									34977							

Probe Wash | Cleaning Patch

Silica Gel | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

APPENDIX E

FIELD DATA FOR MISCELLANEOUS SAMPLES AND OPERATIONS

INCLUDES:

APPENDIX E-1

SCRUBBER WATER DATA (INLET AND OUTLET)

INCLUDES:

Collection Times, pH, Temp.
and Laboratory Analysis Results

SUMMARY OF JANUARY 17 AND 18, 1979 pH AND TEMPERATURE MEASUREMENTS ON INDIVIDUAL SAMPLES OF SCRUBBING LIQUID ENTERING AND EXITING "B" GRANULATOR SCRUBBER AT CF INDUSTRIES, INC., DONALDSONVILLE, LOUISIANA

			Scrubber Inlet Sample		Scrubber Outlet Sample	
Run No.	Date	Sampling Time	pH	°F	pH	°F
1	01-17-79	1215	9.50	135	8.15	126
		1255	9.25	154	8.10	124
		1331	9.15	164	8.10	124
		1416	9.10	152	7.95	120
2	01-17-79	1550	9.7	166	8.3	129
		1620	9.5	183	8.2	128
		1655	9.2	174	8.2	129
		1725	9.2	167	8.1	128
		1800	9.0	172	8.0	129
3	01-18-79	0955	9.2	180	8.30	128
		1030	9.3	~~172~~ 172	8.25	126
		1105	9.3	177	8.25	129
		1140	9.3	173	8.20	127
		1215	9.2	173	8.20	124

Project No. CFI Donaldsonville

Book No. _____ TITLE Scrubber inlet/outlet temp, pH

Page No. ____

Test #	Scrubber Inlet			Scrubber Outlet			date
	time	temp, °F	pH	time	temp, °F	pH	~~1/17/79~~ KWC
1-1	1216	135	9.50	1214	126	8.15	1/17/79
1-2	1256	154	9.25	1254	124	8.10	"
1-3	1333	164	9.15	1330	124	8.10	"
1-4	1417	152	9.10	1415	120	7.95	"
~~1-5~~							
2-1	1550	166	9.7	1550	129	8.3	"
2-2	1620	183	9.5	1620	128	8.2	"
2-3	1655	174	9.2	1655	129	8.2	"
2-4	1725	167	9.2	1725	128	8.1	"
2-5	1800	172	9.0	1800	128	8.0	"
3-1	0955	180	9.2	0955	128	8.3	1/18/79
3-2	1030	172	9.3	1030	126	8.25	"
3-3	1105	177	9.3	1105	129	8.25	"
3-4	1140	173	9.3	1140	127	8.2	"
3-5	1215	173	9.2	1215	124	8.2	"

To Page No. ____

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		Recorded by	

SUMMARY OF UREA, AMMONIA AND FORMALDEHYDE MEASUREMENTS ON THE SCRUBBING LIQUID ENTERING AND LEAVING THE "B" GRANULATOR SCRUBBER AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

Run Number	Run 1		Run 2		Run 3		Average	
Date	01-17-79		01-17-79		01-18-79			
Location	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Urea Concentration (mg/l)[e]								
Uncorrected[a]	114	516300	83	525100	94	538300	97	526600
Corrected[b]	122	552400	89	561900	101	576000	104	563400
Ammonia Concentration (mg/l)								
Direct Nesslerization	180	f	44	f	23	f	82	-
Distilled Uncorrected[c]	138[i]	14100	52[j]	12800	31	13100	74	13330
Distilled Corrected[d]	133	-7800	85	-9500	27	-9700	82	-
Formaldehyde Concentration (mg/l)	26	0.01	20	0.08	14	0.05	20	0.05
pH[g]	9.25	8.08	9.32	8.16	9.26	8.24	9.28	8.16
Temperature (°F)[h]	151	124	172	128	175	127	166	126
Percent Solids	1.2	3.9	0.9	4.6	3.6	4.8	1.9	4.4

[a]Kjeldahl analysis results uncorrected for urea conversion during distillation.
[b]Kjeldahl analysis results corrected for urea conversion during distillation (corrected = uncorrected x 1.07).
[c]Distillation/Nesslerization (D/N) analysis results uncorrected for urea conversion during distillation.
[d]D/N analysis results corrected for urea conversion (corrected = uncorrected - 0.07*corrected urea/1.765).
[e]Milligrams per liter.
[f]Average spectrophotometric measurement not possible due to turbidity.
[g]Average of several individual liquid samples taken during each run.
[h]Average of individual sample temperatures taken immediately after collection.
[i]Average slight turbidity may have given high instrument readings. Visual estimate for this sample is 60 mg/l.
[j]Average slight turbidity may have given high instrument readings. Visual estimate for this sample is 30 mg/l.

APPENDIX E-2

SCRUBBER PRESSURE DROPS

SUMMARY OF JANUARY 17 and 18, 1979 "B" GRANULATOR SCRUBBER PRESSURE DROP MEASUREMENTS AT CF INDUSTRIES, INC. IN DONALDSONVILLE, LOUISINA

DATE	CLOCK TIME	ΔP, "H_2O
1-17-79		
	1207	21.8
	1212	21.6
	1217	21.5
	1222	20.9
	1227	20.7
	1232	20.7
	1237	20.7
	1242	21.1
	1247	21.1
	1252	20.7
	1257	20.5
1-17-79	1321	20.5
	1326	20.7
	1331	20.9
	1336	20.9
	1341	20.7
	1346	20.7
	1351	20.7
	1356	20.9
	1401	20.7
	1406	20.5
	1411	20.5
	1416	20.5
1-17-79	1549	20.2
	1554	20.2
	1559	20.2
	1604	20.8
	1609	20.9
	1614	20.9
	1619	20.7
	1624	20.8
	1629	20.9
	1634	21.0
	1639	21.0
	1644	20.2
1-17-79	1658	20.4
	1703	20.4
	1708	20.4
	1713	20.2
	1718	20.3
	1723	20.4
	1728	20.6
	1733	20.6
	1738	20.6
	1743	20.4
	1748	20.4
	1753	20.2
1-18-79	0946	21.6
	0951	21.2
	0956	21.0
	1001	21.1
	1006	21.0
	1011	21.2
	1016	21.0
	1021	20.7
	1026	20.5
	1031	20.7
	1036	20.6
	1041	20.7
1-18-79	1122	20.5
	1127	20.5
	1132	20.4
	1137	20.6
	1142	20.3
	1147	20.3
	1152	20.2
	1157	20.1
	1202	19.8
	1207	20.0
	1212	19.7
	1217	19.5

APPENDIX E-3

PROCESS SAMPLES ANALYSIS DATA

1. Details Specific to the Analysis of the Scrubber Liquid Samples:

a. Urea

A five ml. aliquot of the scrubber inlet and outlet water sample was digested and distilled to 250 ml. The inlet sample was analyzed in this state, while the outlet scrubber sample distillate was diluted 100 fold, and a 2 ml. aliquot of this was taken for nesslerization.

b. Ammonia

The inlet scrubber waters from Test 1 and 2 were cloudy after the addition of nessler reagent to the distilled samples. Visual estimation of color intensity against the standard solution color intensity yielded "estimated" ammonia concentrations.

The outlet scrubber waters from all three tests were very cloudy when analyzed by the direct nesslerization method, precluding either instrumental or visual determination of ammonia concentrations.

c. Formaldehyde

Dilutions of the liquid samples was not required. The samples were analyzed directly by colorimetric analysis.

The three outlet scrubber water sample concentrations were below the limit of detection for formaldehyde (<0.05 µg/ml.)

2. Analysis of the Process Samples:

A. Chemical Analysis

Two solid samples were received for analysis. Samples for analysis were prepared by weighing approximately 1 gram of sample to the nearest 0.1 mg. and then diluting it to 100.0 ml. with deionized distilled water. Aliquots of these solutions were taken for the analyses which were carried out without problems from interferences for ammonia and urea. A problem with the formaldehyde analysis is described in Appendix J.

The laboratory results were reported as the percent of each component present in the sample.

B. Bulk Density Analytical Procedure

The bulk density of the unscreened product was determined using a graduated cylinder and platform balance.

The sample was passed through a riffle and a 300-350 ml portion was obtained. The tare weight of the graduated cylinder was determined. The sample was then passed into the graduated cylinder until it overflowed the cylinder. The sample was then leveled with the top of the cylinder. The cylinder and contents were then reweighed and the bulk density was then determined as a weight of material per unit volume.

C. Sieve Analysis Analytical Procedure

The particulate size of the product was estimated by means of a sieve analysis. This analysis employed a sieve shaker, timer, balance, sample splitter and sieves (sieves 6, 8, 10, 12, 14, and 16 and a pan were used).

A small amount (about 250 grams) from each of the three unscreened product samples was weighed to the nearest 0.2 gram. The sieves were then arranged in numerical order with the smallest sieve number on top and a pan on the bottom. The sample was poured into the top sieve while tapping the stack of sieves. The stack was next vigorously shaken in a rotary horizontal motion for one minute. The sieves were then inserted in the shaker and shaken for five minutes. After shaking, the contents of each sieve and bottom pans were weighed.

The percent in each sieve was calculated as follows:

$$\% \text{ Retained} = \frac{(\text{Weight of material} \times 100)}{(\text{Total Weight})}$$

SUMMARY OF JANUARY 17 AND 18, 1979 SIEVE AND BULK DENSITY MEASUREMENTS ON THE "B" GRANULATOR PRODUCT BEFORE SCREENING AT CF INDUSTRIES, INC. IN DONALDSONVILLE, LOUISIANA

	Granulator Unscreened Product Sample #1 Collected @1343 on 01/17/79			Granulator Unscreened Product Sample #2 Collected @1730 on 01/17/79			Granulator Unscreened Product Sample #3 Collected @1045 on 01/18/79		
	Mass, gm	Percent of Total Mass	Cumulative Percent of Total Mass	Mass gm	Percent of Total Mass	Cumulative Percent of Total Mass	Mass, gm	Percent of Total Mass	Cumulative Percent of Total Mass
Total Sample To Sieves	237.36			245.26			224.37		
Sieve No. 6	28.25	11.90	100	24.44	10.03	100	16.55	7.39	100
Sieve No. 8	44.50	18.75	88.10	46.77	19.20	89.97	42.92	19.12	92.63
Sieve No. 10	58.42	24.62	69.34	60.74	24.93	70.77	56.15	25.01	73.51
Sieve No. 12	45.56	19.20	44.73	48.87	20.06	45.84	46.20	20.58	48.49
Sieve No. 14	39.91	16.82	25.52	40.43	16.59	25.78	40.58	18.08	27.91
Sieve No. 16	13.75	5.79	8.71	14.74	6.05	9.19	14.37	6.40	9.83
Bottom	6.92	2.92	2.92	7.64	3.14	3.14	7.70	3.43	3.43
Sum of Mass on Sieves	237.31			243.63			224.47		
Bulk Density, grams per 250 ml	213.11			214.64			213.53		

Project No. CFI DONALDSONVILLE

TITLE urea bulk sample analysis (sieve + bulk density) Book No. ____

From Page No. ____

~~Sieve No~~	Granulator unscreened prod Sample #1 collected @1343 on 1/17/79			Granulator unscreened product Sample #2 collected @1730 on 1/17/79			Granulator unscreened Sample #3 collected @1045 on 1/18/79		
	Mass, gm	percent of total mass	Cumulative percent of total mass	Mass, gm	percent of total mass	Cumulative percent of total mass	Mass, gm	percent of total mass	C p to
sample to sieves	237.36			245.26			224.37		
Sieve No 6	28.25	11.90	100	24.44	10.03	100	16.55	7.39	
" 8	44.50	18.75	88.10 ~~88.05~~ RWC	46.77	19.20	89.97	42.92	19.12	
" 10	58.42	24.62	69.34	60.74	24.93	70.77	56.15	25.01	
" 12	45.56	19.20	44.73 ~~44.73~~ RWC	48.87	20.06	45.84	46.20	20.58 ~~20.58~~ RWC	
" 14	39.91	16.82	25.52	40.43	16.59	25.78	40.58	18.08	
" 16	13.75	5.79	8.70	14.74	6.05	9.19	14.37	6.40	
bottom	6.92	2.92	2.92	7.64	3.14	3.14	7.70	3.43	
Σ on sieves	237.31			243.63			224.47 ~~223.97~~ RWC		
Bulk Density grams per 250 ml	213.11			214.64			213.53		

% H_2O of urea product = 0.24 @ 7AM, 1/17/79 ; 0.21 @ 1530, 1/17/79 ; 0.17 @ 0.7[illegible] 1/18/79 and 0.14 @ 1530 1/18/79 – analysis by CF Industries.

To Page N

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APPENDIX E-4

RELATIVE HUMIDITY AND AMBIENT AIR TEMPERATURE MEASUREMENTS

SUMMARY OF JANUARY 17, 18 AND 19, 1979 AMBIENT TEMPERATURE, RELATIVE HUMIDITY AND BAROMETRIC PRESSURE MEASUREMENTS FOR "B" GRANULATOR AT CF INDUSTRIES, INC. DONALDSONVILLE, LOUISIANA

Date	Sampling Time	Ambient Temperature °F	Relative Humidity %	Barometric Pressure Inches Hg
01-17-79	1230	69	76	
	1245	69	76	
	1306	69	76	30.40
	1320	69	76	30.40
	1356	69	79	30.39
	1448	70	74	30.39
	1523	69	79	30.39
	1635	67	85	30.39
	1715	68	80	30.39
	1815	66	85	30.38
01-18-79	0945	62	94	30.39
	1005	62	94	30.39
	1020	64	90	30.39
	1040	64.5	87	30.38
	1055	66	82	30.38
	1115	67.5	85	30.36
	1140	67	83	30.36
	1200	68	85	30.36
	1435	69	85	30.28
	1500	71	77	30.28
	1525	73	73	30.27
	1540	71	77	30.27
01-19-79	1000	68	90	30.17
	1020	68	90	30.17
	1040	70	86	30.17
	1100	70	86	30.17
	1120	70	86	30.14
	1140	75	70	30.12
	1200	77	66	30.10
	1230	73	75	30.10

Project No. CFI DONALDSONVILLE

TITLE Temperature + Relative Humidity Measurements Book No. _____

From Page No. _____

Test #	Date	Time	Dry Bulb °F	Wet Bulb °F	R.H. %	~~measurement taken @~~ P bar Rest "Hg	Comments
1	1/17	1230	69	64	76	~~Rest outside~~	measurement taken
"	"	1245	69	64	76	~~chem lab~~ Rest	outside chem lab
"	"	1306	69	64	76	30.40	"
"	"	1320	69	64	76	30.40	"
"	"	1356	69	64.5	79	30.39	"
"	"	1448	70	64.5	74	30.39	"
"	"	1523	69	64	79	30.39	"
"	"	1635	67	64	85	30.39	"
"	"	1715	68	64	80	30.39	"
"	"	1815	66	63	85	30.38	"
	1/18	0945	62	61	94	30.39	"
	"	1065	62	61	94	30.39	"
	"	1020	64	62	90	30.39	"
	"	1040	64.5	62	87	30.38	"
	"	1055	66	62.5	82	30.38	"
	"	1115	67.5	64.5	85	30.36	"
	"	1140	67	63.5	83	30.36	"
	"	1200	68	64	85	30.36	"
	"	1435	69	66	85	30.28	"
	"	1500	71	66	77	30.28	"
	"	1525	73	66	73	30.27	"
	"	1540	71	65	77	30.27	"
	1/19	1000	68	66	90	30.17	"
	"	1020	68	66	90	30.17	"
	"	1040	70	67	86	30.17	"
	"	1100	70	67	86	30.17	"
	"	1120	70	67	86	30.14	"
	1/9	1140	75	68	70	30.12	"
		1200	77	69	66	30.10	"
		1230	73	67.5	75	30.18	"

check by 1 reading @ 1140 1200 look ok

To Page No

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

APPENDIX F

SYNTHESIS TOWER SAMPLING DATA

INCLUDES:

F-1 Draft Method for Testing Ammonium Nitrate Facilities
F-2 Field Data Sheets for Synthesis Tower Sampling
F-3 Synthesis Tower Test Results Calculations

APPENDIX F-1

DRAFT METHOD FOR TESTING AMMONIUM NITRATE FACILITIES

DETERMINATION OF PARTICULATE (AMMONIUM NITRATE) EMISSIONS FROM AMMONIUM NITRATE PLANTS

1. Principle and Applicability

1.1 Principle. Particulate emissions are assumed to be ammonium nitrate. A portion of the emission is withdrawn isokinetically from the source using a sampling train. The ammonium nitrate is collected in the impinger water and on the final filter of the sampling train. The total weight of ammonium nitrate collected is calculated from the determination of nitrate ion concentration using a specific ion electrode method.

1.2 Applicability. This method is applicable for the determination of particulate (ammonium nitrate) emissions from neutralizers, evaporators and prilling towers in ammonium nitrate production facilities only when specified by the appropriate test procedure for determining compliance.

2. Range and Sensitivity

2.1 Range. The range of the procedure is limited only by the lower detection limit of nitrate concentration using a specific ion electrode. A typical linear measurement range is 6×10^{-6} to 1.0 M (gm moles/liter) nitrate ion. This converts to a particulate emission concentration range of about 2.5×10^{-4} to 43 grains per standard cubic foot, using a 90 percent water vapor stream for calculation basis.

2.2 Sensitivity. The sensitivity of the technique will vary depending on the particular combination of electrode and readout meter. The manufacturer specifications should be consulted when an estimate is required.

3. Interferences

The following ions concentrations are reported by one vendor to cause a 10 percent error when measuring a 10^{-3}M nitrate concentration:[1]

[1] Analytical Methods Guide, Orion Research, May 1975.

10^{-7}M ClO_4^-; $10^{-5}I^-$; 10^{-4} ClO_3^-; 6 x $10^{-4}Br^-$; 4 x 10^{-3} HS^-, CN^-; 2 x 10^{-3} NO_2^-; 4 x 10^{-2} HCO_3^-, Cl^-; 10^{-1} OAc^-.

4. Precision, Accuracy, and Stability

A statistically valid estimate has not been made for the precision of the total technique. However, using a limited amount of data collected during the initial demonstration tests resulted in a precision based on a 95 percent confidence interval of 19.7 percent. No standard reference materials are available to form a basis for the determination of accuracy. Samples collected during the demonstration tests were stored for a period of about 30 days with no apparent degradation of the nitrate ion concentration.

5. Apparatus

5.1 Sampling train. See Figure 1. Many of the design specifications of this sampling train are described in APTD-0581.

5.1.1 Nozzle--Stainless Steel (316) with a sharp, tapered leading edge.

5.1.1 Probe--Borosilicate[1] glass or stainless steel (316) with a heating system capable of maintaining a gas temperature of about 121°C (250°F) at the exit of the probe when it is desired to prevent condensation in the probe.

5.1.3 Orifice flow-meter--Stainless steel (316) constructed and calibrated such that sampling rates can be monitored and adjusted as required. Additional information regarding the construction, calibration, and use of this type meter can be obtained from: Emission Measurement Branch, Emission Standards and Engineering Division, Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

5.1.4 Pitot tube--Type S, or equivalent, attached to probe to monitor stack gas velocity.

5.1.5 Impingers--Five impingers connected in series as shown in Figure 1 with ground glass vacuum tight fittings. The first, second, fourth, and fifth impingers are of the Greenburg-Smith design, modified by replacing the tip with a 1.25 cm (1/2 inch) inside diameter glass tube extending to 1.25 cm (1/2 inch) from the bottom of the flask. The third impinger is of the Greenburg-Smith design with a standard tip.

5.1.6 Filter holder--Borosilicate glass with a glass frit filter support and a silicone rubber gasket. The holder design shall provide a positive seal against leakage from the outside or around the filter.

5.1.7 Filter heating system--Capable of maintaining the filter holder at about 121°C (250°F). The filter heating system is required only when necessary to prevent condensation on the filter media.

5.1.8 Metering system--Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3°C (~5°F), dry gas meter with 2 percent accuracy at the required sampling rate, and related equipment, or equivalent, as required to maintain an isokinetic sampling rate and to determine sample volume.

5.1.9 Barometer--To measure atmospheric pressure to ±2.5 mm Hg (0.1 in.).

5.2 Sample Recovery

5.2.1 Probe brush--At least as long as the probe.

5.2.2 Wash bottle--Glass or polypropylene.

5.2.3 Sample storage containers--1 liter, polypropylene, wide mouth, with Teflon cap liner.

5.3 Analysis

5.3.1 Glass or polypropylene beaker; 5000 ml.

5.3.2 Balance--Triple beam or dual pan, 1500 gram capacity to measure ±0.5 g.

5.3.3 Nitrate ion activity sensing electrode.

5.3.4 Reference electrode--Silver/silver chloride. Saturated Calomel electrode, or equivalent, suitable for use with the nitrate electrode and electrometer used.

5.3.5 Electrometer--a pH meter with millivolt scale capable of ±0.5 mv resolution, or a specific ion meter made especially for specific ion use.

5.3.6 Magnetic stirrer and TFE flourocarbon coated stirring bars.

6. Reagents

6.1 Sampling

6.1.1 Filters--MSA 11088H glass fiber, or equivalent, to fit filter holder.

6.1.2 Silica gel--Indicating type, 6-16 mesh, dried at 175°C (350°F) for two hours.

6.1.3 Water--Distilled.

6.1.4 Crushed ice.

6.2 Sample recovery

6.2.1 Water--Distilled, from same container as 6.1.3.

6.3 Analysis

6.3.1 Methyl red indicator.

6.3.2 Water--Distilled, from same container as 6.1.3.

6.3.3 Dibasic potassium phosphate (ACS reagent grade).

6.3.4 Sulfuric acid, 25 percent. Add 143 ml concentrated sulfuric acid to 857 ml distilled water. Cool.

6.3.5 Ammonium hydroxide, concentrated reagent grade.

6.3.6 Ammonium nitrate standard solution, 0.100 M--Weigh 8.005 grams of ACS reagent grade ammonium nitrate. The ammonium nitrate should be dried prior to weighing according to standard laboratory practices to eliminate the presence of water. Add to a 1000 ml volumetric flask, dissolve, and dilute to volume.

7. Procedure

7.1 Sampling

7.1.1 Select the sampling site and the minimum number of sampling points; determine the stack pressure, temperature and range of velocity head as described in Methods 1, 2, and 3 (Federal Register, Vol. 36, No. 247, Thursday, December 23, 1971).

7.1.2 Preparation of sampling train--Place glass fiber filter into filter holder. Weigh approximately 200 gm. of silica gel to the nearest gram. Place 100 ml of distilled water in each of the second and third impingers; leave the first and fourth impingers empty, and place the pre-weighed silica gel in the fifth impinger. Assemble the train as shown without the probe in Figure 1, with the filter between the fourth and fifth impinger.

Leak check the sampling train at the sampling site by plugging the inlet to the train and pulling a 380 mm Hg. (15 inch) vacuum, or the maximum vacuum that is expected to occur during the test run, whichever is greater. A leakage rate not in excess of 0.00057 m^3/min (0.02 ft^3/min) at a vacuum of 380 mm Hg. (15 inch) is acceptable. Attach the probe and

adjust the probe heater to provide a gas temperature of about 121°C (250°F) at the probe outlet. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger at 21°C (70°F) or less.

7.1.3 Train operation--For each run, record the data required on the example sheet shown in Figure 2. Take readings at each sample point at least every five minutes, and when changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for the same amount of time at each traverse point. Maintain isokinetic sampling throughout. Turn off the pump at the conclusion of each run and record final readings. Remove the probe and nozzle from the stack and seal for transport.

7.2 Sample recovery. Move the impinger train to the cleanup area. If the sample analysis is to be performed in the field, transfer the train contents directly to the analysis beaker. If samples are to be transported, transfer the impinger contents to the sample storage bottles as follows:

7.2.1 Container 1--Record the container tare. A sample cleanup form is given in Figure 3. Add the contents of the first four impingers to the container if possible. Record weight either when filled to capacity or when all impinger contents have been added. Cap and seal. If additional impinger contents remain, proceed to container 2.

7.2.2 Container 2--Record the container tare. Transfer any remaining impinger contents and record weight. With distilled water, rinse all sample exposed surfaces three times. Rinse and brush the probe three times also.

Add all rinses into container. Disassemble the filter holder and rinse the front half three times and add rinses to container. Record final weight. Now add glass fiber filter to washes in container 2. Cap and seal. If rinses have not been completed before the container is filled proceed to use a third container, recording the tare and final weight.

7.2.3 Silica gel container--Transfer the silica gel from the fifth impinger to this container. Cap and seal.

7.3 Analysis. Treat the contents of each example container as described below:

7.3.1 Containers 1 and 2 (plus any other impinger water or train rinse container)--Quantitatively transfer the contents of each sample and rinse container to a larger mixing container of sufficient volume to hold the entire sample. Record the total volume of transfer rinse water in order to determine the total sample and blank correction volumes.

7.3.2 Silica gel container--Weigh the spent silica gel and report to the nearest gram.

Note: If concentration analysis is to be performed at the sample recovery site, the transfer steps to storage containers can be omitted. The impinger contents and rinses can be placed directly into a large volume mixing container. The appropriate weights of impinger contents and rinses should be recorded as described in 7.2.1 and 7.2.2. The mixed sample should be allowed to stand for at least one-half hour to allow dissolution of the filter catch.

7.3.3 Determination of concentration--Remove three 100 ml aliquots from the sample mixing container and place in separate 250 ml beakers. Add one or two drops of methyl red indicator to each beaker. If sample is yellow, add 25 percent H_2SO_4 dropwise until first red. To the red solution add concentrated

agua ammonia dropwise to first yellow. Add 0.20 grams of dibasic potassium phosphate and stir to dissolve.

The sample should be at the same temperature as the calibration standards when measurements are made. If ambient lab temperature fluctuates more than ±2°C from the temperature at which the calibration standards were measured, condition samples and standards in a constant temperature bath before measurement. Stir the sample with a magnetic stirrer during measurement to minimize electrode response time. If the stirrer generates enough heat to change solution temperature, place a piece of temperature insulating material such as cork, between the stirrer and the beaker.

Insert the nitrate and reference electrodes into the solution. When a steady millivolt reading is obtained, record it. Determine the concentration from the calibration curve. Between electrode measurements rinse the electrodes with distilled water and wipe dry. Report the average of the three aliquot determinations as the sample nitrate concentration in gram moles/liter (molarity).

7.3.4 Blank determination--Treat three 100 ml aliquots of the distilled water used for sampling and sample recovery as in 7.3.3. Report the average blank concentration in molarity.

8. Calibrations

8.1 Sampling train. Use methods and equipment which have been approved to calibrate the orifice meter, pitot tube, dry gas meter, and temperature sensors.

8.2 Analytical apparatus.

8.2.1 Estimate the approximate concentration of the samples to be analyzed by using a previous or manufacturer's supplied calibration with a trial aliquot treated as in 7.3.3.

8.2.2 Prepare standardizing solutions that closely bracket this range and provide at least two calibration points between the end points. These can be prepared by appropriate dilution of the 0.1 M standard solution.

8.2.3 Zero and standardize the electrometer according to the manufacturer's instructions using the standards in 8.2.2, treated as in 7.3.5. Begin with the most concentrated and proceed to the most dilute. Reverse the order and repeat the millivolt determination. Record the readings for each concentration. Prepare a calibration curve by plotting the millivolt reading on the linear scale of semi-logarithmic graph paper versus the concentration on the log scale. Calibrate the nitrate electrode daily and check hourly.

9. Calculations

9.1 Average dry gas meter temperature: see data sheet, Figure 2.

9.2 Sample gas volume at standard conditions: Calculate the volume of gas sampled on a wet basis at standard conditions (70°F, 29.92" Hg.) using equation 9-1.

$$V_{ss} = \frac{17.71\ V_m\ P_b}{\bar{T}_m} + 0.0474\ W_c \qquad \text{Equation 9-1}$$

Where:

V_{ss} = Volume of gas sampled at standard conditions

V_m = Volume measured by dry gas meter

P_b = Dry gas meter pressure (barometric) in. Hg.

$\bar{T}_m$ = Average dry gas meter temperature, °R

W_c = Weight of water condensed in the sampling train and collected in the silica gel, grams

17.71 = Conversion to standard conditions, $\frac{530°R}{29.92"\ Hg.}$

0.0474 = Conversion factor, ft^3/gm at 70°F, 29.92" Hg.

9.3 Weight of ammonium nitrate collected: Calculate the total weight of ammonium nitrate collected in the sample by Equation 9-2.

$$W_n = 0.08 [v_t C_t - v_b C_b] \qquad \text{Equation 9-2}$$

Where:

W_n = Weight of ammonium nitrate collected, grams

v_t = Total volume of mixed sample, ml

C_t = Nitrate molarity of mixed sample, gm moles/liter

v_b = Total volume of water initially placed in train plus all rinse volumes, ml

C_b = Nitrate molarity of blank water, gm moles/liter

0.08 = Conversion factor: gram·liters/ml·gm mole

9.4 Emission concentration. Calculate the particulate (ammonium nitrate) emission concentration at wet standard conditions by Equation 9-3.

$$C_{ns} = \frac{15.43\ W_n}{V_{ss}} \qquad \text{Equation 9-3}$$

Where:

C_{ns} = Particulate (ammonium nitrate) emission concentration at wet standard conditions, grains/SCF

15.43 = Conversion factor, grains/gram

W_n = Weight of ammonium nitrate collected, grams

9.5 Isokinetic variation. Calculate the average isokinetic variation by Equation 9-4.

$$\%I = \frac{1032\ V_{ss}\ T_s}{V_s\ P_s\ D_n^{\ 2}\ t} \qquad \text{Equation 9-4}$$

Where:

%I = Isokinetic variation

1032 = Conversion factor

V_{ss} = Total sample volume at standard conditions, SCF

T_s = Average stack temperature, °R

V_s = Average stack velocity, fpm, from Equation 2-2, Method 2, Federal Register, Vol. 36, No. 247, December 23, 1971

P_s = Stack pressure, in. Hg. absolute

D_n = Nozzle diameter, inches

t = test time, minutes

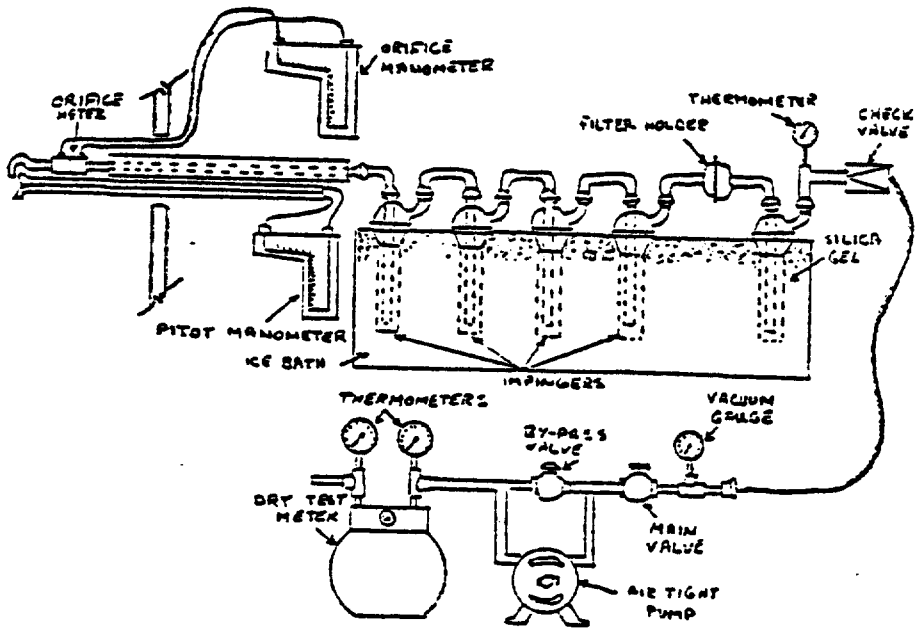

FIGURE 3. NITRITES SAMPLING TRAIN

FIELD DATA

PLANT ____________________
DATE ____________________
SAMPLING LOCATION ____________________
SAMPLE TYPE ____________________
RUN NUMBER ____________________
OPERATOR ____________________
AMBIENT TEMPERATURE ____________________
BAROMETRIC PRESSURE ____________________
STATIC PRESSURE, (P_s) ____________________
FILTER NUMBER (s) ____________________

PROBE LENGTH AND TYPE ____________________
NOZZLE I.D. ____________________
ASSUMED MOISTURE, % ____________________
SAMPLE BOX NUMBER ____________________
METER BOX NUMBER ____________________
METER K_m ____________________
C FACTOR ____________________
PROBE HEATER SETTING ____________________
HEATER BOX SETTING ____________________
REFERENCE Δp ____________________

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ________ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			

COMMENTS:

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SAMPLE RECOVERY DATA

Plant: _____ Comments

Date: _____

Sampling Location: _____

Sample Type: _____

Run Number: _____

Sample Box I.D.: _____

Cleanup Operator: _____

	Container 1	Container 2	Container 3
Sample Number			
1. Container Tare			
2. Weight after adding impinger contents			
3. Weight after adding washes			
Net liquid weight = (3-1)			
Net impinger contents weight = (2-1)			

A. Total Net Liquid Weight: _____

B. Total Impinger Contents: _____

C. Initial Impinger Contents: _____

D. Net Condensate: _____ = (B-C)

E.* Sample Transfer Rinse Volume: _____

F. Final Silica Gel Weight: _____

G. Initial Silica Gel Weight: _____

H. Net Silica Gel Weight Gain: _____ = (F-G)

I. Total Water Collected: _____ = (D+H)

J. Total Sample Volume: _____ = (A+E)

K. Total Blank Volume: _____ = (A-B+C+E)

* Laboratory

APPENDIX F-2

FIELD DATA SHEETS FOR SYNTHESIS TOWER SAMPLING

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT C F Industries
DATE 1-18-79
SAMPLING LOCATION SOLUTION TOWER VENT
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 14"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) –
STACK I.D., (DISTANCE A - DISTANCE B) 14"
NEAREST UPSTREAM DISTURBANCE 16' (13.7 Dia.)
NEAREST DOWNSTREAM DISTURBANCE ~30' (~26 Dia.)
CALCULATOR S. Richardson

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.067	14"	1"	–	1"
2	0.250	↓	3½"	–	3½"
3	0.750	↓	10½"	–	10½"
4	0.933	↓	13"	–	13"

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FIELD DATA SHEETS

Firm Name: CF Ind | Pump No.: 11 | Nozzle No. & Dia.: 4-4 0.5" in. | Nomograph C Factor: NA

Plant Location: Doraldsonville | Orifice No.: Instack 0.25" | Assumed Moisture: NA % | Pitot Coefficient: 0.837

Test No.: 4 | Ambient Temp: 75 °F | Test Duration: 15 min. | Orifice ΔH_A: NA

Sampling Location: Solution Tower | Bar Press: 30.27 "Hg | Traverse Point Interval: 15 min. | Test Start Time: 1540

TRC Project No.: 82988-20 | Probe Ident. No.: 3850 | Probe Heater Setting: 190°F amps | Test End Time: 1555

Date: 1/18/79 | Filter Ident. No.: NA | Filter Temp. Setting: NA | Leak Test Start: 0.004 CFM@ -4 "Hg

Tester: RWC/DEB/SFR | Duct Area: 1.07 ft² | Dry Gas Meter Y: | Leak Test Final: 0.004 CFM@ -4 "Hg

$\Delta h = 21.24 \Delta P$

Port	Point	Time Min (3-5)	Velocity ΔP in H_2O (6-10)	ΔH in H_2O (12-15)	T_M in °F (18-20)	T_M Out °F (23-25)	P_{STACK} in H_2O (26-30)	T_{STACK} °F (32-35)	Initial Meter Volume cu. ft. (40-45)	PROBE (50)	Cyc. Angle (52-53)	Heater Box Temp. Δh on Inc	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
		5	006	015	73	72		194	35156	4		1.27	51	-0.5	183	
		5	006	022	72	72		193	35259	4		1.27	54	-0.5	183	
		5	006	020	72	72		193	36371	4		1.27	54	-0.5	192	
									35473	4						

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Probe Wash: | Cleaning Patch: NA

Silica Gel: 4-3-5 | H_2O Collected:

Silica Gel Cond.: | H_2O Condition:

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CE, Pump No. 11, Nozzle No. & Dia. 4-4 0.5 in., Nomograph C Factor NA

Plant Location Donaldsonville LA, Orifice No. instack 0.25, Assumed Moisture NA %, Pitot Coefficient 0.837

Test No. 5, Ambient Temp 70 °F, Test Duration 16 min., Orifice ΔH_A NA

Sampling Location Solution Tur, Bar Press 30.17 "Hg, Traverse Point Interval 16 min., Test Start Time 1030

TRC Project No. ____, Probe Ident. No. 50, Probe Heater Setting 190°F amps, Test End Time 1046

Date 1/18/79, Filter Ident. No. NA, Filter Temp. Setting NA, Leak Test Start .004 CFM@ 4.0 "Hg

Tester SFR/DER, Duct Area 1.07 ft^2, Dry Gas Meter Y ____, Leak Test Final 0.000 CFM@ 2.5 "Hg

Port	Point	3 4 5 Time Min	6 7 8 9 10 Velocity ΔP in H_2O	12 13 14 15 ΔH in H_2O	18 19 20 T_M in °F	23 24 25 T_M Out °F	26 27 28 29 30 P_{STACK} in H_2O	32 33 34 35 T_{STACK} °F	40 41 42 43 44 45 Initial Meter Volume cu. ft.	50 PROBE	52 Cyc. Angle ϕ	53 Orifice ΔH Heater ~~Box~~ Temp.	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
		5 0	0 6 5	1 2 1 0	6 7	6 7		1 8 7	3 5 6 1 4	4		1.311	64	2.2	180	
		5 0	0 6 5	1 7 0	6 8	6 8		1 8 2	3 5 7 1 5	4		1.311	64	2.0	187	
		6 0	0 6 5	1 7 0	6 8	6 8		1 1 8	3 5 8 2 2	4		1.311	65	7.1	187	
									3 5 9 1 2	4						

Probe Wash ____, Cleaning Patch ____

Silica Gel 5-5-5, H_2O Collected ____

Silica Gel Cond. ____, H_2O Condition ____

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

FIELD DATA SHEETS

Firm Name CF Ind | Pump No. 11 | Nozzle No. & Dia. 4-4 0.5" | Nomograph C Factor NA

Plant Location Doylestown | Orifice No. Insteck 0.25 | Assumed Moisture NA % | Pitot Coefficient 0.837

Test No. 6 | Ambient Temp 74 °F | Test Duration 15 min. | Orifice ΔH_A NA

Sampling Location sliding tan | Bar Press 30.12 "Hg | Traverse Point Interval 15 min. | Test Start Time 1135

TRC Project No. 82988-20 | Probe Ident. No. 50 | Probe Heater Setting 190 amps | Test End Time 1150

Date 1/19/29 | Filter Ident. No. NA | Filter Temp. Setting NA | Leak Test Start 0.002 CFM@ 4 "Hg

Tester SFR/DER | Duct Area 1.07 ft² | Dry Gas Meter Y | Leak Test Final 0.002 CFM@ 5 "Hg

Port	Point	Time Min	Velocity ΔP in H_2O	ΔH in H_2O	T_M in °F	T_M Out °F	P_{STACK} in H_2O	T_{STACK} °F	Initial Meter Volume cu. ft.	PROBE	Cyc. Angle ∅	~~Heater Box Temp~~	Temp. of Gas Leaving Condenser °F	Pump Vac. in Hg	Probe Temp. °F	O_2 Conc. %
		5.0	0.60	0.00	72	72		188	360.70			1210	66	2.0	187	
		5.0	0.60	1.30	72	72		192	361.36			1210	66	3.0	188	
		5.0	0.60	0.80	72	72		192	362.21			1210	65	2.0	188	
									362.96							

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Probe Wash | Cleaning Patch

Silica Gel 6-5-5 | H_2O Collected

Silica Gel Cond. | H_2O Condition

ORSAT Measurements

	Time	CO_2	O_2	CO	N_2
1					
2					
3					

Orsat Bag Sample Triplicate Analysis

CO_2	O_2	CO	N_2

APPENDIX F-3

SYNTHESIS TOWER TEST RESULT CALCULATIONS

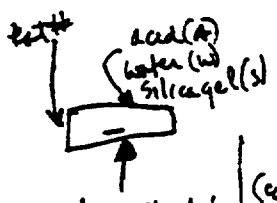
Synthesis Tower Data Analysis

The impinger catch for these synthesis tower test runs consisted of water mass and ammonia mass; the masses of urea and formaldehyde were negligible. The ammonia mass was therefore subtraced from the total impinger catch to yield the mass of water collected. This water includes both collected condensed vapor and collected liquid water droplets. As discussed in Section 5, the existence of liquid water droplets in the gas stream was confirmed by observation and by the moisture data. As is shown in the following data and calculations, the volume of water collected exceeded the volume that would be carried by a saturated gas stream at the stack temperatures:

Run	Condensed Water Vapor (lb) (Saturated Conditions)	Actual Water collected (lb)
1	0.479	0.65
2	0.339	0.77
3	0.437	0.80

The following pages show the procedure used to calculate urea, formaldehyde and ammonia emissions.

Table F-1: Mass H_2O collected for solution tower tests



Container #	A final wt. (container tare + sample + H_2O) gm	B initial wt. (container tare) gm	C impinger charge weight gm	A-B-C $H_2O + NH_3$ collected gm	D wt NH_3 in sample gm	A-B-C-D wt H_2O collected, gm	total H_2O gm	lb
4S-A	874.18	498.84	381	-5.66	<0.1	-5.66		
4S-W	1142.54	501.89	300	340.65	37.69	302.96	306.86	0.45
4S-S	252.75	243.19	—	9.56	0	9.56		
5S-A	875.73	498.64	381	-3.91	<0.1	-3.91		
5S-W	1279.5	498.97	300	40853	45.8	362.73	363.81	0.77
5S-S	249.21	244.22	—	4.99	0	4.99		
6S-A	883.65	498.04	381	4.61	~0.1	4.61		
6S-W	1226.8	501.29	300	425.51	57.81	367.7	380.83	0.83
6S-S	251.33	242.81	—	8.52	0	8.52		

4/4/79

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RWC

TRC Project # 82988-20 CF Industries, Inc

Calculation of Synthesis Tower Results

Run #1 (Test #4), Run #2 (Test #5), Run #3 (Test #6)

1. Determine Moisture Content of Gas Stream - assumed saturated conditions

Dalton's Law $$\frac{V_{H_2O}}{V_{total}} = \frac{P_{H_2O}}{P_T}$$

where V_{H_2O}/V_{total} = volume ratio of water vapor to total

P_{H_2O} = vapor pressure of H_2O @ T_{stack}

P_T = Stack Pressure Total

Run #	T_{STACK}, °F	P_{STACK}, "Hg	VAPOR PRESSURE OF WATER AT T_{STACK} P_{H_2O}, ("Hg)**	Theoretical % M $(V_{H_2O}/V_{TOTAL}) \times 100$	CALCULATED % M*
1	193	30.27	20.27	67.0	74.2
2	186	30.17	17.44	57.8	76.5
3	191	30.12	19.42	64.5	77.8

* CALCULATED FROM TOTAL VOLUME OF WATER COLLECTED

** "METHODS FOR DETERMINATION OF VELOCITY, VOLUME, DUST, AND MIST CONTENT OF GASES" BY Harold H Haaland, page 35.

2. Calculate Volume of Water Vapor in Sample, V_{H_2O} SCF

$$\left(\frac{V_{H_2O}}{V_T}\right) = \frac{V_{H_2O}}{V_{Air} + V_{NH_3} + V_{H_2O}}$$

$$V_{H_2O} = \frac{\left(\frac{V_{H_2O}}{V_T}\right)\left(V_{air} + V_{NH_3}\right)}{\left(1 - \frac{V_{H_2O}}{V_T}\right)}$$

where $V_{NH_3} = \omega_{NH_3} \times \rho$

$$V_{NH_3} = {}^{mg}_{NH_3} \times 4.99 \times 10^{-5} \; ft^3 \, NH_3 / {}_{mg} \, NH_3$$

Run #	V_{H_2O}/V_T	V_{Air}, ft^3	ω_{NH_3}, mg	V_{NH_3}, ft^3	V_{H_2O}, ft^3
1	0.6696	3.19	37,720	1.882	10.25
2	0.5780	3.01	45,840	2.287	7.26
3	0.6448	2.26	57,810	2.885	9.34

3 A. Calculate Wet Molecular Weight of Gas Stream, $\overline{M}_\omega$, lb/lb-mole

$$\overline{M}_\omega = \frac{1}{\omega_{NH_3} + \omega_{Air} + \omega_{H_2O}} \left(\frac{1}{lb}\right)\left[\omega_{NH_3} \times 17 + \omega_{air} \times 29 + \omega_{H_2O} \times 18\right]\left(\frac{lb\text{-}lb}{lb\text{-mole}}\right)$$

Run *	ω_{NH_3}, lb	ω_{air}, lb	ω_{H_2O}, lb	M_ω, lb/lb-mole
1	0.0831	0.240	0.479	21.2
2	0.101	0.226	0.339	21.6
3	0.127	0.170	0.437	20.4

where $\omega(lb) = V(ft^3) \times \frac{M(lb/lb\text{-mole})}{385(ft^3/lb\text{-mole})}$

$M_{air} = 29$

$M_{H_2O} = 18$

$M_{NH_3} = 17$

3 B. Calculate Dry Molecular Weight of Gas Stream, $\overline{M}_D$, lb/lb-mole

$$M_D = \frac{1}{\omega_{air} + \omega_{NH_3}} \left(\frac{1}{lb}\right)\left[\omega_{NH_3} \times 17 + \omega_{air} \times 29\right]\left(\frac{lb\text{-}lb}{lb\text{-mole}}\right)$$

3 B (continued)

Run #	$\bar{M}_D$, lb/lb-mole
1	25.9
2	25.3
3	23.9

4. Calculate Velocity V, ft/min and Volumetric Flow Rate Q, ft^3/min of Gas Stream

$$V = 174 \times C_p \times \overline{\sqrt{VP \times T_R}} \times \sqrt{\frac{29.92}{P_s} \times \frac{28.84}{M_w}}$$

$$Q = V\,(ft/min) \times A\,(ft^2)$$

where

174 = units correction factor

C_p = pitot tube calibration coefficient

$\overline{\sqrt{VP \times T_R}}$ = average of square roots of individual VP and T product for each sampling point

note $T = {}^\circ R = {}^\circ F + 460$

P_s = Stack Pressure, "Hg

$\bar{M}_w$ = Gas Stream Molecular Weight, lb/lb-mole (WET)

A = stack Cross-Sectional Area, ft^2

4 (continued)

Run #	C_p	$\sqrt{VP \times T_R}$	P_s, "Hg	M_w, lb/lb-mole	v, ft/min	Q, ft³/min
1	0.837	6.26	30.27	21.2	1057	1131
2	0.837	6.18	30.17	21.6	1086	1162
3	0.837	6.25	30.12	20.4	1079	1154

$A = 1.07\ ft^2$

5. Calculate Gas Stream Flow Rate, Q_{STD} dry @ 68°F and 29.92 "Hg

$$Q_{STD}\left[ft^3/min\right] = Q_{ACFM}\left[ft^3/min\right] \times \left(1 - \frac{\%\,H_2O}{100}\right) \times \frac{528}{T_s + 460}\left(\frac{°R}{°R}\right) \times \frac{P_{STACK}}{29.92}\left(\frac{"Hg}{"Hg}\right)$$

Run #	Q_{ACFM}	$1 - \%H_2O/100$	$T_s + 460$, °R	P_s, "Hg	Q_{DSCFM}
1	1131	0.33	653	30.27	306
2	1162	0.42	646	30.17	402
3	1154	0.36	651	30.12	339

6. Calculate Ammonia Emissions, M_{NH_3} (lb/hr)

$$M_{NH_3}\left(\frac{lb}{hr}\right) = \frac{\omega_{NH_3}}{\omega_{NH_3} + \omega_{air}}\left(\frac{lb}{lb}\right) \times Q_{STD}\left(\frac{ft^3}{min}\right) \times M_D\left(\frac{lb}{lb\text{-mole}}\right) \times 0.156\left(\frac{min}{ft^3}\frac{1}{hr}\right)$$

Run #	ω_{NH_3}, lb	ω_{air}, lb	Q_{STD}, ft³/min	M_D, lb/lb-mole	M_{NH_3}, lb/hr.
1	0.0831	0.240	306	25.9	318
2	0.101	0.226	402	25.3	490
3	0.127	0.170	339	23.9	540

7. Calculate Urea Emissions, M_U (lb/hr)

$$M_U(lb/hr) = \frac{\omega_{urea}}{\omega_{NH_3} + \omega_{air}}\left(\frac{lb}{lb}\right) \times Q_{STD}\left(\frac{ft^2}{min}\right) \times M_D\left(\frac{lb}{lb\text{-mole}}\right) \times 0.156\left(\frac{min\ lb\text{-mole}}{ft^2\ hr}\right)$$

Run #	ω_{urea}, lb	ω_{NH_3}, lb	ω_{air}, lb	Q_{STD}, ft³/min	M_D, lb/lb-mole	M_U, lb/hr.
1	4.16×10^{-4}	0.0831	0.240	306	25.9	1.59
2	4.36×10^{-4}	0.101	0.226	402	25.3	2.11
3	4.09×10^{-4}	0.127	0.170	339	23.9	1.74

8. Calculate Ammonia Concentration, C_A (grains/dscf)

$$C_A \text{ (grains/dscf)} = \frac{\omega_{NH_3}}{V_{Air} + V_{NH_3}} \left(\frac{lbs}{ft^3}\right) \times 7000 \text{ grains/lb}$$

Run #	ω_{NH_3}, lb	V_{air}, ft^3	V_{NH_3}, ft^3	C_A, gr/dscf
1	0.083	3.19	1.882	115
2	0.101	3.01	2.287	134
3	0.127	2.26	2.885	173

9. Calculate Urea Concentration, C_U (grains/dscf)

$$C_U \text{ (grains/dscf)} = \frac{\omega_U}{V_{Air} + V_{NH_3}} \left(\frac{lbs}{ft^3}\right) \times 7000 \text{ grains/lb}$$

Run #	ω_U, lb	V_{air}, ft^3	V_{NH_3}, ft^3	C_U, gr/dscf
1	4.16×10^{-4}	3.19	1.882	0.574
2	4.36×10^{-4}	3.01	2.287	0.576
3	4.09×10^{-4}	2.26	2.885	0.556

CF I Donaldsonville

SOLUTION TOWER ISOKINETIC CALCULATIONS 11/4/79 JEK

test 4

$T_{S\,AVG} = 193°F$ $V_{mSTD\,(air)} = 3.19$ $P_{bar} = 30.27$ $P_s = 0.00$
$V_s = 1057$ ft/min $T_{total} = 15$ min $\%H_2O = 67.0$ $D_n = 0.508$
lb $NH_3 = 0.083$

$$V_{NH_3\,STD} = \frac{\text{lb } NH_3}{17 \text{ lb/lb-mole}} \times 385 \frac{ft^3 NH_3}{\text{lb-mole}} = 1.88 ft^3 \text{ at } 68°F, 29.92" Hg$$

$$\therefore I = \frac{5.67(T_{S\,AVG} + 460)\left[V_{mSTD\,(air)} + V_{STD\,(NH_3)}\right]}{\left(P_{bar} + \frac{P_{S\,AVG}}{13.6}\right) V_S \, T \left(1 - \frac{\%H_2O}{100}\right)\left(\frac{D_n^2 \times 0.7854}{144}\right)}$$

$$= \frac{(5.67)(193+460)\left[3.19 + 1.88\right]}{(30.27)(1057)(15)\left(1 - \frac{67.0}{100}\right)\left(\frac{(0.508)^2(0.7854)}{144}\right)}$$

$$= 84.1\%$$

---

test 5

$T_{S\,AVG} = 186°F$ $V_{mSTD\,(air)} = 3.008$ $P_{bar} = 30.17$ $P_s = 0.00$
$V_s = 1086$ $T_{total} = 15$ min $\%H_2O = 57.8$ $D_n = 0.508$
lb $NH_3 = 0.101$

$$V_{NH_3\,STD} = \frac{0.101}{17} \times 385 = 2.29 ft^3$$

$$I = \frac{(5.67)(186+460)(3.008 + 2.29)}{(30.17)(1086)(15)\left(1 - \frac{57.8}{100}\right)\left(\frac{(0.508)^2(0.7854)}{144}\right)}$$

$$= 66.5\%$$

SOLUTION TOWER ISOKINETIC CALCULATIONS

4/14/79 dEK

test 6

$T_{S\,AVG} = 191°F$ $V_{m\,STD}(air) = 2.26$ $P_{bar} = 30.12$ $P_s = 0.00$

$V_S = 1079$ ft/min $T_{total} = 15$ min $\%H_2O = 64.5$ $D_n = 0.508$

$lb\,NH_3 = 0.127$

$$V_{NH_3\,STD} = \frac{lb\,NH_3}{17\,lb/lb\text{-mole}} \times 385\,\frac{ft^3\,NH_3}{lb\text{-mole}} = 2.88\,ft^3\,NH_3$$

$$I = \frac{(5.67)(191+460)(2.26+2.88)}{(30.12)(1079)(15)\left(1-\frac{64.5}{100}\right)\left(\frac{(0.508)^2(0.7854)}{144}\right)}$$

$$= 77.9\,\%$$

APPENDIX F-4

IN-STACK ORIFICE DEVELOPMENT

The standard EPA-5 particulate sampling procedure requires the isokinetic collection of a stack gas. The moisture in the wet stack gas is removed in a condenser/dryer after particulate removal. The dried sample stream then passes through a pump, a gas meter for volume measurement, and then finally through an orifice meter for continuous sampling rate measurement and control. The orifice meter differential pressure required to achieve isokinetic conditions at the sampling nozzle, expressed as a function of the pitot tube pressure differential, is:

$$\Delta h = \left\{ 847.8\ C_p^{\,2}\ (1-B)^2\ \Delta H_@ \left[\frac{M_d}{M_d(1-B) + 18B} \right] \left(\frac{P_s}{P_m} \right) (TM) \right\} \frac{1}{T_s}\ D_n^{\,4}\ \Delta_p$$

where:

Δh = orifice meter differential pressure, inches H_2O

847.8 = units conversion factor

C_p = pitot tube coefficient, dimensionless

B = stack gas moisture content, volume fraction

$\Delta H_@$ = standard orifice meter calibration coefficient

M_d = stack gas dry molecular weight, lb/lb mole

P_s = absolute pressure of stack gas, inches H_g

P_m = absolute pressure of sample stream at orifice meter, inches Hg

T_m = temperature of sample stream at orifice meter, ^oR

T_s = temperature of stack gas, ^oR

D_n = nozzle diameter, inches

Δp = pitot tube pressure differential, inches H_2O

In order to use this relationship, it is necessary to know prior to sampling the following variables:

(1) pitot tube coefficient, Cp

(2) standard orifice calibration coefficient, $\Delta H_@$

(3) nozzle diameter, D_n

(4) stack gas pressure P_s

(5) sample gas temperature and pressure at the orifice, T_m and P_m

(6) stack gas dry molecular weight, M_d

(7) stack gas temperature, T_s

(8) pitot tube pressure differential, Δp

(9) stack gas moisture content, B

Variables (1) to (3) are determined by the particular combination of pitot tube, orifice meter and nozzle used for sampling. Variables (4) to (6) are usually constant or can be estimated with confidence from a preliminary measurement. Variables (7) and (8) are continuously monitored during testing. This leaves the stack gas moisture content as the remaining variable.

In the majority of sampling situations encountered, the stack gas moisture content can be measured or estimated to an adequate degree of confidence so that isokinetic sampling can be easily achieved. This is the case when the moisture content is less than about 40 percent by volume and is relatively constant.

However, in those cases where the moisture content is greater than 40 percent, or when the content varies significantly, a single average value is usually an inadequate estimate. Since the moisture content is not a linear variable in the isokinetic equation, the estimation error that is tolerable decreases as the absolute value of moisture content increases.

There have been two different types of sampling situations recently encountered where the moisture content was very high (40 to 90 percent) and highly variable.

In the first of these cases, the sampling location was after a scrubber where the gas temperature was less than 212°F, psychometric charts could be used to estimate saturation contents, and the essentially instantaneous moisture content values were used to solve the isokinetic equation. At a facility where the moisture content was 45 percent, this procedure for estimation of moisture was adequate while at the higher moisture content location it was not. In either case, the technique was cumbersome and marginally reliable.

In the second type of situation, the sampling location was after an aqueous reactor where the vent stream was essentially water vapor at temperatures greater than 212°F. The moisture contents range from 60 to 99 percent by volume. In these ranges, there is no procedure available to adequately estimate the moisture content with the accuracy necessary. A second complication at this type source is that after condensation of moisture in the sample stream there is an inadequate amount of dry gas left to enable accurate sample flow rate measurement of the orifice meter.

In order to enable accurate reliable isokinetic sampling at these types of sources, an in-stack orifice meter system was developed in which the sampling rate is measured at stack conditions prior to any moisture condensation. The development, specifications, calibration and operation of this type meter is discussed below.

A. Meter Design Development

Three potential systems were evaluated for use in the measurement of sampling rate prior to moisture condensation. These were (1) the null-balance probe, (2) venturi meters, and (3) orifice meters.

The primary factors considered were:

(1) difficulty of fabrication

(2) calibration requirements

(3) interchangibility with standard EPA-5 equipment

(4) usability with standard three-inch sampling ports.

The null-balance probe approach was not used because of the requirement that it be calibrated at each individual source and also because of the large size of most designs.

This left venturi or orifice meters as the potential alternatives. An orifice meter approach was chosen based on the conclusions that an orifice is easier to construct, and that its measurement range can be easily changed by varying the orifice opening.

The first design proposed for the meter assembly is shown in Figure A1. While this assembly was directly mountable on the EPA-5 probe, it was found that it was not usable in three-inch ports. Calibration using this first prototype did confirm that the orifice meter approach was valid and that sampling rates could be controlled as desired.

The second generation design was fabricated so that the orifice meter body and the nozzle were not combined into one unit. In this design, the orifice was located between the gooseneck nozzle and the probe end-union. This allowed use of the assembly in a 3-inch port. The design also allowed for the installation of the orifice in the vertical section between the nozzle

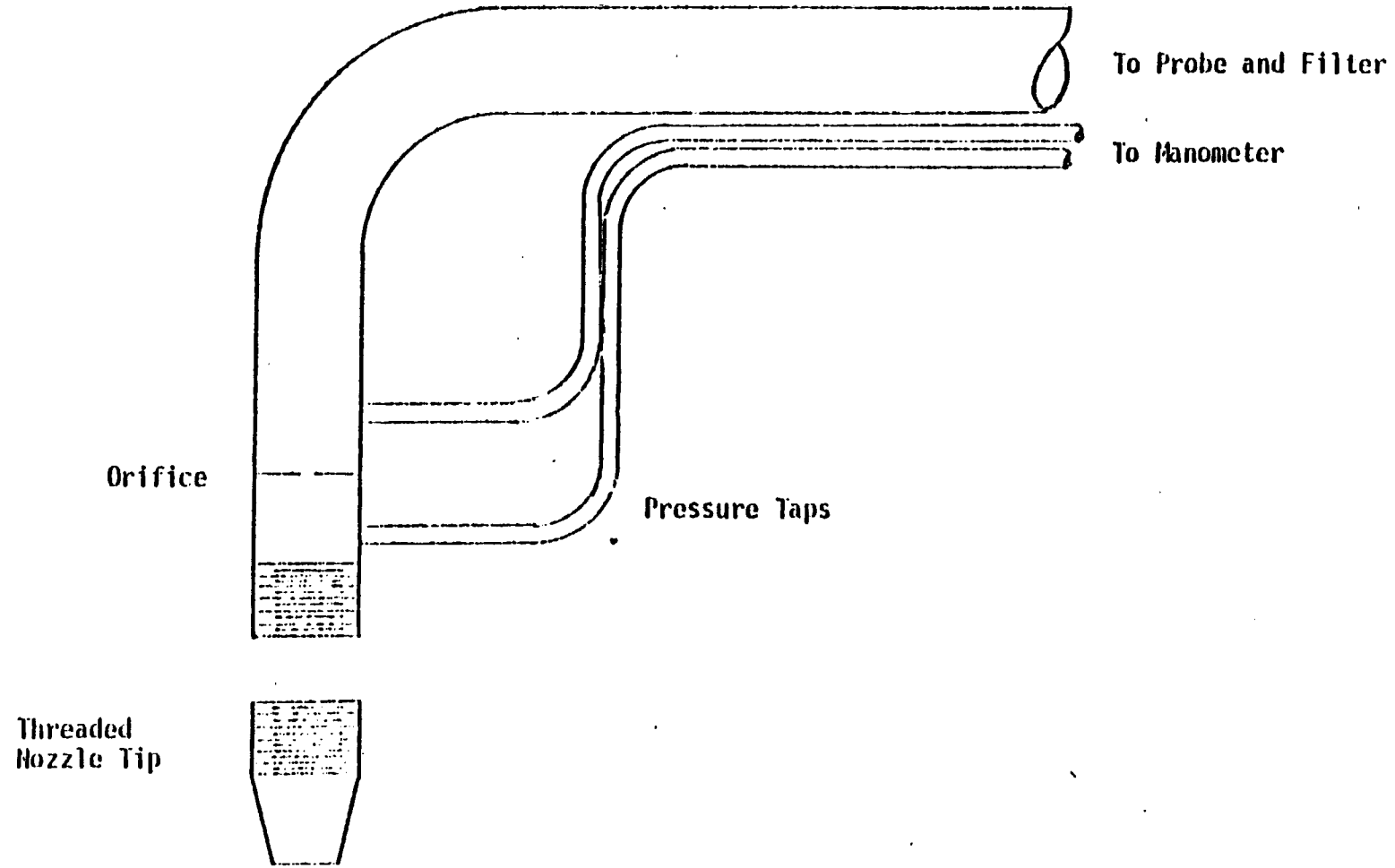


Figure A1. Initial Design, In-stack Orifice and Nozzle

tip and the gooseneck when stack access ports are available to accommodate that configuration. This meter was fabricated from solid stock with the orifice plate machined permanently. This design was found to operate very satisfactorily. The prime disadvantage with this design was that a complete orifice body had to be machined to obtain a different measurement range.

To overcome this time-consuming and expensive problem, a third-generation prototype was fabricated whereby the meter body was separable at the orifice plate and range changing is accomplished by simply installing a washer with a different hole size. This design is illustrated in Figure A2. This entire assembly, including the pressure tap lines, is constructed of stainless steel. This is necessary to maintain an inert surface for sample contact and to prevent erosion and corrosion on the outer surfaces.

B. Orifice Calibration

The standard orifice equation relating volumetric flow rate to orifice pressure differential is:

$$Qm = Km\sqrt{\frac{\Delta h\ Tm}{Pm\ Mm}}$$

where

Qm = volumetric flowrate, acfm
Km = orifice calibration coefficient
Δh = orifice pressure differential, inches H_2O
Tm = gas temperature, ^oR
Pm = gas absolute pressure, inches Hg
Mm = gas average molecular weight, lb/lb mole

During the development of the in-stack orifice, two approaches were taken to determine the orifice coefficient. First, the nozzle/meter assembly was attached to a standard EPA-5 probe, umbilical cord, and meter box, and still room air was drawn through the orifice. In the second, case, a condenser

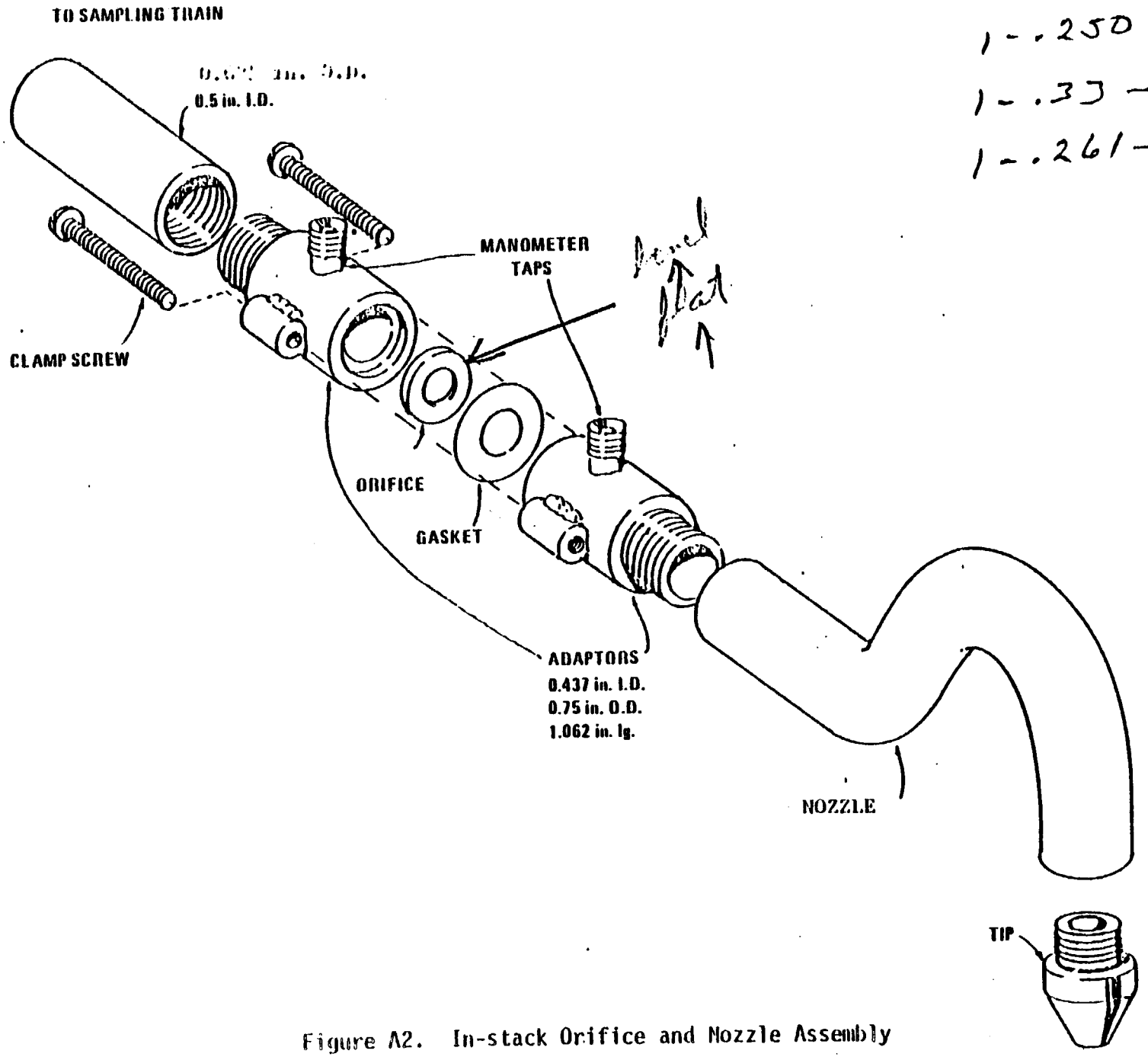


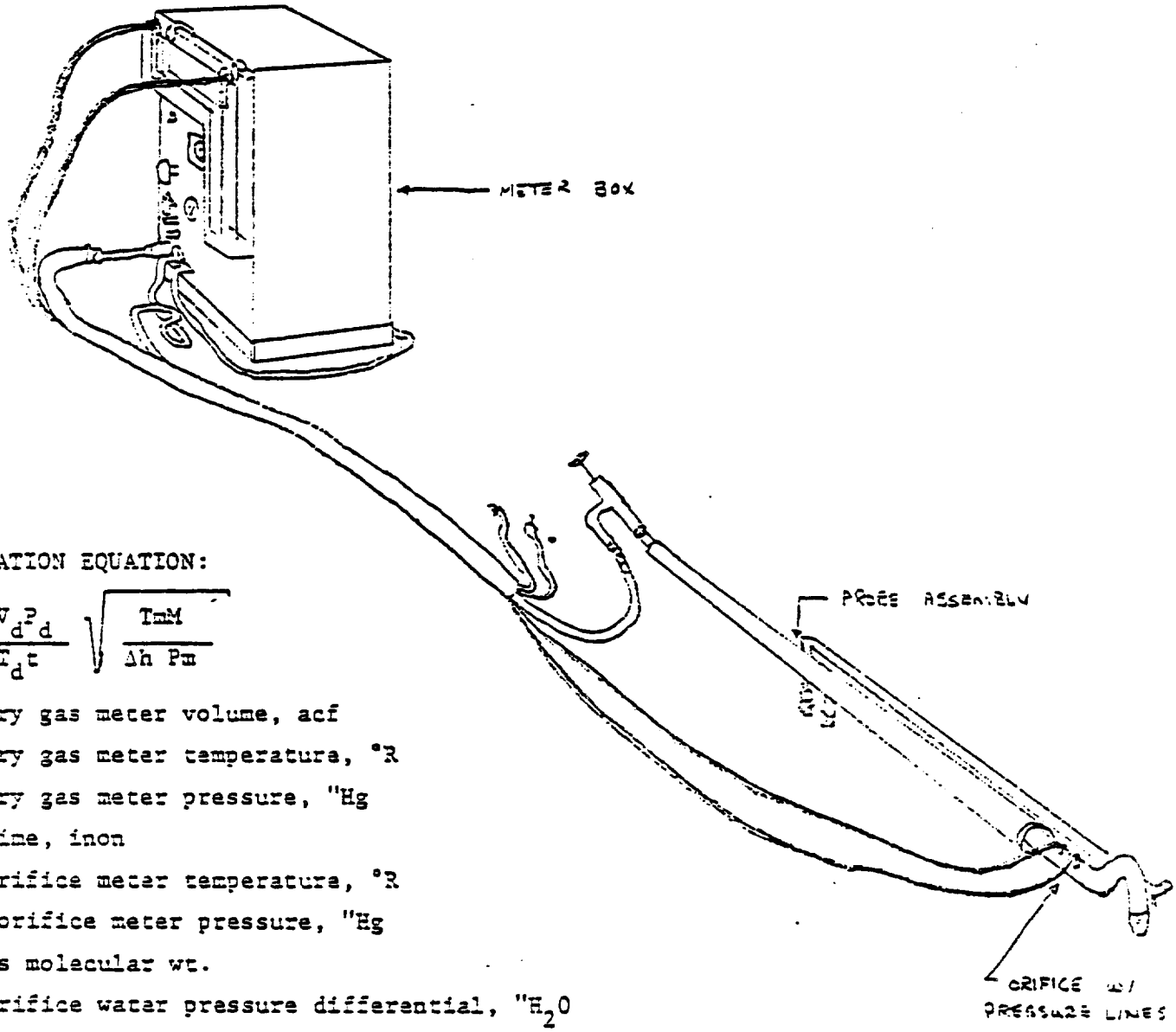
Figure A2. In-stack Orifice and Nozzle Assembly

train was added after the probe and the calibration was carried out in a flowing stream. In the flowing stream, it was possible to perform calibrations at several temperatures.

Calibration calculations were developed based on the combinations of standard equipment used for the procedures described above. These are presented in Figures A3 and A4. A sample of the data sheet developed for calibration studies is shown in Figure A5.

The calibration procedure is essentially identical to that used for the standard orifice in an EPA-5 train. The system is operated at several Δh settings over the range 0.5 to 8 in. H_2O and the average Km is calculated from the individual Km values.

During calibrations, the linear operating range of each orifice should be determined. This can be accomplished by comparing the individual meter coefficients at each pressure differential to the average or midrange value. In order to achieve 100 $\pm$ 10 percent isokinetic conditions, the maximum allowable deviation in the orifice calibration factor would be $\pm$ 10 percent, assuming no errors in any other measurements. Therefore, the maximum linear range of the orifice would be those pressure differentials where the individual meter coefficients are within the range of 90 to 110 percent of the average. It should be recognized that if the meter operation will be near either extreme of the linear range, it is potentially possible to exceed the allowable isokinetic variation. In those cases it is more appropriate to use the calibration factor for that end of the range. This can be avoided if desired by establishing the linear range of the meter at some level less than a $\pm$ 10 percent variation in the meter calibration coefficient. For example, a tolerance of $\pm$ 5 percent in the meter calibration coefficient would yield



CALIBRATION EQUATION:

$$K_m = \frac{V_d P_d}{T_d t} \sqrt{\frac{T_m M}{\Delta h \, P_m}}$$

V_d = dry gas meter volume, acf

T_d = dry gas meter temperature, °R

P_d = dry gas meter pressure, "Hg

t^2 = time, inon

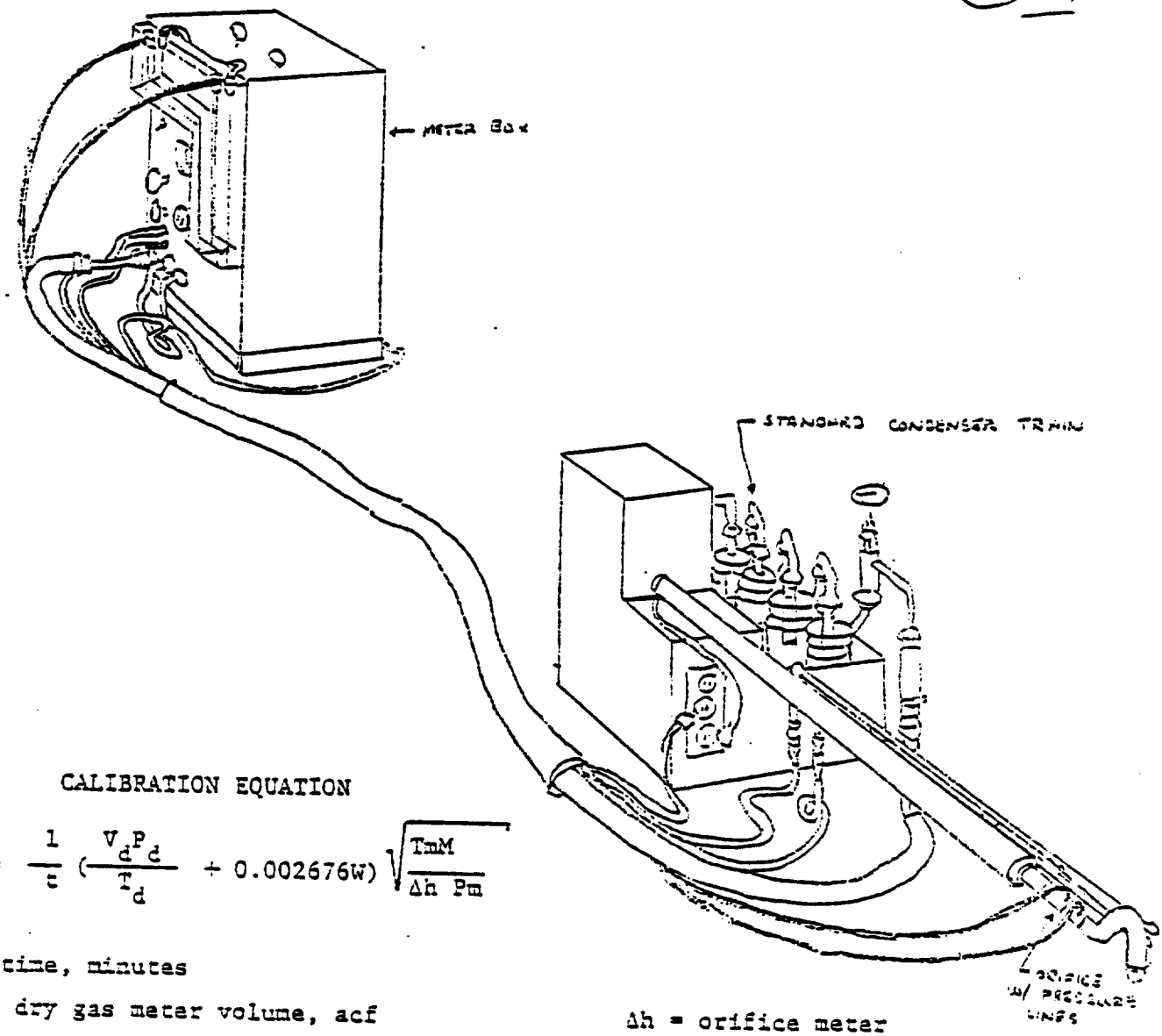
T_m = orifice meter temperature, °R

$P_m 2$ = orifice meter pressure, "Hg

M = gas molecular wt.

Δh = orifice water pressure differential, "H_2O

Figure A-3. Calibration Configuration Using Dry Gas



CALIBRATION EQUATION

$$K_m = \frac{1}{t}\left(\frac{V_d P_d}{T_d} + 0.002676W\right)\sqrt{\frac{T_m M}{\Delta h\ P_m}}$$

t = time, minutes

V_d = dry gas meter volume, acf

T_d = dry gas meter temperature, °R

W = weight of water collected, ml or gm

T_m = orifice meter temperature, °R

M = gas molecular weight

P_d = dry gas meter pressure, "Hg

Δh = orifice meter pressure differential, "H_2O

P_m = orifice meter pressure, "Hg

Figure A-4. Calibration Configuration Using Wet Gas

IN-STACK ORIFICE CALIBRATION

Run No: _____ Water collected: _____ ml

Date: _____ Ambient Temp: _____ °F

Barometric Pressure: _____ "Hg Nozzle Iden.: _____

Time	Volume	Gas meter temp.		Δh	T_m
		Inlet	Outlet		

NOTES: _____

$$K_m = \frac{1}{t}\left(\frac{V_d P_d}{T_d} + 0.002676W\right)\sqrt{\frac{TmM}{\Delta h\ Pm}}$$

K_m = _____

Figure A5. Orifice Calibration Data Sheet

a safety factor of 2, but at the same time would decrease the linear operating range. Either alternative can be used so long as the assumptions involved with selecting an average meter coefficient are recognized.

Initial calibration results using the first orifice design indicated a difference in coefficients depending on whether calibration was conducted using still room air or a flowing stream. The specific cause for this effect could not be identified, but it is probably due to the relative closeness of the orifice to the nozzle entrance in that design. Comparative calibrations using the later designs indicate that there is little difference between results using the two procedures.

Calibrations were also performed at temperatures ranging from 80 to 329°F. The results of these tests showed that the orifice coefficient did not change with temperature.

The results of calibration studies with various orifice opening sizes are summarized in Figures A6 and A7. The flow measurement range versus orifice pressure differential is shown in Figure A6. The variation of Km with orifice opening is shown in Figure A7. These correlations are presented for general information since the specific calibration will depend on the meter design. However, it has been found that duplicate meters of the same design will have essentially identical calibration coefficients for the same size orifice opening.

C. Meter Operation

The operating isokinetic equation for an in-stack orifice meter can be derived from the general EPA-5 operating equation given earlier by substituting the following conditions.

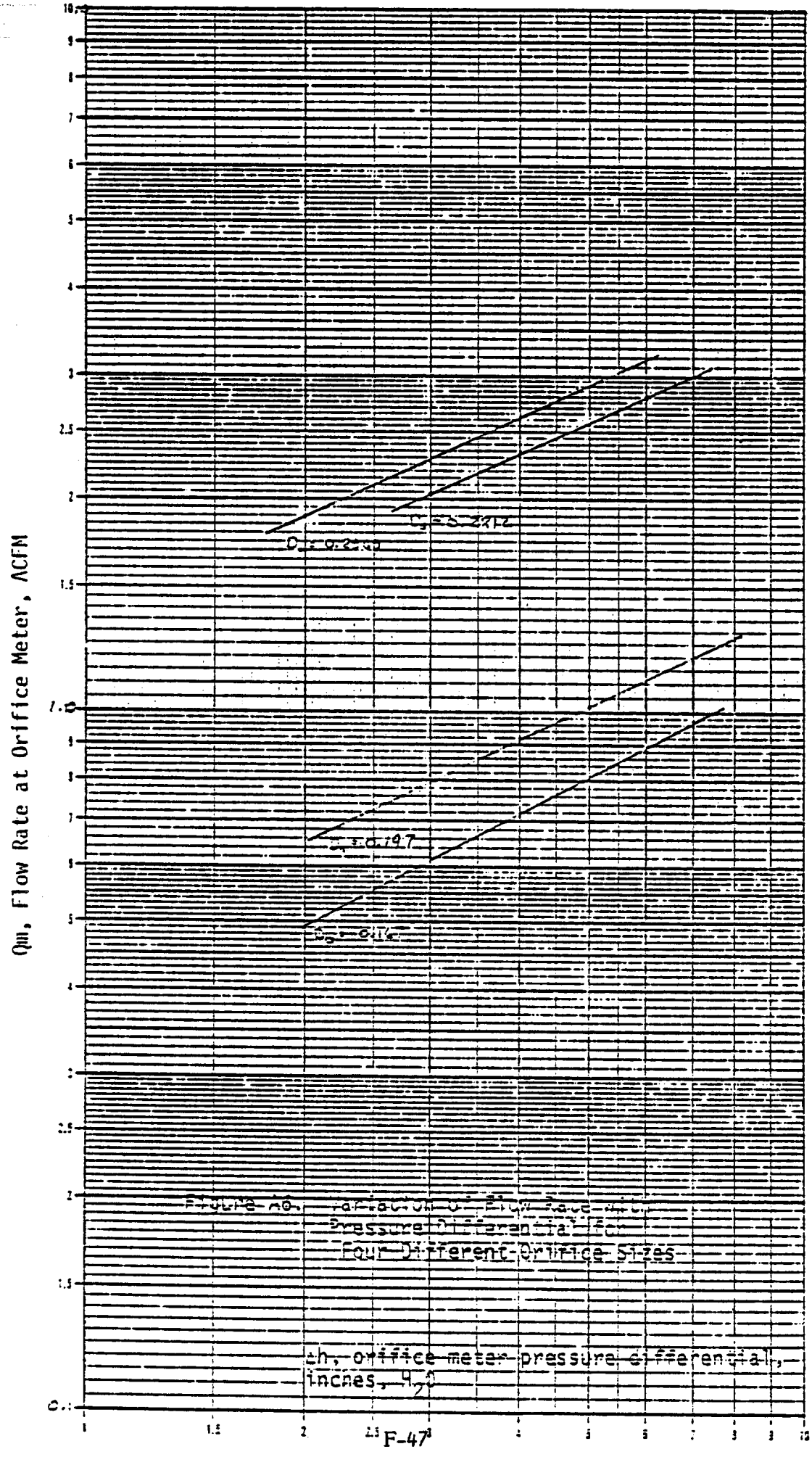


Figure no. Variation of Flow Rate with Pressure Differential for Four Different Orifice Sizes

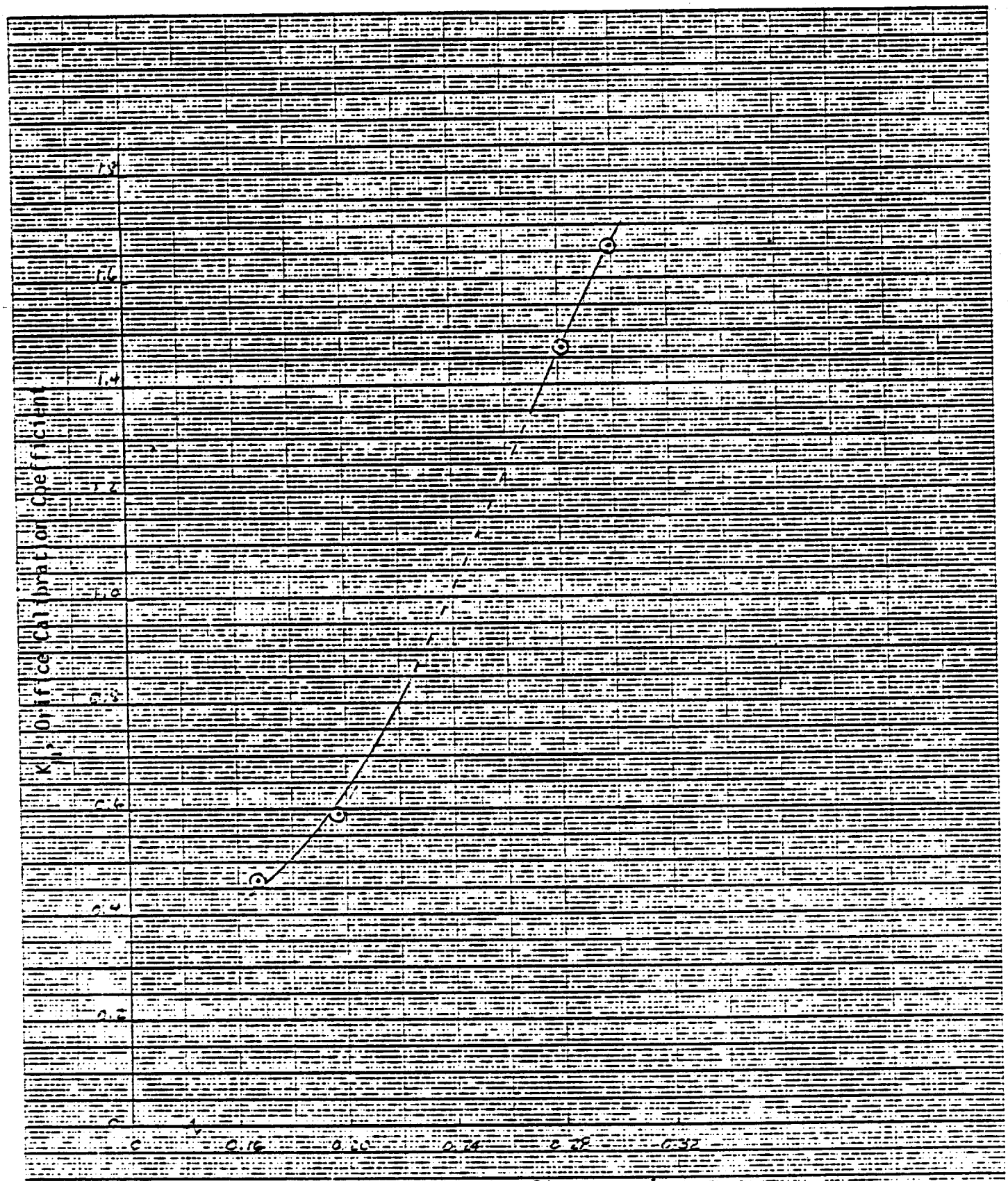


Figure A7. -Variation of Meter Calibration Coefficient with Orifice Size

1. Since the orifice meter is located in the stream, the stack temperature, pressure and molecular weight will equal the meter temperature, pressure, and molecular weight, therefore,

$$\frac{Ps}{Pm} = 1, \quad \frac{Tm}{Ts} = 1, \quad \frac{(1-B)^2\, Md}{M_d(1-B) + 188} = \frac{M_s}{Mm} = 1$$

2. The more convenient form for the meter coefficient is used -

$$\Delta H_@ = \frac{0.923}{Km^2}$$

Making these substitutions, the operting equation becomes

$$\Delta h = 782.502 \left(\frac{Cp}{Km} \right)^2 Dn^4 \Delta p$$

As can be seen, the only independent variable for any one combination of equipment is the pitot tube pressure differential. All of the other variables are removed by placing the orifice in-stack and metering the sample stream at stack conditions. It is necessary, however, to know the approximate stack gas temperature and moisture content in order to properly size the orifice-nozzle combination required.

The standard EPA-5 procedure specifies sampling rates of 0.5 to 1.5 dry standard cubic feet per minute at the orifice meter. For most situations where the use of an in-stack orifice is required, this specification is impractical to achieve. For example, if the moisture content is 50 percent by volume and the stack temperature is 300°F, a sampling rate of 2.35 acfm at the nozzle would be required for a rate of 0.75 dscfm. The multiplication factor becomes even more as the moisture content increases.

A more practical approach is to establish a range of sampling rates at the nozzle. For most cases, a range of from 1.0 to 3.0 acfm will result in adequate total sample volumes. This range will also be compatible with commonly encountered stack velocities. For extremely high velocities, it may be necessary to have a meter with a range as high as 5.0 acfm.

The recommended range of nozzle sizes is from 0.20 to at least 0.325 inches. This range of nozzles combined with one or more orifice ranges should allow sampling in the majority of cases.

The recommended procedure for the selection of an appropriate combination of orifice meter size and nozzle size is as follows:

(1) Determine from preliminary measurements the stack parameters necessary to calculate the average actual stack velocity. The range of pitot tube differential pressures should also be recorded.

(2) Choose a nozzle size and multiply by the average stack velocity to obtain the average sampling rate necessary. Usually, for first trial purposes, a nozzle size of about 0.25 inches is appropriate for stack velocities commonly encountered (2500-3000 fpm). On the basis of these calculations, select the orifice size necessary to place the required sampling rate at approximately the middle of the meter's linear operating range. The field calculations necessary in this step are eliminated if a chart is prepared after initial calibrations that express each available orifice meter's linear range in terms of orifice pressure differential (Δh), flowrate (Q), and the applicable stack velocity range for each nozzle size that is available. The stack velocity range is obtained by dividing the upper and lower flowrate limits by the available nozzle areas.

(3) Use the meter calibration coefficient Km, and the nozzle size as selected above with the pitot tube coefficient to calculate the proportionality constant in the isokinetic equation:

$$\Delta h = 782.50 \cdot \left[\frac{Cp}{Km}\right]^2 D_n^4 \quad \Delta p$$

As a final check, insert the maximum and minimum velocity pressure differential obtained during the preliminary traverse to ascertain that the meter will not be operating outside its linear range. Also, the sampling rate at the dry gas meter should be estimated using the stack moisture and temperature, and an estimate of the dry gas meter temperature. This rate should not exceed the capacity of the meter, which is approximately 2.5 cfm in most cases. After the appropriate orifice size has been selected, all parts should be thoroughly cleaned and assembled. The orifice meter-nozzle assembly can then be attached to a standard EPA-5 probe sheath. A leak check should then be performed by attaching the umbilical cord directly to the probe. A leak rate of zero is attainable at 15 inches Hg vacuum when a metal probe liner is used. However, if a glass liner is used this criteria may not be achievable at vacuums greater than 2-5 inches Hg. In all cases, it must be insured that there are no leaks in the pressure differential lines. The rest of the train assembly and testing are performed similarly to that used in EPA-5.

There are several specific areas that are unique to sampling with this equipment configuration and require comment. These are:

(a) In some sampling cases, there will be a measurable pressure differential across the final orifice in the standard equipment configuration. In order to correct the dry gas meter pressure to standard conditions, this differential should be recorded. Since this would require an extra manometer

and data entry, it is more convenient if the final orifice is replaced with a straight piece of pipe. The second manometer in the meter box can then be used for the instack orifice and the dry gas meter pressure is then ambient or barometric.

(b) In the configuration described, the orifice meter assembly will be out of the stack flow for points located about seven inches or less from the near stack wall. The port should be insulated and/or heated to as near the stack temperature as possible since it is assumed that the orifice meter temperature is equal to the stack temperature. A general guideline is that the two temperatures expressed in absolute (^{o}R) terms must be within about 20 percent of each other, assuming all other vairables are measured with no error, to achieve $\pm$ 10 percent of isokinetic conditions.

(c) In many cases, the pressure differential taps can become plugged with condensate. This is usually indicated by a reduced pressure differential, a sluggish variation, or no response to flow control valve changes. Sampling should be interrupted and the manometer lines should be momentarily backflushed. Backflushing during sampling is undesirable since the air then becomes part of the gas sampled.

(d) In cases where the moisture content is very high and high sampling rates are required, it may be necessary to add an additional fine metering valve to the pumping system prior to the coarse valve commonly used in EPA-5 systems. Additional metering control is necessary due to the small fraction of dry gas flow that remains after condensation. Since the flow is very small, the coarse valve by-pass combination does not allow an accurate regulation of vacuum. This extra needle valve can be conveniently installed at the quick-correct fitting for the umbilical cord sample hose.

(e) During sampling, the operating equation may be solved by using a slide rule, calculator, graph, etc., since it is simply a constant multiplication. The EPA-5 operating nomograph can also be used if desired. In this case, all scales except the Δh and Δp are ignored. The factor $\left[782.502\left(\frac{Cp}{Km}\right)^2 Dn^4\right]$ is aligned on the Δh scale with 1.0 on the Δp scale to set the pivot point.

After a sampling run has been completed and the train has been transported to the cleanup area, the orifice-nozzle assembly should be removed from the probe for cleanup purposes. All openings on the assembly should be plugged and the outer surface should be thoroughly cleaned prior to recovery of the sample fraction. The meter body can then be separated at the orifice plate and rinsing with the appropriate solvent and brushing can be performed on the two halves of the assembly.

APPENDIX G

SAMPLING TRAIN CALIBRATION DATA

INCLUDES

G-1. SAMPLING ORIFICE CALIBRATIONS
   a. Granulator Testing
   b. Synthesis Tower Testing
G-2. NOZZLE MEASUREMENTS
   a. Granulator Testing
   b. Synthesis Tower Testing
G-3. PITOT TUBE CALIBRATIONS
   a. Granulator Testing
   b. Synthesis Tower

APPENDIX G-1a

SAMPLING ORIFICE CALIBRATIONS
FOR
GRANULATOR TESTING

DATE 12/27/78 ORIFICE NO D6 NAME C EKROTH

INLET, INLET PARTICLE SIZING

BAROMETRIC PRESSURE 30.03 IN HG DRY GAS METER NO 6

ORIFICE MANOMETER SETTING IN WATER	GAS VOLUME WET TEST METER CU FT	GAS VOLUME DRY GAS METER CU FT	TEMPERATURE WET TEST METER F	TEMPERATURE DRY GAS METER INLET F	TEMPERATURE DRY GAS METER OUTLET F	TEMPERATURE DRY GAS METER AVERAGE F	TIME MIN	RATIO	DHO
0.5	5.0	5.03	70.4	73.0	74.0	73.5	12.7	1.00	1.80
1.0	5.0	5.03	70.5	72.0	72.0	72.0	9.2	0.99	1.89
2.0	10.0	10.05	70.2	74.0	75.0	74.5	13.0	1.00	1.88
3.0	10.0	10.08	70.0	75.0	75.0	75.0	10.8	0.99	1.94
						AVERAGE		1.00	1.88

DATE 1/03/79 ORIFICE NO DS NAME T EOLOUC

OUTLET

BAROMETRIC PRESSURE 29.70 IN HG DRY GAS METER NO 5

ORIFICE MANOMETER SETTING IN WATER	GAS VOLUME WET TEST METER CU FT	GAS VOLUME DRY GAS METER CU FT	TEMPERATURE WET TEST METER F	TEMPERATURE DRY GAS METER INLET F	TEMPERATURE DRY GAS METER OUTLET F	TEMPERATURE DRY GAS METER AVERAGE F	TIME MIN	RATIO	DHO
0.5	5.0	4.96	70.0	69.0	69.0	69.0	11.9	1.00	1.61
1.0	5.0	4.96	70.0	72.0	72.0	72.0	8.6	1.01	1.67
2.0	10.0	9.92	70.0	71.0	72.0	71.5	12.3	1.01	1.71
3.0	10.0	9.93	70.0	71.0	72.0	71.5	10.1	1.00	1.73
						AVERAGE		1.01	1.68

APPENDIX G-1b

SAMPLING ORIFICE CALIBRATIONS
FOR
SYNTHESIS TOWER TESTING

PRETEST CALIBRATION

Orifice = 0.2500" P_{bar} = 30.59 1/12/79

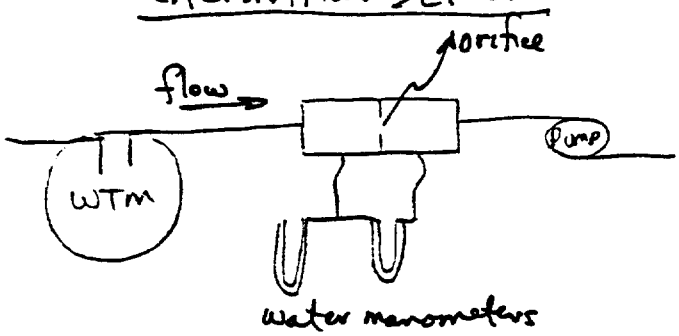
CF_w	time, min.	ΔH, "H_2O	orifice static press. "H_2O	T_w, °F	CF_w/time	K_m
1.00 ft^3	1.03	1.0	−0.15	71.5	0.97	1.25
1.00 "	0.58	3.0	−0.35	71.5	1.72	1.28
1.00 "	0.45	5.0	−0.60	71.4	2.22	1.28
					AVG	1.27

POST TEST CALIBRATION

Orifice = 0.2500" P_{bar} = 30.06 3/20/79

CF_w	time, min.	ΔH, "H_2O	orifice static press, "H_2O	T_w, °F	CF_w/time	K_m
2.00 ft^3	2.39	0.70	−0.3	72.5	0.84	1.28
2.00 "	1.85	1.0	−0.45	72.5	1.08	1.38
2.00 "	1.76	1.3	−0.4	72.5	1.14	1.28
2.00 "	1.60	1.6	−0.5	72.5	1.25	1.27
					AVG	1.30

CALIBRATION SET UP



CALIBRATION CALCULATIONS (see following page)

$$K_m = \frac{CF_w}{\text{time}} \sqrt{\frac{\left(P_{bar} + \frac{\text{static}}{13.6}\right) M_m}{\Delta H (T_w + 460)}}$$

T_w = temp wet test meter
M_m = mol. wt air = 28.83 lb/lb-mole
static = orifice static pressure

Instack Orifice Calculations

For isokinetic flow $V_n = V_s$

where $V_n \equiv$ nozzle velocity, fpm

$V_s \equiv$ stack velocity, fpm

$$V_n = \frac{Q_n}{A_n}$$

where $Q_n \equiv$ volumetric flow rate through nozzle, cfm

$A_n \equiv$ area of nozzle, ft^2

assuming that $Q_n = Q_m$

where $Q_m \equiv$ volumetric flow rate through instack orifice, cfm

$$V_n = \frac{Q_m}{A_n}$$

$$Q_m = k_m \sqrt{\frac{\Delta h \, T_m}{P_m \, M_m}}$$

where $k_m \equiv$ meter constant

$T_m \equiv$ meter temperature, °R

$P_m \equiv$ meter pressure, "Hg

$M_m \equiv$ meter gas molecular weight, lb/lb-mole

$\Delta h \equiv$ pressure drop across orifice, "H_2O

and $$A_n = \frac{0.7854 \, d_n^2}{144 \, in^2/ft^2}$$

where $d_n \equiv$ nozzle diameter, inches

$$V_s = 5128.8\, C_p \sqrt{\frac{T_s\, \Delta P}{P_s\, M_s}}$$

where C_p ≡ pitot tube coefficient, dimensionless
T_s ≡ stack temperature, °R
ΔP ≡ velocity pressure, "H_2O
P_s ≡ stack pressure, "Hg
M_s ≡ molecular weight of stack gas, lb/lb-mole

$V_n = V_s$ therefore

$$K_m \sqrt{\frac{\Delta h\, T_m}{P_m\, M_m}} \times \frac{144}{0.7854\, d_n^2} = 5128.8\, C_p \sqrt{\frac{T_s\, \Delta P}{P_s\, M_s}}$$

for instack orifice assume $T_m = T_s$, $P_m = P_s$ and $M_m = M_s$

$$\Delta h = 7825 \left[\frac{C_p}{K_m}\right]^2 d_n^4\, \Delta P$$

For CFI Donaldsonville

$d_n = 0.5"$
$C_p = 0.837$
$K_m = 1.27$

$\Delta h = 21.24\, \Delta P$

APPENDIX G-2a

NOZZLE MEASUREMENTS
FOR
GRANULATOR TOWER TESTING

(5)

DATE 12/29/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC - The Research Corp. CUSTOMER P.O. NO. 1577

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 5-2

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. _____

PART NAME ST / STL NOZZLE

TOOL NAME INLET

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls
.1859 - .1860 - .1860	.1860	12/[illegible]			
.1869 - .1870 .1871	1870	5/5/78			
.1875 - .1874 - .1875	.1875	7/5/78			
.1875 - .1876 - .1876	.1876	11/22/78			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

G-10

REJECTED ☐

INSPECTOR [signature]

ELFRED MACHINE COMPANY
150 JORDAN LANE
WETHERSFIELD, CONN. 06109

DEC 29 ENT

DATE 1/10/79

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC THE RESEARCH CORP. CUSTOMER P.O. NO. 3790

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO.

PART NO. I-6 NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. — PART NAME SJ/STL NOZZLE 1/8

TOOL NAME INLET PARTICLE SIZING

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls
.1250 - .1251 - .1252	.1251	1/10/79			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

G-11

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
165 JORDAN LANE
WETHERSFIELD, CONN. 06109

JAN 10 ENTD

(4)

DATE 11/29/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC - THE RESEARCH CORP. CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 4-2

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

TOOL NO. SET #4

PART NAME ST/STL NOZZLE OUTLET

TOOL NAME _____

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.2551-.2550-.2550	.2550	11/30/77			
.2557 - .2558 . 2558	.2558	8/11/78			
.2574 - .2575 - .2575	.2575	12/28/78			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

INSPECTOR

ELFRED MACHINE COMPANY
185 JORDAN LANE
WETHERSFIELD, CONN. 06109

APPENDIX G-2b

NOZZLE MEASUREMENTS
FOR
SYNTHESIS TOWER TESTING

(4)

DATE 11/29/77

INSPECTION REPORT

ELFRED MACHINE COMPANY

CUSTOMER TRC-THE RESEARCH CORP CUSTOMER P.O. NO. 9964

S.O. NUMBER —

PURCHASED FROM ELFRED P.O. NO. _____

PART NO. 4-4

NO. PIECES ORDERED 1 NO. PIECES RECEIVED 1

PART NAME ST/STL NOZZLE

TOOL NO. SET # 4

TOOL NAME SOLUTION TOWER

Actual in 3 Places	Average	Date/Initls	Actual in 3 Places	Average	Date/Initls.
.5010-.5010-.5010	.5010	11/30/77			
.5013-.5015-.5014	.5014	3/11/78			
.5080-.5085-.5090	.5085	11/29/77			

1st PIECE INSPECTION ☐

PARTIAL INSPECTION ☐

COMPLETE INSPECTION ☑

ACCEPTED ☑

REJECTED ☐

G-14

INSPECTOR

ELFRED MACHINE COMPANY
165 JUNIPER LANE
WETHERSFIELD, CONN. 06109

NOV 30 1977

APPENDIX G-3a

PITOT TUBE CALIBRATIONS
FOR
GRANULATOR TESTING

THE RESEARCH CORPORATION OF NEW ENGLAND

CLIENT EPA
CHARGE NO. 82988 TESTER T GOLDOC

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 01/10/79 TEMP.(F)= 50.0 BARO.PRES.(IN.HG) = 0.00

STANDARD PITOT NO. CE-1 SERIAL NO. 44 INLET

NO. OF SCREENS	STANDARD DELTA P ** W.C.	TYPE S DELTA P ** W.C.	COEFFICIENT +CP(S)
1	0.051	0.078	0.801
2	0.100	0.145	0.822
3	0.200	0.285	0.829
4	0.310	0.440	0.831
5	0.420	0.599	0.829
6	0.500	0.710	0.831
7	0.610	0.865	0.831
		AVERAGE CP(S)	0.825

REVERSE (S) PITOT AND RERUN TEST

1	0.055	0.081	0.816
2	0.103	0.153	0.812
3	0.201	0.295	0.817
4	0.300	0.435	0.822
5	0.395	0.570	0.824
6	0.505	0.725	0.826
7	0.595	0.857	0.825
		AVERAGE CP(S)	0.820

* CP(S)=0.99*SQRT(DELTA P(STANDARD) / DELTA P(S))

F$DD EXIT

THE RESEARCH CORPORATION OF NEW ENGLAND

CLIENT EPA
CHARGE NO. 82988 TESTER T BOLDUC

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 01/10/79 TEMP.(F)= 50.0 BARO.PRES.(IN.HG)=30.00

STANDARD PITOT NO. CE-1 SERIAL NO. 35 INLET PARTICLE SIZING

NO. OF SCREENS	STANDARD DELTA P ** W.C.	TYPE S DELTA P ** W.C.	COEFFICIENT +CP(S)
1	0.100	0.158	0.738
2	0.205	0.300	0.818
3	0.400	0.560	0.837
4	0.595	0.825	0.841
5	0.795	1.105	0.840
6	0.990	1.375	0.840
7	1.200	1.670	0.839
		AVERAGE CP(S)	0.829

REVERSE (S) PITOT AND RERUN TEST

1	0.105	0.165	0.790
2	0.200	0.310	0.795
3	0.405	0.600	0.813
4	0.600	0.875	0.820
5	0.800	1.155	0.824
6	1.010	1.450	0.826
7	1.205	1.750	0.822
		AVERAGE CP(S)	0.813

+ CP(S)=0.99*SQRT(DELTA P(STANDARD) / DELTA P(S))

F$00 EXIT

THE RESEARCH CORPORATION OF NEW ENGLAND

CLIENT EPA
CHARGE NO. 82938 TESTER BOLDUC

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 01/10/79 TEMP.(F) = 50.0 BARO.PRES.(IN.HG) = 0.00

STANDARD PITOT NO. CE-1 SERIAL NO. 38 OUTLET

NO. OF SCREENS	STANDARD DELTA P ** W.C.	TYPE S DELTA P ** W.C.	COEFFICIENT +CP(S)
1	0.050	0.078	0.793
2	0.100	0.148	0.814
3	0.195	0.275	0.834
4	0.297	0.420	0.833
5	0.405	0.570	0.834
6	0.505	0.705	0.838
7	0.595	0.830	0.838
		AVERAGE CP(S)	0.826

REVERSE (S) PITOT AND REYN TEST

1	0.050	0.075	0.808
2	0.105	0.146	0.834
3	0.195	0.270	0.841
4	0.295	0.410	0.840
5	0.400	0.550	0.844
6	0.495	0.695	0.835
7	0.605	0.845	0.838
		AVERAGE CP(S)	0.834

+ CP(S) = 0.99 SQRT(DELTA P(STANDARD) / DELTA P(S))

FSOC EXIT

APPENDIX G-3B

PITOT TUBE CALIBRATION

FOR

SYNTHESIS TOWER

THE RESEARCH CORPORATION OF NEW ENGLAND

CLIENT SPA
CHARGE NO. 82988 TESTER T BOLDUC

CALIBRATION DATA
TYPE S PILOT TUBE

DATE 01/10/79 TEMP.(F)= 50.0 BARO.PRES.(IN.HG)=30.00

STANDARD PITOT NO. CE-1 SERIAL NO. SC SOLUTION TOWER

NO. OF SCREENS	STANDARD DELTA P ** W.C.	TYPE S DELTA P ** W.C.	COEFFICIENT *CP(S)
1	0.102	0.148	0.822
2	0.200	0.280	0.837
3	0.395	0.550	0.839
4	0.600	0.830	0.842
5	0.792	1.095	0.842
6	1.005	1.395	0.840
7	1.200	1.680	0.837
		AVERAGE CP(S)	0.837

REVERSE (S) PITOT AND RERUN TEST

1	0.100	0.145	0.822
2	0.205	0.290	0.832
3	0.402	0.555	0.843
4	0.606	0.825	0.848
5	0.800	1.085	0.850
6	0.995	1.365	0.845
7	1.200	1.645	0.846
		AVERAGE CP(S)	0.841

* CP(S)=0.99 SQRT(DELTA P(STANDARD) / DELTA P(S))

FSDD EXIT

APPENDIX H

DAILY SAMPLING LOGS

H-1 Sampling Task Logs

H-2 Field Laboratory Logs

APPENDIX H-1

SAMPLING TASK LOGS

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-17-79

Plant Location Donaldsonville LA
Recorded by EA Pearson

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Urea Particulate B Granulator							
Scrubber Inlet							
Start 1st Traverse.	1	Scrubber Inlet	Urea Part.	1200			
pitot plugged					1210	10	
continue				1222			
probe plugged					1223	1	
continue				1226			
complete, 1st Traverse					1310	44	
Start 2nd Traverse, nozzle plugged	1			~~1314~~	1318	0	
complete RUN 1				1327	1423	56	
Start 1st Traverse	2			1548			
complete 1st Traverse					1644	56	
Start 2nd Traverse probe plugged	2			~~1657~~	1657	0	
complete 2nd traverse				1702	1756	54	

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-18-79

Plant Location Donaldsonville LA
Recorded by EAFerguson

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
B Granulator Scrubber Inlet							
Start 1st Traverse	3	Scrubber Inlet	Urea Part.	0947			
pitot plugged					1017	30	
continue				1021			
probe plugged					1021	0	
continue				1030			
Nozzle plugged					1047	17	
continue				1055			
end 1st traverse					1102	7	
Start 2nd Traverse	3			1107			
probe plugged					1108	1	
continue				1112			
complete 2nd traverse					1210	58	
Start Cascade Impactor	1	Scrubber Inlet	Part.	1528	1643	15	
Moisture Determination	1	Scrubber Inlet	moisture	1615	1649	34	
Urea Synthesis Tower	1	Syn. Tower	Urea/Ammonia	1540	1555	15	
	(called Test 4)						

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-19-77

Plant Location Donaldsonville LA
Recorded by EAHeare

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
B Granulator Scrubber Inlet							
Cascade Impactor	2	Scrubber Inlet	Part	1000	1015	15	
Cascade Impactor	3	Scrubber Inlet	Part	1125	1140	15	
Urea Synthesis Tower	2	Syn. Tower	Urea/Ammonia	1030	1046	16	
(called Test #5)							
	3	Syn Tower	Urea/Ammonia	1135	1150	15	
(called test 6)							

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-17-79 / 1-15-79

Plant Location Donaldsonville LA
Recorded by EAHara

	Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
	K Granulator Scrubber Outlet							
1-17-79	Start 1st Traverse	1	Scrubber Outlet	Urea Part.	1201			
	Complete 1st Traverse					1301	60	
	Start 2nd Traverse	1			1316			
	Complete 2nd Traverse					1416	60	
	Start 1st Traverse	2			1549	1649	60	
	Start 2nd Traverse	2			1653	1753	60	
1-18-79	Start 1st Traverse	3			0946	1046	60	
	Start 2nd Traverse	3			1117	1217	60	

H-6

SAMPLING TASK LOG

Plant CF Industries
Date 1-17-79 / 1-18-79

Plant Location Donaldsonville LA
Recorded by EAllen

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
B Granulator Scrubber Liquid Sample Temperature and pH, Urea, Ammonia, Formaldehyde							
				~~1255~~			
1-17-79 Sample	1	Inlet / outlet		1215			
				1255			
				1331			
				1416			
1-17-79 Sample	2			1550			
				1620			
				1655			
				1725			
				1810			
1-18-79 Sample	3			0955			
				1030			
				1105			
				1140			
				1215			

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-17-79 / 1-18-79 / 1-19-79

Plant Location Donaldsonville LA
Recorded by EA Cleaver

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Plume Opacity Observations							
1-17-79 Plume Opacity obs mode every 15 seconds cloudy to overcast		Top of Syn. Tower	Opacity	1207	1423	81	
Plume Opacity overcast				1550	1637	47	
1-18-79 Plume Opacity. overcast				1244	1344	60	
1-19-79 Plume Opacity overcast				0953	1153	120	

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-17-79 / 1-18-79 / 1-19-79

Plant Location Donaldsonville LA
Recorded by E. Hoover

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
→ B Granulator Scrubber Pressure Drops							
1-17-79 Measurements ~every 5 minutes		across scrubber	pressure	1207	1257	50	
				1321	1416	55	
				1549	1653	64	
1-18-79 Measurements ~every 5 minutes		across scrubber	pressure	0946	1041	55	
				1122	1217	55	
→ Ambient Temp, Pressure, RH							
1-17-79 Measurements (10 measurements)		at B Granulator	T, P, RH	1230	1315		
1-18-79 (12 measurements)		at B Granulator	T, P, RH	0945	1540		
1-19-79 (8 measurements)		at B Granulator	T, P, RH	1000	1230		

SAMPLING TASK LOG

Plant CF Industries Inc
Date 1-17-79 / 1-18-79

Plant Location Donaldsonville LA
Recorded by

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
B Granulator Product ~~Analysis~~ Samples							
1-17-79 Sample 1 Unscreened product and melt		B Granulator		1343			
~~1-17-79~~							
1-17-79 Sample 2				1730			
1-18-79 Sample 3				1045			

APPENDIX H-2

FIELD LABORATORY LOGS

Project No. 82988-20

TITLE C.F Industries, Donaldsonville, La. Book No. ____

From Page No. ____

sample container #	sample container tare wt, gm	Volume H_2O or H_2SO_4 or wt SGel	Probe wash tare + wash gm ~~tare plus wash gm~~	H_2O imp. tare + H_2O + sample ~~H_2O, tare plus sample~~, gm	H_2SO_4 imp. tare + H_2SO_4 + sample ~~H_2SO_4 tare plus sample~~, gm	H_2SO_4 imp. tare + H_2SO_4 + sample + wash ~~H_2SO_4 tare plus sample plus wash~~, gm	total sample vol. ml	S Gel + tare wt + H_2O	H_2O imp tare + H_2O + sample + wash, gm
B-W-I	328.27	200.0							
B-W-O	326.08	200.0							
B-A-I	326.54	200.0			528.94	617.25			
B-A-O	325.15	200.0	~~N/A~~		530.45	647.87			
1-S-O	242.45	200.0						264.48	
1-S-I	244.54	200.0						256.43	
1-PW-I	325.43	~~200~~	712.44	~~604.00~~ RWC ~~712.44~~					
1-PW-O	326.52		~~712~~ 597.67						
1-A-I	327.07	204.8 gm			526.35	677.26			~~677.26~~
1-A-O	325.08	204.8 gm			527.79	630.49			~~630.49~~
1-W-O	327.28	200ml		634.64					691.62
1-W-I	327.70	200ml		604.00					691.41
2-S-O	243.34	200gm						263.89	
2-S-I	242.68	200gm						256.52	
2-PW-O	327.24		570.92						
2-PW-I	326.28		746.20						
2-A-O	327.26	204.8 gm			530.98	658.97			
2-A-I	327.40	204.8 gm			518.87	719.71			
2-W-O	328.18	200ml		641.36					749.50
2-W-I	~~326.28~~ 329.09	200ml		~~746.20~~ 589.06					687.74
3-S-O	242.88	200gm						261.74	
3-S-I	245.33	200gm						258.88	
3-PW-O	325.85		618.36						
3-PW-I(1)	326.68		663.00						
3-A-O	326.23	204.8gm			531.72	704.70			
3-A-I	327.83	204.8gm			475.47	701.65			
3-W-O	325.29	200ml		534.86					649.10
3-W-I	326.25	200ml		596.44					722.35
3-PW-I(2)			631.70						

100ml H_2SO_4 (1N) = 102.4 gm

To Page ____

Witnessed & Understood by me,	Date	Invented by	Date
		H-12 Recorded by	

111

TITLE CF Industries Donaldsonville La

Project No. _____

Book No. _____

From Page No. ____

Sample #	tare weight	Vol. of H_2O, H_2SO_4 or SG	Probe Wash tare + wash (gm)	H_2O Imp tare, H_2O + Sample	H_2SO_4 Imp tare, H_2SO_4 and sample	H_2SO_4 Imp tare, H_2SO_4 sample + wash	Total sample Vol.	SG. tare + H_2O	H_2O Imp tare, H_2O sample + wash
~~4-A~~									
4S-A	498.84	300ml			879.18	1132.76			
4S-W	501.89	300ml		1142.54					1341.2
4S-PW	328.11	0	531.65						
4S-S	243.19	200gm						252.75	
5S-A	498.64	300ml			875.23	1092.83			
5S-W	498.97	300 ml		1279.5					
5S-PW	327.88	0	522.85						
5S-S	244.22	200 gm						249.21	
5S-W(2)	327.84	0							542.35
6S-A	498.04				883.65	1127.00			
6S-W	501.29			1226.8					
6S-PW	328.56		542.25						
6S-S	242.81							251.33	
6S-W(2)	328.24								559.64

This sa jar conta only impin wash.

Impin Wash C

H_2O Test	S.G. tare	SG tare + H_2O	Vol H_2O Impinger collected	vol H_2O in S.C.	Total H_2O collected
Scrubber Inlet	244.14	253.1	6 ml	8.96	14.96

To Page No

Witnessed & Understood by me,

Date

Invented by

Date

Recorded by

test# — Silicagel(S) acid(A) water(W) — Inlet(I) Outlet(O)

1 - S - I

Container # key

[redacted] Scrubber inlet/outlet tests; sample weight gain data.

	Container*	2 Simulat (container+charge+H_2O) gm	3 Initial (container+wt), gm	4 charge wt, gm	5	6 weight gain, gm	7	8	9
1									
2	1-S-I	256.43	244.54*	—		11.89			
3									
4	1-A-I	526.35	327.07	204.8		-5.52			
5							76.8		
6	1-W-I	604.00	327.70	200		76.3			
7					total	82.67 ✓			
8									
9									
10	1-S-O	264.48	242.45*	~~200~~		22.03			
11									
12	1-A-O	527.79	325.08	204.8		-2.09			
13							145.3		
14	1-W-O	634.64	327.28	200		147.36			
15					total	127.3 ✓			
16									
17									
18	2-S-I	256.52	242.68*	—		13.84			
19									
20	2-A-I	518.87	327.40	204.8		-13.33			
21							46.6		
22	2-W-I	589.00	329.09	200		59.91			
23					total	60.42			
24									
25									
26	2-S-O	263.89	243.34*	—		20.55			
27									
28	2-A-O	530.88	327.26	204.8		-1.08			
29							112.1		
30	2-W-O	641.36	328.18	200		113.18			
31					total	132.65			
32									
33									
34	3-S-I	258.88	245.33*	—		13.55			
35									
36	3-A-I	475.47	327.83	204.8		-57.16			
37							13.3		
38	3-W-I	596.44	326.25	200		70.19***			
39					total	26.58 ✓			
40									
41									
42	3-S-O	261.74	242.88*	—		18.86			
43									
44	3-A-O	531.72	326.23	204.8		0.69			
45							110.3		
46	3-W-O	534.86	325.29	100**		109.57			
47					total	129.12 ✓			
48				H-14					
49	* includes 200 gm silica gel charge								
50	** no H_2O in impinger 2 for Test 3-O								
	*** H_2SO_4 impinger sample sucked back to H_2O impinger								

EFFICIENCY® LINE NO. 636 AMPAD

APPENDIX I

PROCESS OPERATION DATA

This entire Appendix is confidential. See Item 9 - Confidential Addendum, Contact Eric Noble, EPA (919) 541-5213

APPENDIX J

TRC LABORATORY ANALYTICAL DATA

INCLUDES:

J-1 Analytical Log w/ Discussion
J-2 Sample and Analysis Results Logs
J-3 Laboratory Data Sheets

APPENDIX J-1

ANALYTICAL LOG WITH DISCUSSION

Upon arrival at the CF Industries laboratory, samples of the five water containers transported from TRC were analyzed for formaldehyde. Results were at the limit of detection, 0.05 µg/ml.

Next, a blank analysis was run on the sampling train pretest wash. This is described in detail in APPENDIX L.

Scrubber inlet and outlet probe wash and impinger volumes were measured in a graduated cylinder before the analyses were begun. Within 24 hours of collection, all the samples were analyzed for ammonia by direct nesslerization. Then they were distilled and digested for the distilled ammonia and urea analyses (by nesslerization) that were subsequently performed the following week at the TRC laboratory. A portion of the sample was kept on ice and analyzed for formaldehyde by the chromatotropic-sulfuric acid colorimetric method within twelve days.

The scrubber water solutions were analyzed for suspended solids by passing 100 to 200 ml. of sample, at the temperature of collection, through a preweighed gooch crucible containing a glass fiber filter

The two solid samples, Feed Melt to Granulator and Granulator Unscreened Product, were prepared immediately before analysis by dissolving an amount weighed to 0.1 mg. in distilled deionized water and then diluting to 100.0 ml in a volumetric flask. The results were reported as percentage.

The Feed Melt sample was a solid at room temperature. A saturated solution of it in water was prepared, and the pH was measured.

1. Direct Ammonia

An aliquot of sample was diluted to 50ml. Then one ml. of nessler reagent was added and the color read on a spectrophotometer at 405 nm. The blank probe wash samples, the outlet scrubber water solutions, and the solid samples turned cloudy upon the addition of the nessler reagent. The formaldehyde concentration in the blank probe washes was higher than in the impinger blanks which were at the limit of detection (0.05 µg/ml). This has been known to cause turbidity like that observed. The interference in the outlet scrubber waters could be due to the high urea concentration - about 50%. The solid samples were prepared as an approximately 1% solution. The limit of detection for this method is ~ 0.06 µg/ml.

2. Distilled Ammonia

The blank inlet probe wash and inlet scrubber waters for tests 1 and 2 turned cloudy with nesslerization. The calculated results were high due to this turbidity.

The distillation of 25 ml of sample into a final volume of 250ml. resulted in a ten fold decrease in sensitivity referred to the original sample solution; that is, ~0.6 µg/ml.

3. Urea

There were no problems with interferences or turbidity for these samples analyzed by the kjeldahl urea method. The limit of detection was ~ 1 µg/ml for this method.

4. Formaldehyde

The solid samples, dissolved in water, were analyzed four to six times. The results are an average of three values run on a particular dissolved sample. The results agree within ± 0.1%, about 20% of the total.

The sample was diluted from 25 to 100 fold, and an aliquot of this dilution of one to four ml was analyzed so that equal amounts of sample were reacted with the color reagent. The 50 and 100 fold dilutions agreed within about 5%, whereas the 25 fold dilution differed from these values by about ±20-25%. These variations indicate that further study should be done on the proper preparation and analysis methodology of solid urea samples for formaldehyde content.

The following pages contain a summary of the analytical laboratory results along with the raw laboratory data.

Appendix J
Analysis Report

USE ALL MINF VALUES EXCEPT 45-W

7 Nov 79
SAF

DISTILLED Ammonia — UREA — k = 1.765

Sample ID	Sample Volume SAF	Sample Volume MINF	Sample Titer & Dilution Factor D	F Blank correction Dilution Factor	Absorbance	Y_i Indicated Conc. µg/50ml	$Y_i - 11F$ Blank Corrected	Y_s $(Y_i - 11F)D$ Actual Sample Conc. µg/ml	$X_s \cdot V_s/1000$ Total Sample µg	$X_s \cdot V_s/1000$ Sample mass (mg)		Total Sample Dilution Factor D	F Blank Corr. Dil. Factor	Absorbance	X_i Indicated Conc. µg/50ml	$Y_i - 21F$ Blank Corrected	$k(X_i - 21F)D$ Actual Sample Conc. µg/ml	$X_s \cdot V_s/1000$ Total Sample µg	$X_s \cdot V_s/1000$ Sample mass (mg)
1-S-I	—	—	50	1	.512	154/50	138/50	.138 ✓	—	—		50	1	.300	85.5/50	64.5/50	113.8 ✓	—	—
1-S-O	—	—	5000	1	.480	141.5/50	11134/50	14134 ✓	—	—		125000	$\frac{1}{2500}$ = .0004	.412	117/50	117/50	516263 ✓	—	—
1-A-I	350	341	250	$\frac{1}{10} \times \frac{1}{10}$ = .01	.930	68/50	48.8/50	324	113	110	888	100	.5	.082	23/50	11.5/50	91.1	15.4	15.0
1-W-I	251	245	500	$\frac{1}{10}$ = .10	.375	106/50	1044/50	1044	784	778		10000	.005	.320	91/50	70.9/50	32088	24098	23.5
1-A-O	106	105	250	$\frac{1}{25}$ = .04	.535	158/50	137.36/50	787	241	232	938	20	.5	.115	33/50	22.5/50	15.9	4.86	4.69
1-W-O	635	640	250	$\frac{1}{25}$ = .04	.320	68/50	64.36/50	723	204	206		50	.2	.220	62.5/50	48.3/50	103	65.3	65.9
2-S-I	—	—	50	1	.230	68/50	52/50	52 ✓	—	—		50	1	.240	68/50	47/50	82.96 ✓	—	—
2-S-O	—	—	5000	$\frac{1}{10} \times \frac{1}{5}$ = .01	.432	128/50	12784/50	12784 ✓	—	—		125000	.0004	.420	119/50	119/50	5250.88 ✓	—	—
2-A-I	393	382	250	$\frac{1}{5}$ = .20	.102	31/50	20.8/50	134	53	51.2	941	100	.5	.108	30.5/50	20/50	70.6	22.35	20.97
2-W-I	779	778	500	$\frac{1}{10}$ = .10	.410	116/50	104.4/50	1144	891	850		10000	.005	.336	95/50	74.9/50	33500	26096	26063
2-A-O	321	323	250	$\frac{1}{25}$ = .04	.505	149/50	148.36/50	742	246	243	926	20	.5	.148	41/50	31.5/50	22.2	7.38	7.29
2-W-O	665	668	250	$\frac{1}{25}$ = .04	.188	55.5/50	57.36/50	394	182	183		50	.2	.212	60/50	55.8/50	98.5	65.5	65.8
3-S-I	—	—	50	1	.160	47/50	31/50	31 ✓				50	1	.260	74/50	53/50	93.5 ✓	—	—
3-S-O	—	—	5000	$\frac{1}{10} \times \frac{1}{5}$ = .01	.445	131/50	13084/50	13084 ✓				125000	.0004	.430	122/50	122/50	538325 ✓	—	—
3-A-I	379	384	250	$\frac{1}{5}$ = .20	.045	13/50	9.8/50	49	18.3	17.8	944	100	.5	.148	42/50	31.5/50	111.2	41.6	40.47
3-W-I	1038*	1033	250	$\frac{1}{5}$ = .20	.620	177.5/50	179.3/50	897	931	926		10000	.005	.252	72/50	70.9/50	25381	26345	26218
3-A-O	395	386	250	$\frac{1}{25}$ = .04	.950	149.5/50	148.36/50	715	272	263	388	20	.5	.108	30.5/50	20/50	14.1	5.34	5.17
3-W-O	646	634	250	$\frac{1}{25}$ = .04	.138	40.5/50	39.36/50	159	173	125		50	.2	.158	56/50	41.8/50	91.4	56.3	57.1
4S-A	634**	455	50	1	.230	68/50	52/50	52	40.0	25.7	77524	50	1	.136	65.5/50	44.5/50	78.5	49.8	38.9	38.7
4S-W	1035^A	515	25000	$\frac{1}{10} \times \frac{1}{25}$ = .002	.315	93/50	92.97/50	464885	48812	37658		50	1	.440	132/50	104/50	163.6	144.0	145.6	
5S-A	584**	461	100	$\frac{1}{2}$ = .5	.440	125/50	117/50	234	139	108	48618	50	1	.212	64/50	38/50	67.1	35.8	34.8	34.7
5S-W	1190	1155	25000	.002	.845	84/50	83.97/50	419855	49962	46510		50	1	.362	101.5/50	81.5/50	143.8	127.2	166.1	
6S-A	629**	502	100	.5	.248	70.5/50	62.5/50	125	78.6	64.8	58232	50	1	.252	72/50	51/50	90.0	56.6	45.2	45.4
6S-W	1171	1135	25000	.002	.348	102.5/50	102.41/50	512135	59956	58169		50	1	.320	91/50	70/50	123.6	149.7	170.2	
MIST	1.0295 g into 100 ml H_2O		100	.5	.340	97/50	89/50	178	17.8	17.8	% mg 1.773 ✓	5000	$\frac{1}{10} \times \frac{1}{10}$ = .01	.185	53/50	32.75/50	931.7	931.7	932.6	94.5
UNSCRUBBED	1.0069 g into 100 ml H_2O		10	.5	.480	114/50	106/50	212	21.2	21.2	2.11% ✓	5000	.01	.154	55/50	5875/50	5670	91.9	967.9	96.2

A SAF value should be corrected according to Note on p.7 "Clean up Area" notebook
* second 3 has faint back mark
✓ agrees with MINF values
** acid impinger volumes by SAF not reliable because of high conc acid having density much different that that of water

Appendix J
ANALYSIS REVIEW

8 Nov 79
EAF
Duke Phoenix F

FORMALDEHYDE

Sample ID	Sample Vol EAF	Sample Vol CHI	D Total Sample Dil. Factor	Absorbance	X_i Indicated Conc mg/ml	$X_i = X_i D$ Actual Sample Conc mg/ml	X_i mg/1000 Total Sample EAF	X_i mg/1000 mass (mg) CHI	
1-S-I	—	—	10	.490	10.4/4	26 ✓	—	—	
1-S-II	—	—	1	.008	<.04/4	<.01 ✓	—	—	
1-A-I	354	341	1	.208	5.0/4	1.25	0.438	0.436	2.476
1-W-I	751	745	1	.470	11.0/4	2.75	2.07	2.05	
1-A-II	306	355	1	.234	5.6/4	1.4	0.418	0.413	2.523
1-W-II	635	640	1	.565	13.3/4	3.3	2.10	2.11	
2-S-I	—	—	10	.350	8.6/4	20.0 ✓	—	—	
2-S-II	—	—	1	.016	0.3/4	0.075 ✓	—	—	
2-A-I	383	382	1	.020	0.4/4	0.10	0.0353	0.0382	1.545
2-W-I	779	778	1	.380	7.75/4	1.9375	1.507	1.507	
2-A-II	332	323	1	.022	0.45/4	0.1125	0.0374	0.0363	1.172
2-W-II	665	668	1	.340	6.8/4	1.7	1.131	1.136	
3-S-I	—	—	10	.273	5.4/4	13.5 ✓	—	—	
3-S-II	—	—	1	.010	0.2/4	0.05 ✓	—	—	
3-A-I	374	364	1	.052	1.0/4	0.25	0.094	0.091	3.087
3-W-I	1038 A	1035	1	.560	12.0/4 B	3.025	3.140	2.996	
3-A-II	378	366	1	.026	0.5/4	0.125	0.0473	0.0458	1.296
3-W-II	616	625	1	.393	8.0/4	2.00	1.23	1.25	
4S-A	634 **	495							
4S-W	1435 A	815							
5S-A	554 **	1162			not analyzed for CH_2O				
5S-W	1190	1155							
6S-A	629 **	502							
6S-W	1171	1135							
MT17	C	C	100	.378	11.7/4	9.37/4	234.75	23.18	23.17
			100	.290	8.7/4				
			100	.208	6.8/4				
unassigned	C	C	100	.494	11.5/4	14.33/4	354.3	55.83	35.83
			100	.570	15.3/4				
			100	.538	15.2/4				

Sample wt: 5.061 g → % CH_2O = $\frac{.0238}{5.061} \times 100$ = 0.47% ✓

Total sample wt: 5.055 g → % CH_2O = $\frac{.0583}{5.055} \times 100$ = 1.13% ✓

C = 5.0 g pulped dissolved with 100 ml H_2O
A = ASSUMED
B = MAY value of 11.0 for the chamber in ORANGE
/ = agrees with initial values
* = assumed 50% of final pulp with fines
** = SUSPENDED

ANALYSIS REVIEW

For appendix J

7 Nov 79
CAJ
DWARDSVILLE

AMMONIA – DIRECT NESSLERIZATION

Sample ID	Sample Volume V_s CAP (ml)	Sample Volume V_s MAF (ml)	Aliquot volume	Aliquot Diluted to	Dilution Factor D_1	Additional Dilution D_2	Absorbance	Y_i Indicated Concentration (mg/50 ml)	Y_B Blank Concentration	$Y_i - Y_B$ net Conc. X_v (mg/50 ml)	$X_s = (Y_i - Y_B) D_1 D_2 / V_s$ Actual Sample Conc. (mg/l)	$X_s \cdot V_s$ CAP (mg) Total Sample mass	$X_s \cdot V_s$ MAF (mg) Total Sample mass	
1-S-I	–	–	2	250	125	–	0.22	72/50	–	72/50	180 ✓	–	–	
1-S-O	–	–	2	250	125	–	cloudy	–	–	–	–	–	–	
1-A-I	380	341	1	100	100	–	0.51	168.5/50	–	168.5/50	317	111	108	410
1-W-I	751	945	1	100	100	–	0.644	213/50	–	213/50	406	305	382	
1-A-O	306	295	2	50	25	10	0.505	167/50	–	167/50	785	248	232	450
1-W-O	635	640	2	50	25	10	0.209	69/50	–	69/50	340	216	218	
2-S-I	–	–	2	250	125	–	.055	17.5/50	–	17.5/50	43.8 ✓	–	–	
2-S-O	–	–	2	250	125	–	cloudy	–	–	–	–	–	–	
2-A-I	353	352	2	250	125	–	.164	53.5/50	–	53.5/50	131	51.5	50.1	441
2-W-I	779	779	1	250	125	–	.650	208/50	–	208/50	502.5	391	391	
2-A-O	332	323	2	50	25	10	.645	208/50	–	208/50	1000	332	323	654
2-W-O	665	669	2	50	25	10	.345	111/50	–	111/50	555	369	371	
3-S-I	–	–	–	–	–	10	.360	116/50	–	116/50	29.2 ✓	–	–	
3-S-O	–	–	2	250	125	–	cloudy	–	–	–	–	–	–	
3-A-I	374	364	2	250	125	–	.026	9/50	–	9/50	22.5	8.4	8.2	514
3-W-I	1035 **	1033	1	250	125	–	.611	196/50	–	196/50	450	509	506	
3-A-O	378	346	2	50	25	16.7	.265	86/50	–	85/50	713	271	262	387
3-W-O	616	625	2	50	25	10	.122	40/50	–	40/50	200	123	125	
4S-A	634 **	495	–	–	–	25	.330	110/50	–	110/50	55	34.9	27.2	37771
4S-W	1043 A	815	2	250	125	125	.505	148/50	–	148/50	46250	48239	37694	
5S-A	594 **	462	–	–	–	25	cloudy	–	–	–	–	–	–	
5S-W	1190	1155	2	250	125	125	.435	123/50	–	123/50	40000	47600	45831	
6S-A	627 **	502	–	–	–	25	cloudy	–	–	–	–	–	–	
6S-W	1171	1135	2	250	125	125	.555	163/50	–	163/50	50938	59648	57814	

✓ agrees with titration
Process samples were cloudy
** CAP values partially lost amounts due to high concentrations of dissolved solids. Many samples were diluted before measurement. Mass values for calculated from sample weights.
* Diluted 25.6 g for 24 hr test
A 2 is not clear why CAP volume is so much greater than MAF volume. Effluent should be correct, according to note on 8-7 of "Cleaning of parts" with bulk

APPENDIX J-2

SAMPLE AND ANALYSIS RESULTS LOG

Report of Chemical Analysis of Non-Routine Samples

Client: EPA CF Industries — Laboratory No: 478-79 (1)

Contract No: 82788-20 — Date Received: 1/23/79

Reviewed by: _____ — Date Reported: _____

Report to: RTDC / IWAW

Type Sample: Filter _____ Fuel Oil _____ Sediment _____ Impinger _____ Other _____

Sample Number	Location	Analysis No. 1 Direct NH_3	Analysis No. 2 Distilled NH_3	Analysis No. 3 Urea	Analysis No. 4 Formaldehyde	Analysis No. 6 Suspended Solids	pH-TLV
B-W-I		0.20 µg/ml	1.42 µg/ml * / 0.60 **	6.84 µg/ml / 4.24	< 0.05 µg/ml		
B-W-O		0.12 µg/ml	1.32 µg/ml / 0.52	4.66 µg/ml / 2.62	< 0.05 µg/ml		
B A-I		cloudy 1.00 µg/ml	1.20 µg/ml / 0.50	4.44 µg/ml / 3.04	< 0.05 µg/ml		
B-A-O		cloudy 1.16 µg/ml	1.40 µg/ml / 0.60	3.29 µg/ml / -1.44	< 0.05 µg/ml		
B-PW-I		cloudy	7.3 µg/ml cloudy / cloudy less	10.24 µg/ml / 8.39	0.075 µg/ml		
B-PW-O		cloudy	2.45 µg/ml / 1.65	10.33 µg/ml / 8.47	0.088 µg/ml		
1-S I		180 µg/ml	154 µg/ml cloudy / 138	150.9 µg/ml	26.0 µg/ml	1117 mg/l.	
1-S O		very cloudy	14,150 µg/ml / 14,130	516,300 µg/ml	< 0.04 µg/ml	3.9 mg/l.	
1-A-I		108 mg	116 mg / 110	27.7 mg / 15.0	0.486 mg		
1-A-O		232 mg	233 mg / 232	6.87 mg / 4.64	0.413 mg		
1-W-I		302 mg	790 mg * / 774 mg	23,932 mg / 23,905	2.05 mg		
1-W-O		315 mg	208 mg / 206	70.6 mg / 65.9	2.11 mg		

* upper value is not blank corrected

** bottom value is blank corrected

Analyzed by: M. Fox

Form CL 0012

J-10

Client: EPA, CF Industries

Contract No: 82988-20

Reviewed by:

Report to: MWC/WAW

Laboratory No: 48-79 (1)

Date Received: 1/23/79

Date Reported:

Type Sample: Filter ____ Fuel Oil ____ Sediment ____ Impinger ____ Other ____

Sample Number	Location	Analysis No. 1 Direct NH_3	Analysis No. 2 Distilled NH_3	Analysis No. 3 Urea	Analysis No. 4 Formaldehyde	Analysis No. 6 Suspended Solid	ppm TLV
2-S-I		43.8 µg/m³	68 µg/m³ / 52	120.0 µg/m³ / 82.96	20.0 µg/m³	0.188 mg/l	
2-S-O		very cloudy	12,800 µg/m³ / 12,800	525,100 µg/m³ / 525,100	0.075 µg/m³	4.6 mg/l	
2-A-I		50.1 mg	57.3 mg / 51.2	41.1 mg / 26.97	0.0382 mg		
2-A-O		323 mg	244 mg / 243	9.73 mg / 7.29	0.0363 mg		
2-W-I		391 mg	902 mg / 890	26,090 mg / 26,063	1.507 mg		
2-W-O		371 mg	185 mg / 183	70.7 mg / 65.8	1.136 mg		
			/				
3-S-I		23.2 µg/m³	47 µg/m³ / 31	130.6 µg/m³ / 93.5	13.5 µg/m³	3.6 mg/l	
3-S-O		very cloudy	13,100 µg/m³ / 13,100	538,300 µg/m³ / 538,300	0.05 µg/m³	4.8 mg/l	
3-A-I		8.19 mg	23.7 mg / 17.8	53.97 mg / 40.47	0.091 mg		
3-A-O		262 mg	264 mg / 263	7.88 mg / 5.17	0.0458 mg		
3-W-I		498 mg	943 mg / 926	26,255 mg / 26,218	2.996 mg		
3-W-O		125 mg	127 mg / 125	61.8 mg / 57.1	1.25 mg		

Analyzed by:

Form CL-0012

THC – THE RESEARCH CORPORATION OF NEW ENGLAND

Report of Chemical Analys[illegible] Non-Routine Samples

3-73

Client: EPA CF Induction

Contract No: 82988-20

Reviewed by:

Report to: RWC / WAW

Laboratory No: 48-79 (1)

Date Received: 1/23/79

Date Reported:

Type Sample: Filter _____ Fuel Oil _____ Sediment _____ Impinger _____ Other _____

Sample Number	Location	Analysis No. 1 Direct NH_3	Analysis No. 2 Distilled NH_3	Analysis No. 3 Urea	Analysis No. 4 Formaldehyde	Analysis No. 6 Perfluoroisobutene	pH TLV
4-S-A		37.2 mg	33.7 mg / 25.7	57.2 mg / 38.9			
4-S-W		37,694 mg	37,898 mg / 37,896 mg	174.8 mg / 149.6			
5-S-A		cloudy	~~45,510 116 mg~~ / ~~45,510 mg~~ 108	48.9 mg / 31.8			
5-B-W		45,839 mg	48,510 mg / 48,510	209.0 mg / 166.1			
6-S-A		cloudy	70.8 mg / 62.8	63.9 mg / 45.2			
6-S-W		57,814 mg	58,164 mg / 58,169	182.3 mg / 141.2			
Feed mist trans milliliter		cloudy	1.88% / 1.73%	90.9% / 90.6%	0.41% *		B36 Saturated solution pH 9.2
Recirculation Uncorrected Purified		cloudy	2.26% / 2.11%	96.4% / 96.1%	0.63 *		
					* Average, see p 23		

Analyzed by: M. F

Form CL-65

APPENDIX J-3

LABORATORY DATA SHEETS

Project No. 82955-20

TITLE C.E Industries, Formaldehyde - Laboratory Book No. 82955-4

From Page No. ——

1/16/79

CF- Lab

Prepare Chromotrope Acid solution
0.10 g in 10.0 mls H_2O (Water Canister #4)

weighing paper 0.0372 g tare to 0.0000 g weighed 0.10

Stock Formaldehyde Solution 4.4703 g Na formaldehyde bisulfite / l H_2O
(Prepared at TRC 1/9/79 sw stirrer 1 hr) 1000 µg/ml

Dilute 1.0 ml → 100 ml #4 TRC H_2O ⇒ 10 µg/ml Working Solution

Standard ml Working Solution	total µg Cformaldehyde	Abs
0	0	.012 ← Sewer Sample
0.1	1	.068
0.3	3	.160
0.5	5	.252 .348
0.7	7	.348
1.0	10	.490
2.0	20	.842 (15.5 µg/l) zero OK

* Brought up to 4.0 ml with TRC #4 H_2O (all std's)

Water TRC Spec Criteria	ml Sample	Abs
1	4 ml	.003
2		.005
3		.012
use pg 2 note 4		.012 ✓
5		.005
H_2O + H_2SO_4 only		.000 use to zero Spec 21
500 ml Plastic Water Bottle (just filled)	4.0 ml	.008 (zero OK)

@ 16:10 hours Bottle filled with
TRC #4 H_2O - Sample spritzed within 3 minutes

In order to zero the Spec 21 with a solution that is clear

To Page

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Project No. 82755.20
Book No. " -4 TITLE C F Ind. Doraldsonville GA -LPG

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ig not colored by any trace contained, I made up a Blank with 4.1 mls #4 TRC H_2O and 6 mls Conc H_2SO_4. Use this to zero Spec 21 @ 580 m m (no Chromotropic Acid)

Prepare 1.0 N H_2SO_4 from TRC H_2O #2

Note ① - The first sample of #4 water which was also used as the standard 0 µg formaldehyde - turned yellow (.028 Abs) the prepared on ~~the~~ did not turn yellow - dirty test tube ?)

~ 15:10 PM - Started using DW #5 in Lab

Margaret M. Bell 1/7/74

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Project No. 82755-20

4 Book No. 11-4 TITLE CE Ind. Doraleville, LA - LAB

From Page No. ___

1/17/79 @ 8:45 AM

- Clean out - Steam out the 6 distillation units.

Prepare Distilled Standards 1000 µg/ml stock - Dilute 10.0 ml => 100 ml = 100 µg/ml working solution

total µg NH_3 in 50.0 mls	total µg NH_3 in 250 mls	mls W.S distilled into 250 ml final volume
0 Blank	0 NH_3	0
20	100	1.0
40	200	2.0
100	500	5.0
160	800	8.0
200	1000 µg NH_3	10.0
200	1000 - Digestion then Distilled	

Do 0 Blank on side of the distillation, add 10.0 mls of 100 µg/ml to 1 flask - Digest the then Distill - Do Compare to 200 µg NH_3 distillation.

N.I.D. of

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Project No. 82788-20

TITLE CF Ind., Donaldsonville, La. Book No. 1-4

From Page No. —

Sample Distillation and Digestion Prep. 1/17/79

S = Scrubber Water
A = Acid
W = Water
I = Inlet O = Outlet

Sample ID	Date of Analysis	Time Start Distilling	Aliquot Distilled or Digested in mls	final total Sample Volume, mls
B-W-I	1/17	12:15 pm	100.0 mls	
B-W-O	↓	↓	↓	
B-A-I				
B-A-O				
B-P.W-I	1/17	13:20	100.0	
B-P.W-O		↓	↓	
1-I-Water (Scrubber Water 1-SI)	1/17	17:30	5.0	
I-O-Water 1-S-O		↓	5.0	
1-AI		17:30	5.0	34 l mls
I-A-O			25.0	295 mls
I-W-I*			5.0	745 mls
1-W-O*	↓	↓	25.0	640 mls
2-S-I	1/18	11:55 am	5.0	
2-S O			5.0	
2-A-I			5.0	382
2-A-O			25.0	323 mls
2-W-I*			5.0	(420 PW + 358 W) = 778 mls
2-W-O*	↓	↓	25.0	(242 PW + 426 W) = 668 mls
3-S-I	1/19	11:35 am	5.0 mls	
3-S-O			↓	
3-A-I				364 mls
3-A-O			25.0	366 mls
3-W-I*			5.0	(728 PW + 305 W) = 1033 mls total
3-W-O*	↓	↓	25.0	(294 mls PW + 327 W) 625 mls total

Continued on p 7

*PW = Water from Imp Combined volume, all Distillations diluted to 250.0 mls

M. Fox

To Page No.

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Project No. 82455-20

6 Book No. -4 TITLE EPA Ind. Roadhouse, LA

From Page No. ___

1/17/79

Formaldehyde - Bubbler Impingers Water and Wash Bottle

Stock pl 1000 µg/ml Formaldehyde - Dilute 1.0 ml → 100 ml → 10 µg/ml Working Solution

Standards	ml WS	Abs		
0 µg Formaldehyde	0	.008		
1	0.1	.060		
3	0.3	.164		
5	0.5	.240		
7	0.7	.360		
10	1.0	.510		
20	Aliquot	.960	11.0% T	
Samples			Equivalent µg	Result µg/ml Formaldehyde
B-W-I	4.0	.010	<.2	<.05
B-W-O	↓	.010	<.2	↓
B-A-I		.006	<.2	
B-A-O		.014	<.2	
New Wash Bottle Added Before Start Service 1/14/79 16:10 hrs	~19:00 hrs 4.0	.000	<.2	
B-PW-I	4.0	.012	.30	.075 µg/ml Formaldehyde
B-PW O	4.0	.024	.35	.085 µg/ml Formaldehyde

~~Distilled Deionized H_2O only~~ .000 Abs

Zero Spec 21 without chromotropic Acid (0.1 ml) present in the Sample - 4.1 ml H_2O + 6.0 ml H_2SO_4 only

M. Dapp

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Project No. 82485-20

TITLE CF Lasky, Donaldsonville La Book No. -4

From Page No. 5

1/19/79

Sample Distillation & Digestion - Preparation

Sample ID	Date of analysis	Time NH_3 distillation started	Aliquot of Sample distilled, then digested	final total sample volume, mls
4SA	1/19/79	5:30PM	5.0 mls	495
4S-W				815 mls *
5SA				462 mls
5SW				1155 mls *
6SA				502 mls
6SW **				1135 mls *

* This volume is the combination of the Impinger water and the Probe Wash Water - Mixed well.

** 6SW - NH_3 may be low because the delivery tube was not under the surface of the Boric Acid at the start of the test. (~10 minutes - just beginning to boil when placed under surface of H_3BO_3. M/fx

S = Solution Power Sample
A = Acid Impinger
W = Water + Probe Wash Combination

M. Fox

To Page N

Witnessed & Understood by me.	Date	Invented by	Date
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Project No. 4955-20

8 Book No. -4 TITLE CP Sed, Dewatering Lg.

From Page No. —

1/18/74

11:20 - finish TRC H_2O #5 - Stad Curve #3

Direct Nesslerization

Note: Some Samples were turbid after the Nessler Reagent was added. The absorbance readings indicate higher concentrations than the visual colyellow color would indicate. I estimated the ug NH_3 in the Sample Nessler tube by comparing the yellow color of the Sample to the color of the 6 Standards.

M. D. of

To Page No. —

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Project No. 82958-20
TITLE C F Ind. Donaldsonville, La. Book No. 11 -4

From Page No. ____

1/18/79

Direct Nesslerization of Blanks, Test / Samples and ~~Test II~~

Stock Solution 1000 μg/ml NH_3 Dilute 5 ml ⇒ 250.0 ml ⇒ 20.0 μg NH_3/ml Working Solution

Standards total μg NH_3 in 50 ml Nes Tube	ml Working Soln	Abs @ 425 nm
0	0.	.000
20.0	1.	.050
40.0	2.	.120
100.0	5.	.306 ov
160.0	8.	.504
200.0	10.	.655 (22.29.T)

Samples	Dilution ~~Aliquot~~ Solution	Aliquot in 50.0 ml Nes.	Abs	equivalents μg NH_3	Result μg/ml NH_3
BWI	none	50.0 ml	.030 ov	10.0 μg	0.20 / dil 5 times
BWO		50.0 540	.018	6.0 μg	0.12
BAI		25.0 25.0	.076 cloudy*	25	1.00 cldy
BAO		25.0 25.0	.085 cloudy*	29	1.16 cldy
BPW-I		50.0 50.0	0.78 - Cloudy*		cldy
BPW-O		50.0 50.0	0.168*	55.8	cldy

2:30 pm

1-S-I	(2 → 250	2 ~~to low~~) (5.0 ml as is ~~to high~~)	50.0 ml of 2 → 250 OK-But high
1-S-O	2 → 250	(2 ~~to low~~) 50.0 ml of 2 → 250 - Cloudy.	
1-A-I	(1 → 100	2 ~~to low~~) (2.0 ml as is ~~to high~~) 50.0 ml of 1 → 100 OK	
1-A-O	2 → 50	5 OK	
1-W-I	(1 → 100	2 ~~to low~~) (2.0 ml as is ~~to high~~) 50.0 ml of 1 → 100 OK	
1-W-O	2 → 50	5 OK (could use 10. ml)	

see p10

- Continue on p 10 - set up Samples / Aliquots

2-S-I
2-S-O
2-A-I
2-A-O
2-W-I
2-W-O

* Visually ~ 5 μg BAI
* " ~ 5 μg BAO
* BPW I ~~visually~~ Visually ~5 μg.
BPW O visually ~ 8 μg

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Project No. 82955-20

10 Book No. " 4 TITLE C.E. Evaluation, Donaldsonville, La

From Page No. 9

1/18/79

Wet Direct Mess.

Sample	Dilution	Aliquot in Nesslerized (150.00 mL Nesslerized)	Abs.	Equivalent µg NH_3	Results µg/mL NH_3	Total volume sample	Results Total mg NH_3
1-S-I	2→250	50.0	0.220	72	180 very cloudy	05	
1-S-O	2→250	50.0 very cloudy spot	1.7 * 0.07	~~1585~~			
1 A I	1→100	50.0	0.510	1585		341 mL	108
1 A O	2→50	5.0	.505	157.0		295	232
1 W I	1→100	50.0	.664	203		745	302
1 W O	2→50	5.0	.208 gor	68		640	218
1-S-O	—	1.0 mL very cloudy	2.0**				

* initially ~ 60µg 1-SO
** " " ~ 100µg 1SO

Calculations:

for Scrubber Waters S-I, S-O

$$\mu g/mL\ NH_3 = \frac{\text{Equivalent } \mu g\ NH_3}{\text{mL in Nesslerized}} \times \frac{\text{final Vol of Dilution mL}}{\text{mL diluted}}$$

for Stack Samples A-I, A-O, W-I, W-O

$$\text{total mg } NH_3 = \frac{\text{Equivalent } \mu g\ NH_3}{\text{mL in Nesslerized}} \times \frac{\text{final volume of Dilution mL}}{\text{mL diluted}} \times \text{total volume of Sample, mL} \times \frac{.001\ mg}{1\ \mu g}$$

To Page No.

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Project No. 82488-20

TITLE C.F. Industries, Donaldsonville La Book No. " -4

From Page No. ___ Direct Mutagenicity of Sect II 1/18/79 16:45

Stds - see p9 for make up

mls WS	Abs @ 405nm
0	.000
1	.060
2	.122
5	.308
8	.515
10	.690

.635 end

Sample	Dilution	mls/Plate	Abs	Equivalent µg WS/3	total rev of single plate	µg/m³ WS/3	total rev
2-S-I	2→250	5.0	.055	17.5		43.8 per day	
2-S O	↓	50.0 very cloudy	2.0 *				
2-A I	↓	50.0	.162 * OK	52.5	382		50.1
2-A O	2→250	5.0	.645	200 µg	323		323
2-W-I	2→250	50.0	.650 ov	201	778		391
2-W O	2→250	5.0	.345 .345	111 µg	668		371

* 250 - Usually ~ 50-60 µg
2AI - approx match 40 µg Std.

see p 10 for Calculations

M. Dyl

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Project No. 82788-20

TITLE CFDnd. Donaldsville, La Book No. " - 4

From Page No. ___

1/19/19

Scrub Water Inlet and outlet is "4th tank Water"
- Should not have Ca or Mg, but may have organics, urea by products bi and tri Urea
- per conversation with Dave Capo 1/18/19 10:20 AM
- attempt to find out why reads S-O is cloudy.

M. Dof

To Page

Witnessed & Understood by me,	Date	Invented by	Date

Project No. 9.2953-20
Book No. 11-4 TITLE C.P. Ind. Donaldsonville, La

From Page No. —

1-19-79

Direct Nesslerization of Sect 3 Samples

Stock 1000 µg/ml NH_3 Dilute 5.0 ml → 250. ⇒ 20 µg NH_3/ml
Working Solution = WS

6 tds

total µg NH_3 in same Nesslertube		Abs
0	0 ml WS	.000
20	1.0	~~.090~~ .064
40	2.0	.110
100	5.0	.306 .305 end abs
160	8.0	.510
200	10.0	.620 .614 .61 end abs

Samples	Dilution	Aliquot in Nesslertube ml	Abs	Equivalent µg NH_3	total µg NH_3 in sample ps	µg/ml NH_3	total mg NH_3
3-S-I	~~none~~	~~2.0~~ 5.0	~~.235~~ .360	116 µg		232 very cloudy	
3-S-O	2→250	50.0	very cloudy*	2.0 ~~3 µg~~			
3-A-I	2→250	50.0	0.026	9 µg	364		8.19 ✓
3-A-O	2→50	3.0	.0.265	86 µg	366		262 ✓
3-W-I	2→250	~~25.0~~ 50.0 ml	.0.610	196 µg	1033		~~415~~ 506. ✓
3-W-O	2→50	5.0	.0.122	40 µg	625		125 ✓
Repeat 3-A-I	none	2.0 ml	.198 visually 0.1	64 µg			

* 3-S-O visually yellow color when compared to standards
looks approximately ~~3~~ 80 µg or more

See p10 for Calculations

mDf

To Page No. —

Witnessed & Understood by me.	Date	Invented by	Date
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Project No. 920-5320

16 Book No. -4 TITLE C.F. Industries, Donaldsonville, La

From Page No. ___ 1/20/78

Out of TRC H_2O - Use CF Ind - Reagent Water to bring up
Urea digestate for distillation onto Boric acid
(30 mls/sample)
Also use CF H_2O for Direct Nes. of Sample 4 & 6
- Dilution.

M. Dop

To Page No.

Witnessed & Understood by me.	Date	Invented by	Date
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Project No. 82988-20

TITLE C-E Lab, Donaldsonville, La. Book No. ~~E-1~~ 1-4

From Page No. —

Direct Nesslerization of Tests 4-6 1/20/79 11 AM

Standard Stock 1000 μg/ml NH_3

Dilute 5.0 ml → 250 ml ⇒ 20 μg NH_3/ml Working Solution

Std total μg NH_3 in Some Nessler Tube	ml W.S	Abs	Abs
0	0	.000	
20	1.	~~.050~~ .015	.060
40	2.	.145	
100	5.	.350	
160	8.	.530	
200	10.	.680 V	.66

Sample	1st Dilution	2nd Dilution	Aliquot of final Dilution	Abs	Equivalent μg NH_3	Sample Volume	Result: total mg NH_3	
4S-A	none	2→250	2.0	.380 +	110 μg	995 ml	27.2	✓ OK
4S-W	2→250	2→250	50.0	.605 ~~.605~~	148 μg	845	37,694	✓ OK
5S-A	none	none	2.0	very dark .2		462	cloudy	
5S-W	2→250	2→250	50.0	.438	127 μg	1155	45,839	
6S-A	none	none	2.0	slightly cloudy .15 ab		502	cloudy	
6S-W	2→250	2→250	50.0	~~.545~~ .555	163 μg	1135 ml	57,514	

† 4-SA visually 90 μg (did not appear cloudy)
5SA " 100 μg very cloudy
6SA " 60 μg

see p 10 for calculations

To Page No. —

Witnessed & Understood by me.	Date	Invented by	Date
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Project No. _____

20 Book No. _____ TITLE _____

From Page No. ___ Formaldehyde Determinations 1/26/79

Standard - stock 1 mg/ml 10 ml → 100 mls = 10 ug/ml (solution "B")

ul Solution "B" (ug)	mls Soln "B"	Abs. 580 nm
0	0	0
.1	0.1	.048
3	0.3	.122
5	0.5	~~.190~~ .190
7	0.7	.290 √
10	1.0	.440
20	2.0	.860

Samples	Aliquot mls	Abs 580 nm sample blank	Equivalent ug CH_2O	Sample Volume ml	ug/ml Formal	total mg Form
~~Test 1 outlet gash~~	4					
Run 2 outlet		.035 √				
Run 3 "		.034				
Test 4 outlet gash		.030				
Run 5 outlet		.048				
Run 6 outlet		.028				
Test 5 Amer. PWS		.100				
1-I-scrubber H_2O		off scale - dilute 1→10				
1-O- " "		.008	<4	<	<.04	
1-A-I		.208	5.0	341	0.	0.426
1-A-O		.234 √	5.6	295		0.413
1-W-I		.470 .470	11.0	745		2.05
1-W-O		.565	13.2	640		2.11

Agricor Samples calculated on p 74-75 Agricor Book

↓ dc Jmm

↓ 2nd Jmm

Calculations

$$\text{total ug/ml Form.} = \frac{\text{Eq. ug } CH_2O}{\text{mls sample}} \times \text{dilution factor}$$

$$\text{total mg } CH_2O = \frac{\text{Eq ug } CH_2O}{\text{mls sample}} \times \text{dilution factor} \times \text{mls sample} \times \frac{.001 \text{ mg}}{1 \text{ ug}}$$

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Project No. 82788.20

TITLE CF 2nd

Book No. [illegible]

From Page No. ____

1/26/79

Prep of Solid Samples for Formaldehyde Analysis

Feed Melt to Granulator 1/18/79

5.8610
-0.2000
5.6610 g /100 ml H_2O

Unscreened Urea Composite

5.8950
- 0.2000
5.6950

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

Project No. _____

:2 Book No. _____ TITLE _____

:om Page No. ___ Formaldehyde Determinations 1/29/75

Standard - stock = 1 mg/ml (na formaldehyde bisulfite) 1.0 ml → 100 mls → 10 µg/ml formaldehyde (soln "B")

Solution "B" (ml)	mls soln "B"	abs 580 nm	
0	0	0.000	
1	0.1	0.068	.080
3	0.3	.170	.180
5	0.5	.255	.260
7	0.7	.348	.347
10	1.0	.480	.475
20	2.0	.880	.870

* See Calculations p20

Samples	Aliquot (mls)	Abs 580 nm	Equivalent µg/ml	total sample volume	µg/ml Formaldehyde	total mg Formaldehyde *
Tests, outlet grab	4 mls	.000	0.2 CHO	Agrico		
1-I-scrubber H2O (d.1.5→5) take 4 mls		.490	10.4		26.0	
2-S-I (d.1.5→5 take)	4 mls	.390	8.0	–	20.0	
2-S-O		.016	0.3	–	0.075	
2-A-I		.020	0.4	382 ml		0.0382
2-A-O		.022	0.45	323		0.0363
2-W-I		.380	7.75	778		1.507
2-W-O		.340	6.8	668		1.136
3-S-I (d.1.5→5) take	4 mls	.273	5.4	–	13.5	
3-S-O		.010	0.2	–	0.05	
3-A-I		.052	1.0	364		0.091
3-A-O		.026	0.5	366		0.0458
3-W-I		.560	11.6	1033		2.996
3-W-O		.393	8.0	625		1.25
Feed mill to granulator						
1:8 liq CF END	1 ml	1.22	high			
Unscreened urea Composite	1 ml	1.20	high			
Feed Mill 2→25	4.0 mls	1.0 ml 0.72	16.1	100.0	20.12	0.356
Unscreened 2→25	4.0 mls	1.0 0.94	>21	100.0	26.25	0.461
Unscreened 2→50		1.0 0.36	7.25	100.0	18.12	0.316
Unscreened 3→200	4.0 mls	.162	3.75	100.0	5.417	0.951

% CH2O formation area p21

To Page No. ___

Witnessed & Understood by me.	Date	Invented by	Date
		Recorded by	

From Page No. ___ Formaldehyde Determination 1/30/79

Standard (Na formaldehyde bisulfite) - stock - 1mg/ml 1.0 → 100 mls ⇒ 10ug/ml formald. (Soln "B")

Soln "B" (ug)	mls taken Soln "B"	Abs. 580 nm	
0	0	0.00	
1	0.1	.225	.230
3	0.3	.080	.095
5	0.5	.150	.160
7	0.7	.250	.252
10	1.0	.388	.390
20	2.0	.650	.653

Samples	Code	1st dilution	aliquot	Abs 580	Equiv. mg CH_2O	total mg CH_2O	% CH_2O in sample	
CFIND Feed Mill	A	2 mls → 50	1 ml	.378	10.7	26.75	0.473	0.41
p21 5.661g/100 mls	B	2 mls → 100	2 ml	.290	8.3	20.75	0.367	
	C	2 mls → 200	4 mls	.308	8.8	22.0	0.389	
Unscreened Urea	D	2 mls → 50	1 ml	.440	12.5	31.25	0.599	0.65
5.695g/100 mls	E	2 mls → 100	2 mls	.540	15.3	38.25	0.612	
p21	F	2 mls → 200	4 mls	.538	15.2	38.0	0.667	

Calculation

Unscreened & Feed melt were solid samples
- dissolved & known wt in 100.0 ml H_2O

Calculate total mg CH_2O in 100 ml of sample (as on p 20)

Then divide total mg CH_2O by total mg of sample in 100 ml (p 22) and multiply by 100 to get %.

To Page No. ___

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

2-16-74

Calculations for Distilled NH_3 and Urea samples
on pp 25-27 p35

Blank Correction Factor from p 27

NH_3 Reagent Blank 16 µg/50 mls of Distilled in Nessler tube = 0.32 µg NH_3/ml in Nessler tube

Urea Reagent Blank 21 µg/50 mls of Distilled in Nessler tube = 0.42 µg NH_3/ml in Nessler tube

$$\mu g/ml\ NH_3 = \frac{\text{Equivalent } \mu g\ NH_3}{\text{mls in Nessler tube}} \times \frac{\text{Total Vol of 2nd dilution}}{\text{mls distilled}} \times \frac{250\ ml}{\text{mls sample distilled}}$$

µg/ml Urea = above × 1.765

$$\text{total mg } NH_3 = \frac{\text{Equivalent } \mu g\ NH_3}{\text{mls in Nessler tube}} \times \frac{\text{Total Vol of 2nd dilution}}{\text{mls distilled}} \times \frac{250\ ml}{\text{mls sample distilled}} \times \text{Sample Volume mls} \times \frac{.001\ mg}{\mu g}$$

total mg Urea = above × 1.765

to apply Blank Correction substitute the below value for Equivalent µg NH_3

$$\text{Equivalent } \mu g\ NH_3 - \left[\begin{matrix}.32\ \mu g/ml \\ .42\ \mu g/ml\end{matrix} \times \text{mls in Nessler tube}\right]$$

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	

om Page No. ——

2/1/79

Analysis of Distilled ammonia Samples. Results

Sample #	Sample Volume	Aliquid distilled to 250 mls	2nd Dilution	mls in 50 ml Nesslerized	Abs.	Titrant observed	µg NH3	µg/ml NH3 not Blank corrected	mg NH3	Blank corrected results
2-1-79										
B-W-I	does not apply	100 mls → 250	none	50.0	.094	10 µg	28	1.04		0.68 µg/ml
B-W-O					.090	10	26.5	1.32		0.52 µg/ml
B-A-I					.088	10	26.0	1.30		0.50 µg/ml
B-A-O					.094	10	28.	1.40		0.60 µg/ml
B-RW-I					.495	cloudy 0 µg	cloudy 146	cloudy 7.3		cloudy 6.5 µg/ml
B-RW-O					.165	20 µg	49	2.45		1.65 µg/ml
1-S-I	—	5.0	—	50.0	.522	cloudy 60-80 µg	cloudy 154	cloudy 154		cloudy 1350 µg/ml
1-S-O	—		5 → 100	(Original 20.0) 100 mls	.480	~60	1415	14150		1415 µg/ml
1-A-I	34 ml		none	10.0	.230	~60	68.0		116.	110 mg/l
1-A-O	295 ml	25.0		2.0	.535		158.		233	232
1-W-I	745 ml	5.0		10.0	.73 repeat		R		R	R
1-W-O	640 ml	25.0		2.0	.22		65		208.	206
2-S-I	—	5.0	—	50.0	.432	cloudy ~40	cloudy 68	68.		52 µg/ml
2-S-O	—		5 → 100	10.0	.595		128	12,800		12,800 µg/ml
2-A-I	382		none	10.0	.102		30.		57.3	57.2 µg/ml
2-A-O	328	25.0		2.0	.505		149		244	243
2-W-I	778	5.0		10.0	.84 repeat		R		R	R
2-W-O	668	25.0		2.0	.148		555		195 mg/l	183 mg/l
3-S-I	—	5.0	—	50.0	0.160	20-30 µg	47	47		31 µg/ml
3-S-O	—		5 → 100	10.0	.445		131	13,100		13,100 µg/ml
3-A-I	364		none	10.0	.045		13.		23.7 mg/l	17.8 mg/l
3A-O	366	25.0		2.0	.490		1445		264 mg/l	263 mg/l
3-W-I	1033	5.0		10.0	.620		1825		943 mg/l	926 mg/l
3-W-O	625	25.0		2.0	.138		405		127 mg/l	125 mg/l

+ 150 - 25 ml aliquid - from a very cloudy brown precipitate upon Nesslerization

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From Page No. 25

2-1-79

Sample #	Sample Volume ml	Aliquot distilled to 250 ml	2nd Dilution	ml in 50 ml Nesslerized	Abs	Equivalent µg NH_3	Blank µg/ml NH_3	total mg NH_3	Given correct results total mg NH_3
4-S-A	495.	5.0→250	—	50.0	.230	68	3	33.7	25.7
4-S-W	815		5→100	2.0	.315	93		37,878	37,878
5-SA	462			50.0	.287 repeat	R			
5-S-W	1155		5→100	2.0	.285	84		49,510	46,510
6-S-A	502			50.0	.68 repeat	R			
6-S-W	1135	↓	5→100	2.0	.348	102.5		58,169	58,169
2-2-79									
Repeat HW I			—	5.0	not done 2-2-79				
5SA			—	25.0					
6SA			—	25.0					

Standards - Stock 1000 µg/ml NH_3

Dilute 10.0 ml → 500 ml ⇒ 20 µg/ml NH_3 Working Solution = W.S

total µg NH_3 in 50 ml Nesslertube	ml of W.S	Abs. 2/1/79	Abs. 2-2-79
0	0	.010	.010
20	1	.068	.065
40	2	.140	.138
100	5	.345	.344
160	8	.540	.538
200	10	~~.670~~ .670	.67

Blanks Test 1 and Tests 4, 5, 6

Standards

2-2-79

0	.000
20	.068
40	.138
100	.348
160	.545
200	.680

To Page No. _

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From Page No. ____ Recalculation of Repeat NH_3 Samples (from p25 & 26) 2/6/79
and Urea Samples

Standard

Stock 1000 µg/ml NH_3 Dilute 10.0 ml → 500 ml → 20 µg NH_3/ml
Working Solution = WS

Standard total µg NH_3 from p 25-27	ml WS in 50 ml Nessler tube	Abs.	Abs after
0	0	.000	.000
20	1.	.065	.070
40	2.	.140	.142
100	5.	.358	.360
160	8.	.550	.560
200	10	.695	.695

Repeat Samples - NH_3

Sample #	Sample Volume ml	aliquot distilled to 250 ml	2nd dilution	ml in 50 ml Nessler tube	Abs	Equivalent µg NH_3	net Blank corrected µg/ml NH_3	net Blank corrected total mg NH_3	Blank Corrected Results total mg
1-W-I	745	5.0	—	5.0	0.375	106		790.	778
2-W-I	778	5.0	—	5.0	0.410	116		902	~~903~~ 890
5-S-A	462	↓	—	25.0	0.440	125		116	108
6-SA	502	↓	—	25.0	0.248	70.5		70.8	62.6

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Recorded by

Project No. [illegible]

28 Book No. 11-4 TITLE C-F Land Application, Z

From Page No. 27

2-6-79

Investigation of Urea Samples Distilled @ C-F Ind.

Sample #	Sample vol. mls	aliquot distilled to 250 mls	2nd dilution	micro 50 ml Titrette	abs	Equiv mg NH_3	Results µg/ml NH_3 as Urea	total mg urea	Blank corrected Results
B-W-I	does not apply	100 → 250 mls	none	50.0	.244	69.	6.09		4.24 µg/ml Urea
B-W-O					.185	53	4.68		2.82 µg/ml Urea
B-A-I					.198	56	4.94		3.09 µg/ml Urea
B-A-O					.152	43	3.79		1.94 µg/ml Urea
B-PW-I					.410	116	10.24		9.39 µg/ml Urea
B-PW-O					.412	117	10.33		8.47 µg/ml Urea
1-S-I	—	5.0		50	.300	85.5	150.9		113.8 µg/ml Urea
1-S-O	—		2 → 200	2	.412	117	516,300	[illegible]	516,300 µg/ml Urea
1-AI	341			25	.082	23		27.7	15.0 mg Urea
1-AO	295	25.0		25	.115	33		6.87	4.69 mg Urea
1-WI	745	5.0	5 → 100	5	.340	91	[illegible]	23,932	23,905
1-WO	640	25.0	—	10 2x	.220	62.5		70.6	65.9 mg Urea
2SI	—	5.0		50	.240	68.	120.0		82.96 µg/ml Urea
2SO	—		2 → 200	2	.420	119	525,100		525,100. µg/ml Urea
2AI	382			25	.108	30.5		41.1	26.97 mg Urea
2AO	328	25.0		25	.148	42		9.73	7.29 mg Urea
2WI	778	5.0	5 → 100	5	.336	95		26,090	26,063 mg Urea
2WO	668	25.0		10	.212	60	[illegible]	70.7	65.8 mg Urea
3SI	—	5.0		50	.260	74	130.6		93.5 µg/ml Urea
3SO	—		2 → 200	2	.430	122	538,300		538,300 µg/ml Urea
3AI	364			25	.148	42		53.97	40.47 mg Urea
3AO	366	25.0		25	.108	30.5		7.88	5.17 mg Urea
3WI	1033	5.0	5 → 100	5	.252	72.		26,255	26,215 mg Urea
3WO	625	25.0		10	.198	56		61.8	57.1

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Project No. 82938-20

TITLE CF Ind, Donaldsonville, La. Book No. " -4

From Page No. 26

2/6/79

Urea Analysis continued

Sample	Sample volume	Aliquot distilled to 250 ml	2nd dilution	ml in 50 ml Nesslerized	abs.	Equiv. to NH_3		net + Blank corrected total mg found	Blank corrected result
4SW	815	50.0	none	50.0	.440	125		179.8	149.6
4SA	495				.230	65.5		57.2	38.9
5SW	1155				.362	102.5		209.0	166.1
5SA	462				.212	60.0		48.9	31.8
6SW	1135				.320	91.0		182.3	140.2
6SA	502				.252	72		63.8	45.2
Reagent Blanks							$\mu g/ml$		
NH_3			-	50.0	.056	16	0.32		
Urea			-	50.0	.063	21	0.42		

Note There does not appear to be any problem with turbidity with the Nesslerized samples run on pp 27, 28 & 29

To Page No.

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Project No. [illegible]-20

0 Book No. 11 -4 TITLE [illegible]

om Page No. ____

2-7-79

Preparation of Solid Samples for NH_3 + Urea analysis

① Feed Melt to Granulator 1/18/79

~~1.2069~~
~~0.2000~~
~~1.0869~~

1.2295
0.2000
1.0295 g / 100 mls H_2O

② Unscreened Urea Composite

1.2069
0.2000
1.0069 g / 100 mls H_2O

Aliquot Distilled 250 mls

① Feed Melt 5.0 mls

② Unsc. Product 5.0 mls

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TITLE _____ Project No. _____ Book No. _____

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Analysis of NH_3 + Urea in Solid Samples (p30 2/7/74

See p35

NH_3 Sample & Desired NH_3	Dilution	2nd Dilution in Titrate	aliquot	abs
Melt	~~5→250~~	~~none~~	50.0	~~.8~~ mg very cloudy
Urea-urea	~~5→250~~	none	50.0	very cloudy
Distilled NH_3 ~~Urea~~				
Melt	5→250	none	50.0	.64
Urea-urea	5→250	none	50.0	.74 repeat

See p35

To Page N

Witnessed & Understood by me.	Date	Invented by	Date
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TITLE _____ Book No. _____

From Page No. ____

5/7/79

Suspended Solids in Inlet-Outlet Scrubber Water

Filter Samples in question with Samples of temperature at the time when the samples were collected

Info from p 4 of Clean up area Notebook 82488-4 SC

Set 1	Inlet temp °F		Outlet temp °F	
①	135	151°F ave	126	124°F ave
②	154		122	
③	164		122	
④	152		120	

Set 2				
①	166	172°F	129	125°F
②	183		128	
③	174		129	
④	167		128	
⑤	172		128	

Set 3				
①	180	175°F	128	127°F
②	172		126	
③	177		129	
④	173		127	
⑤	173		124	

To Page ?

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		Record of	

Project No. _____
Book No. _____ TITLE _____

From Page No. 33

7/5/79

Suspended Solids of Scrubber Water

Sample	Temp °F ± 10° at which sample filtered	Volume filtered ml	Dish ID	Initial wt'g of dish g	2/12/79 final wt'g of dish g	wt'g of suspended solids mg	mg/l TSS	average of a+b TSS mg/l	
1 Outlet a	~~137~~ 124	200.	7	23.95076	23.95156	0.80	4	3.9	
1 Outlet b		200	8	23.82296	23.82362	0.76	3.8		
1 Outlet a	124 151	150	3	23.11615	23.11630	0.15	1.0	1.17	7/5/79
1 Outlet b		150	4	23.63110	23.63130	0.20	1.33		
2 Inlet a	172	200	5	23.54224	23.54250	0.26	1.30	0.88	
2 Inlet b		200	6	23.63853	23.63862	0.09	0.45		
2 Outlet a	128	200	1	23.88590	23.88714	1.24	6.2	4.6	7/5/79
2 Outlet b		200.	A	24.24050	24.24110	0.60	3.0		
3 Inlet a	175	100	9	23.19306	23.19352	0.46	4.6	3.6	
3 Inlet b		100	10	22.85316	22.85342	0.26	2.6		
3 Outlet a	127	200	11	24.12042	24.12152	1.1	5.5	4.8	
3 Outlet b		100	12	23.36181	23.36222	0.41	4.1		

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From Page No. ____

2/9/79

Analysis of Solid Samples see p30 for sample prep

Melt 1.0295 g/100 ml H_2O
Unscrubbed 1.0069 g/50 ml H_2O

Sample	Distillation	2nd Dilution	Aliquot	abs	Equiv ug/ml	total mg NH_3	% NH_3	Blank corrected results
Distilled NH_3 Melt	5.0 → 250	none	25.0	.340	97.	19.4	1.88	17.9 mg NH_3 1.73%
Unscrubbed		none	25.0	.400	114 ✓	22.8 total mg/liter	2.26 % liter	ok 21.2 mg NH_3 2.11%
Ocean Melt		10 → 100 ml	5.0	.185	53	935.4	90.9%	932.6 mg liter 90.6%
Unscrubbed	↓	10 → 100 ml	5.0	.194 ov	55	970.8	96.4%	967.9 mg liter 88.1%

Standards p91 agrico

	Abs end
0	.000
20	.072
40	.140
100	.350
160	.545
200	.665

p31 - Direct Nesslerization samples were very cloudy

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		Recorded by	

Project No. 5285-90
Book No. 11-4 TITLE CF-Lnde Simulant Melt, Lo

Page No. ___ 2/13/79

pH of Feed Melt

This sample was "liquid" when collected. It solidified in sample bottle, a pH is required. Gary McCallister said to make up a solution using the least amount of H_2O possible. Then measure pH

72.5g Feed + Melt
51.8g wt + Beaker
20.7g Feed Melt. added 100 mls H_2O
pH of the saturated solution was 9.2

To Page No. ___

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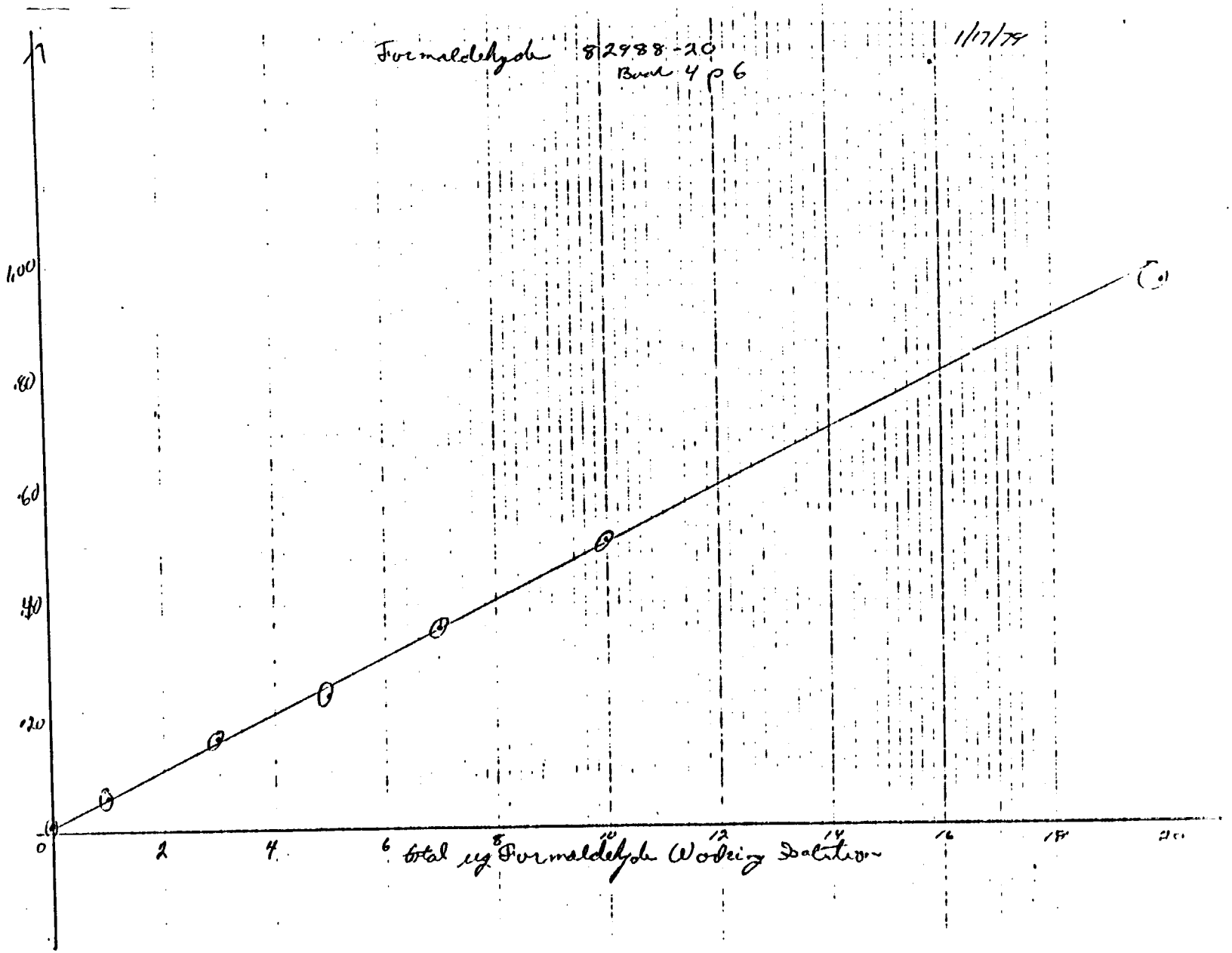
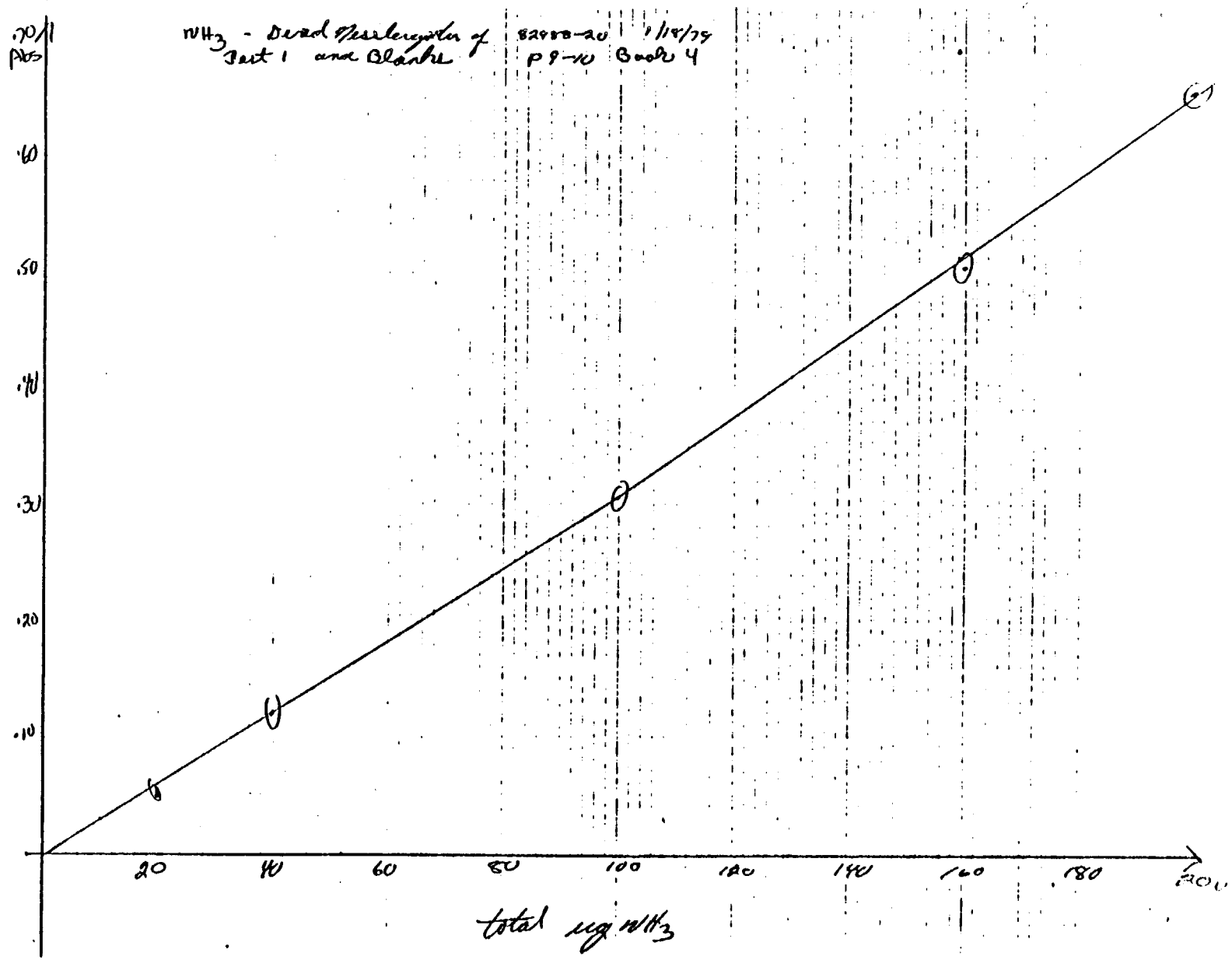
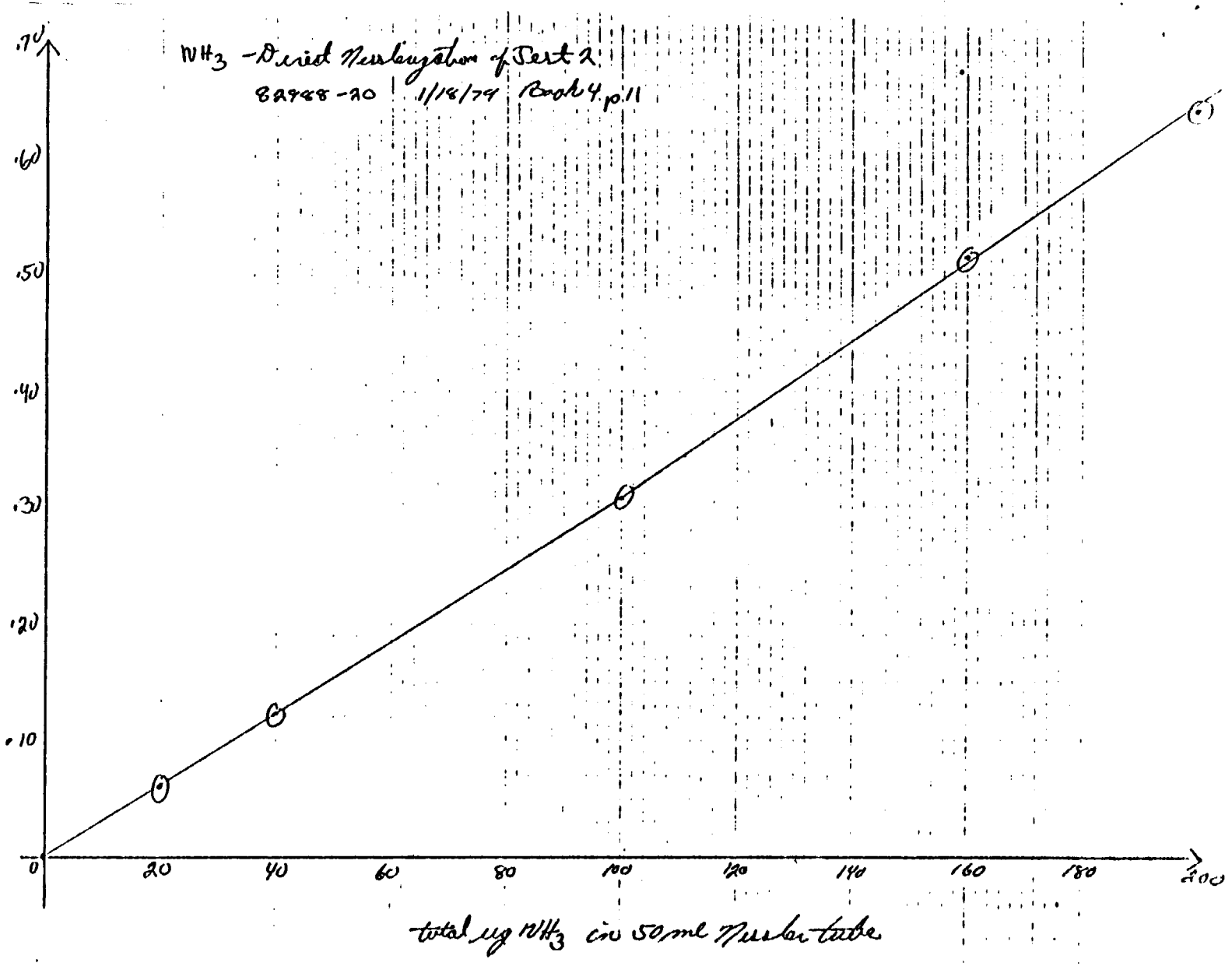
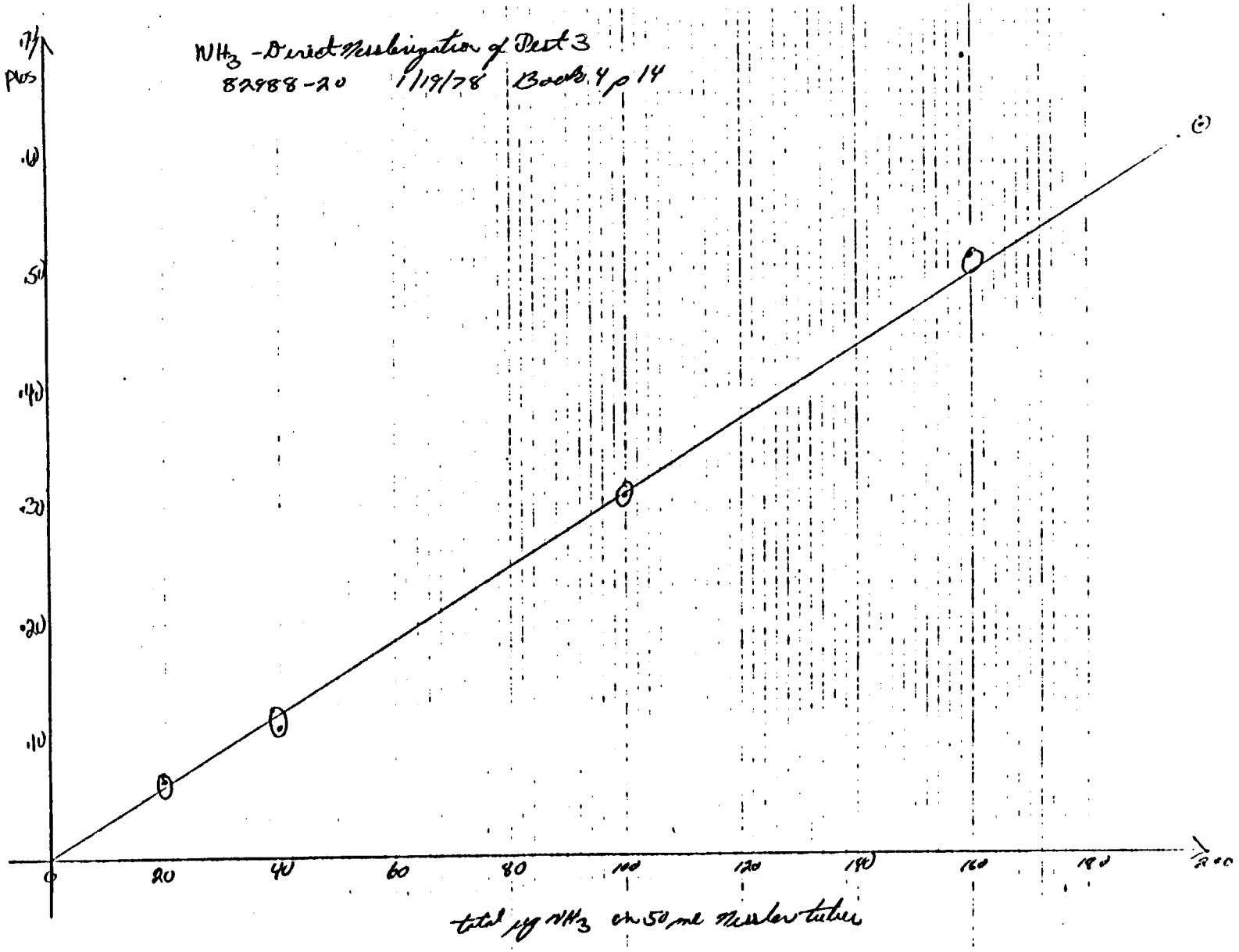
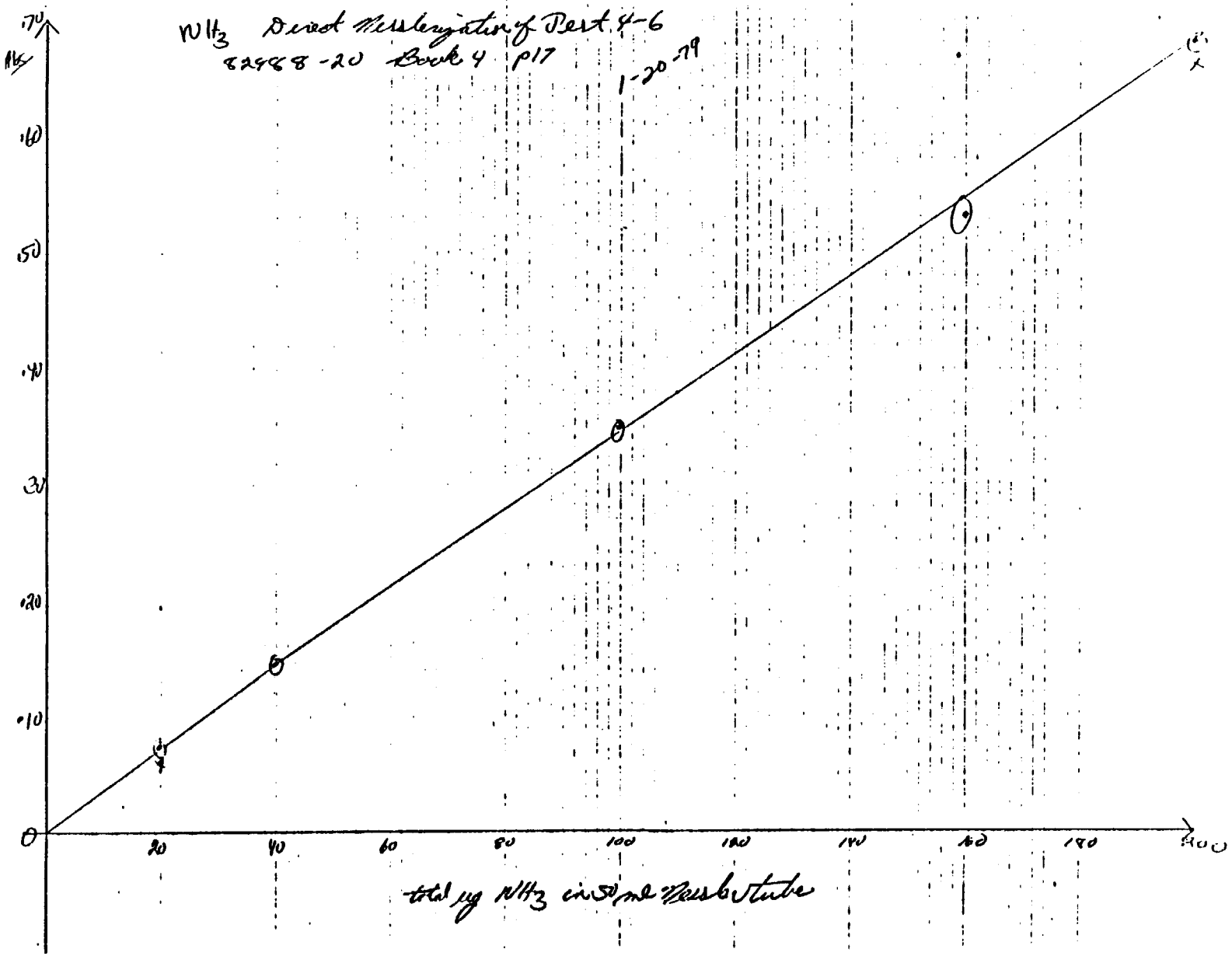
		Recorded by	

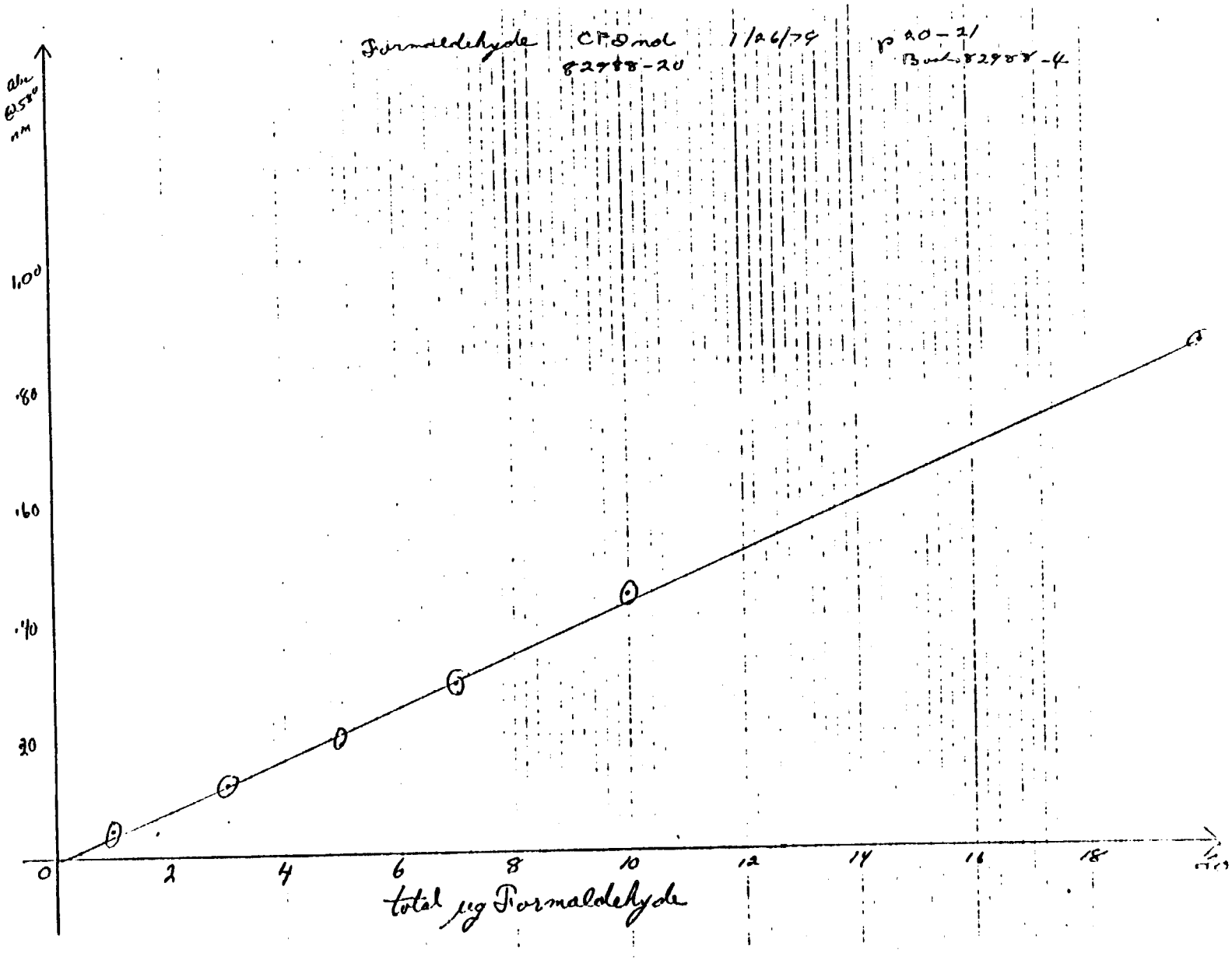

Formaldehyde 82988-20
Book 4 p 6
1/17/78
1.00
.80
.60
.40
.20
0
2
4
6
8
10
12
14
16
18
20
total µg Formaldehyde Working Solution


NH3 - Dead Reckoning of Test 1 and Blanks
82000-20 1/18/79
p 9-10 Book 4
.70 Abs
.60
.50
.40
.30
.20
.10
20
40
60
80
100
120
140
160
180
200
total ug NH3

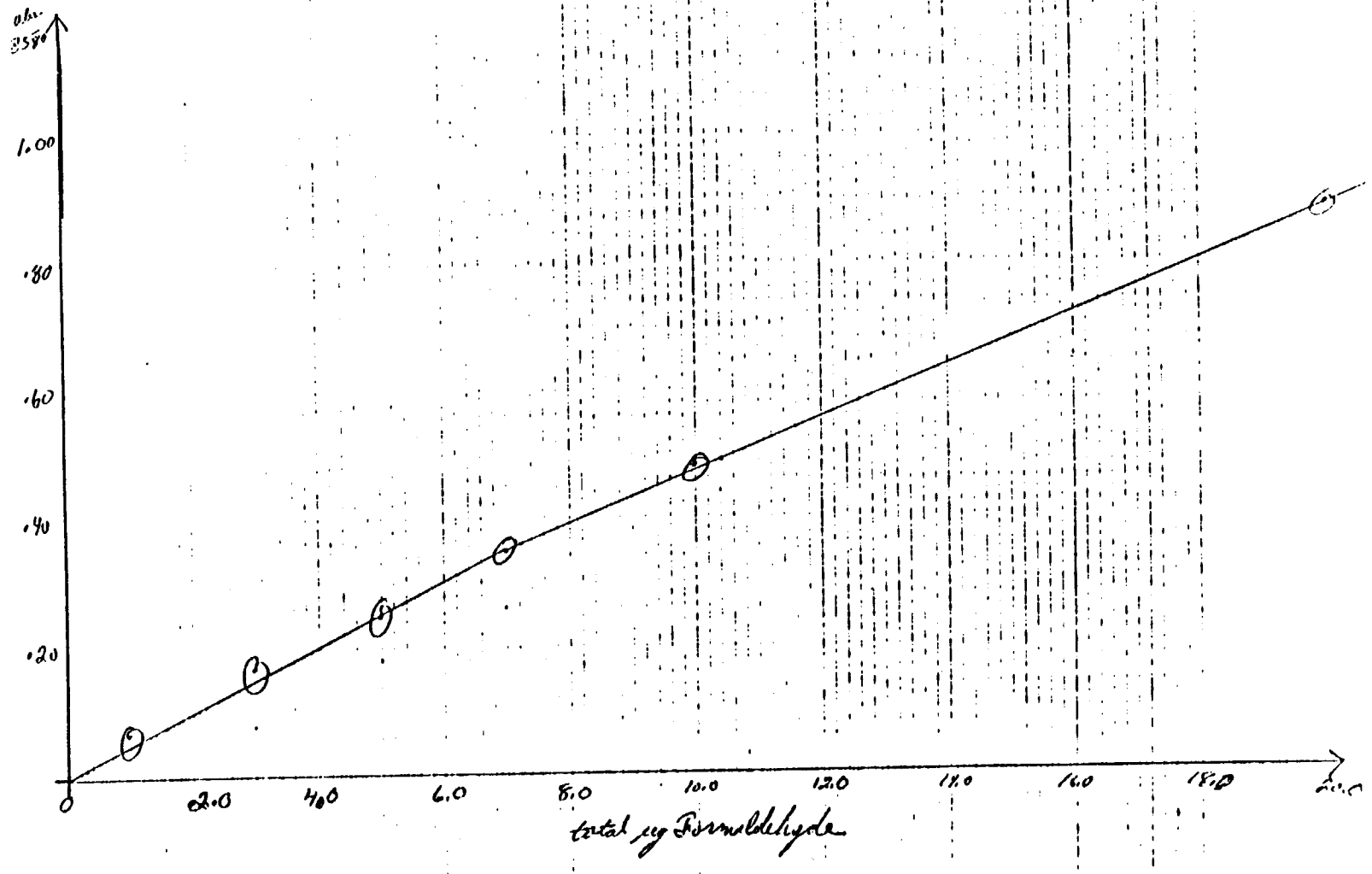

NH_3 - Dried Nesslerization of Set 2
82488-20 1/18/74 Book 4 p.11
.70
.60
.50
.40
.30
.20
.10
0
20
40
60
80
100
120
140
160
180
200
total ug NH_3 in 50 ml Nessler tube

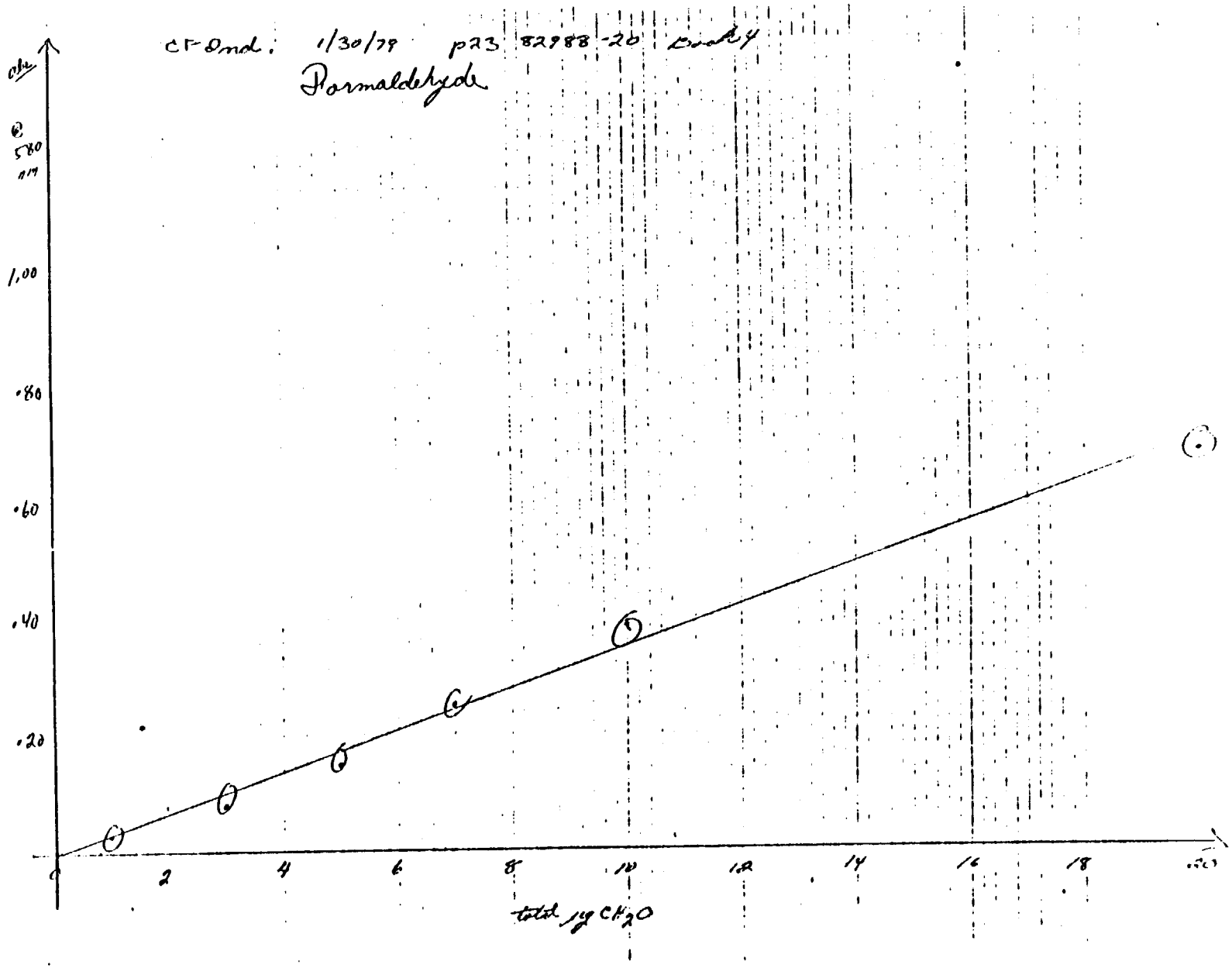

NH3 - Direct Nesslerization of Test 3
82988-20 1/19/78 Book 4 p 14
Abs
.60
.50
.40
.30
.20
.10
0
20
40
60
80
100
120
140
160
180
200
total µg NH3 in 50 ml Nessler tube

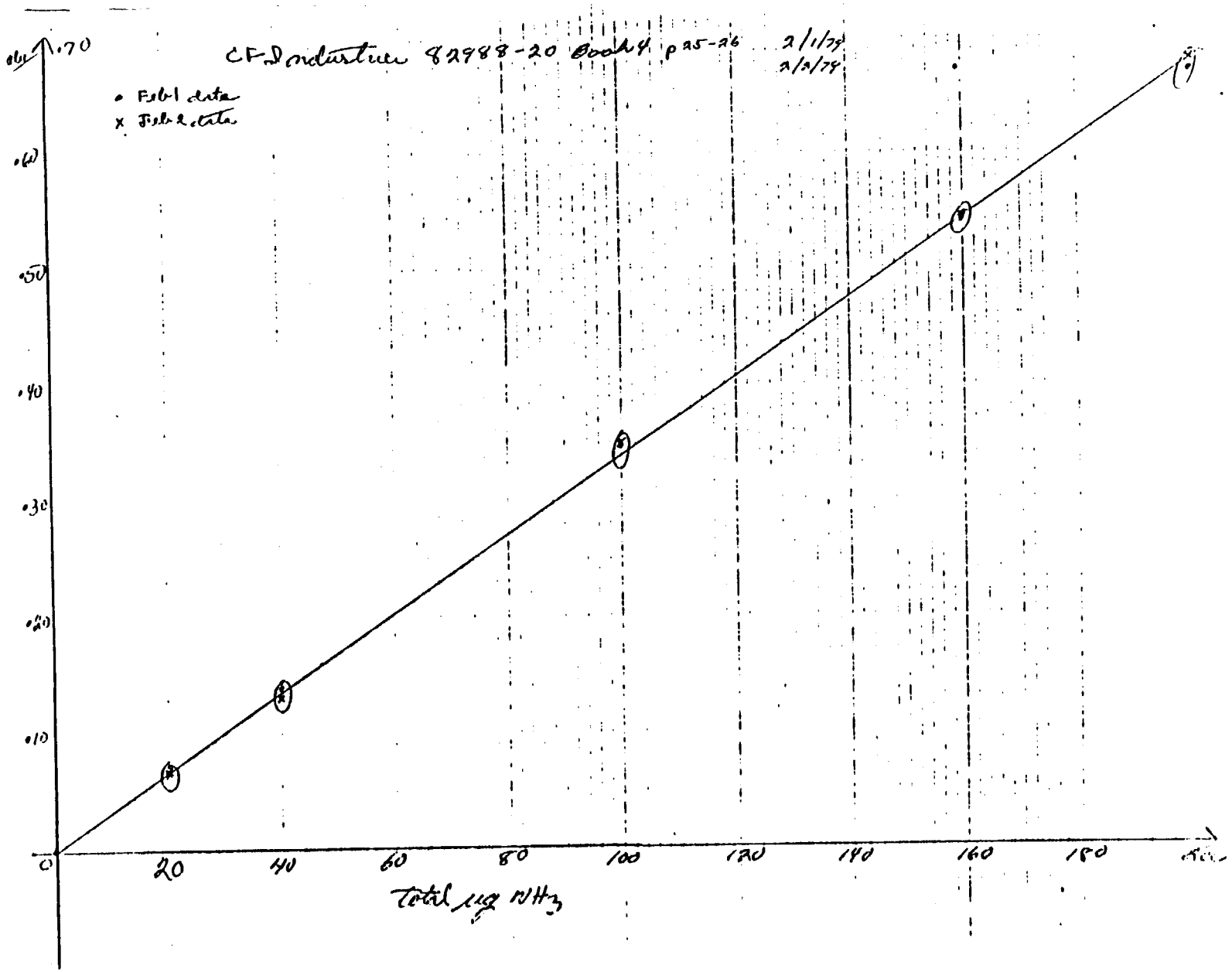

NH3 Direct Nesslerization of Part 4-6
82488-20 Book 4 p17
1-20-79
.70
.60
.50
.40
.30
.20
.10
0
20
40
60
80
100
120
140
160
180
200
total µg NH3 in 50 ml Nesslerized tube

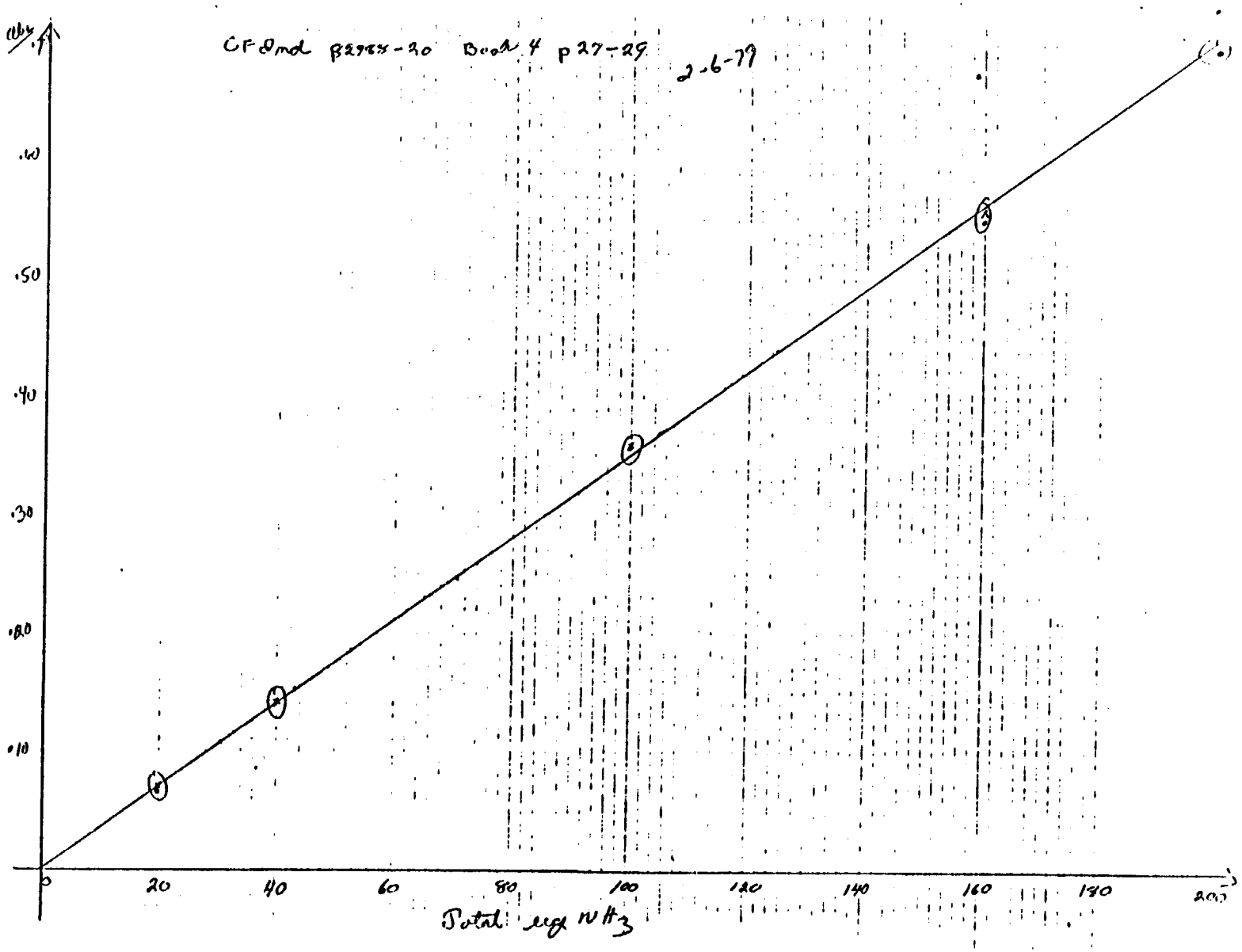

Formaldehyde CRDmol 1/26/79 p 20-21
82788-20 Bul. 82788-4
Abs @ 570 nm
1.00
.80
.60
.40
.20
0
2
4
6
8
10
12
14
16
18
total µg Formaldehyde

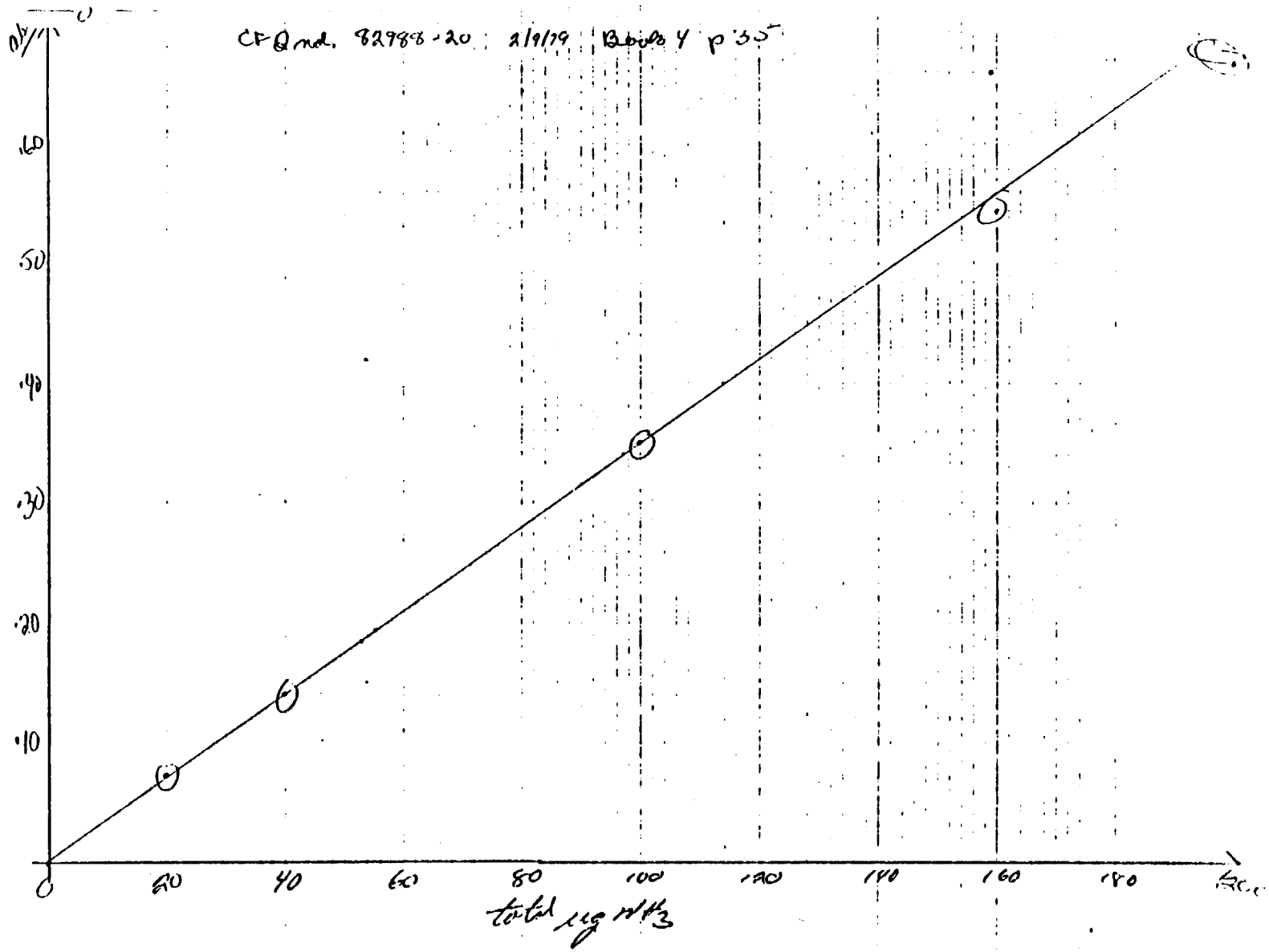
CF Anal. p 22 ~~23~~ 1-29-79
82968-20
Book 4 Formaldehyde




CF-Omd. 1/30/79 p23 82988-26 Bradley
Formaldehyde
Abs @ 580 nm
1.00
.80
.60
.40
.20
0
2
4
6
8
10
12
14
16
18
total µg CH2O


CF Industries 82988-20 Book 4 p 25-26 2/1/78 2/2/78
• Fish 1 data
x Fish 2 data
.70
.60
.50
.40
.30
.20
.10
0
20
40
60
80
100
120
140
160
180
Total µg NH3


CF8md Batch-30 Book 4 p27-29
2-6-79
Abs
.60
.50
.40
.30
.20
.10
0
20
40
60
80
100
120
140
160
180
200
Total µg NH3


CFQ nd. 82988-20 2/9/79 Book 4 p 35
Abs/11
.60
.50
.40
.30
.20
.10
0
20
40
60
80
100
120
140
160
180
Acc
total µg Mn/3

APPENDIX K

SAMPLING AND ANALYTICAL PROCEDURES
INCLUDES PROCEDURES FOR

APPENDIX K-1

EPA PROCEDURES FOR UREA

DETERMINATION OF PARTICULATE, AND UREA EMISSIONS FROM UREA PLANTS

1. Principle and Applicability

1.1 Principle. A gas sample is extracted isokinetically from the stack. The ammonia is removed from the sample by boiling, and the urea is measured by a colorimetric procedure.

1.2 Applicability. This method is applicable for the determination of urea from urea manufacturing facilities.

2. Apparatus

2.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 1; it is similar to construction to Method 5. The sampling train consists of the following components.

2.1.1 Probe Nozzle, Probe Liner, Pitot Tube, Differential Pressure Gauge, Metering System, and Barometer. Same as Method 5, sections 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.8, and 2.1.9 respectively. Stainless steel probe liners may also be used.

2.1.2 Impingers--Five as shown in Figure 1. The second and third shall be of the Greenburg-Smith design with standard tips. The first, fourth, and fifth shall be of the Greenburg-Smith design, modified by replacing the insert with an approximately 13 millimeter (0.5 in) I.D. glass tube, having an unconstricted tip located 13 mm (0.5 in) from the bottom of the flask. Similar collection systems, which have been approved by the Administrator, may be used.

2.2 Sample Recovery. The following equipment is needed:

2.2.1 Probe-Liner and Probe-Nozzle Brushes, Graduated Cylinder and/or Balance, Plastic Storage Container, and Rubber Policeman. Same as Method 5, sections 2.2.1, 2.2.5, 2.2.6, 2.2.7, respectively.

2.2.2 Wash Bottles--Two. Glass wash bottles are recommended; polyethylene wash bottles may be used at the option of the tester.

2.2.3 Glass or Plastic Sample Storage Containers. Chemically resistant, borosilicate glass bottles 500 ml or 1000 ml. Screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free. (Narrow mouth glass bottles have been found to be less prone to leakage). Alternatively, polyethylene bottles may be used.

2.2.4 Funnel, Glass or Polypropylene.

2.3 Analysis.

2.3.1 Pipettes. Volumetric type 0.5-ml, 2-ml, 5-ml, 8-ml, 10-ml, 20-ml, and 25-ml sizes.

2.3.2 Volumetric Flasks. 25-ml size, 100-ml size, 250-ml size, 500-ml size and 1000-ml size.

2.3.3 Graduated Cylinder. 100-ml size.

2.3.4 Distillation Apparatus.

2.3.4.1 Flasks or Beakers. At least two, 800-ml size.

2.3.4.2 Hot Plate. Capable of heating the distillation flasks to 120°C (248°F).

2.3.5 Spectrophotometer. To measure absorbance at 420 nanometers.

2.3.6 Sample Cells. Two matched absorbance cells to fit the spectrophotometer.

3. Reagents

Use ACS reagent-grade chemicals or equivalent, unless otherwise specified. The reagents used in sampling and sample recovery are as follows:

3.1 Sampling and Sample Recovery.

3.1.1 Silica Gel, Crushed Ice, and Stopcock Grease. Same as Method 5, sections 3.1.2, 3.1.4, 3.1.5, respectively.

3.1.2 Water. Deionized distilled to conform to ASTM specification D 1193-74, type 3. At the option of the analyst, the $KMNO_4$ test for oxidizable organic matter may be omitted when high concentrations of organic matter are not expected to be present.

3.1.3 Sulfuric Acid, 1 N. Dilute 28 ml of concentrated sulfuric acid to 1 liter with deionized distilled water.

3.2 Analysis. The reagents need for analysis are listed below.

3.2.1 Water. Same as 3.1.2.

3.2.2 Sodium Hydroxide (NaOH), 10 N. Dissolve 40 g of NaOH in a 100-ml volumetric flask and dilute to exactly 100 ml with deionized distilled water.

3.2.3 Sodium Hydroxide 6 N. Dissolve 240 g of NaOH in 800 ml of deionized distilled water in a 1-liter flask. Dilute to exactly 1 liter with deionized distilled water.

3.2.4 Sodium Hydroxide 1 N. Dissolve 40 g of NaOH in 800 ml of deionized distilled water in a 1-liter flask and dilute to exactly 1 liter with deionized distilled water.

3.2.5 Sodium Hydroxide 0.1 N. Dilute 100 ml of 1 N NaOH to exactly 1 liter with deionized distilled water.

3.2.6 Borate Buffer. Dissolve 2.5 g of sodium tetraborate, $Na_2B_4O_7$, or 4.8 g of the decahydrate $Na_2B_4O_7 \cdot 10\ H_2O$, in 500 ml of deionized distilled water in a 1-liter volumetric flask. Add 88 ml of 0.1 N NaOH solution and dilute to exactly 1 liter with deionized distilled water.

3.3.7 Sulfuric Acid 1 N. Slowly add 28 ml of concentrated sulfuric acid to 800 ml of deionized distilled water in a 1-liter flask and dilute to exactly 1 liter with deionized distilled water.

3.3.8 Ethyl Alcohol, 95 percent.

3.3.9 P-dimethylaminobenzaldehyde.

3.3.10 Hydrochloric Acid, Concentrated (36.5 - 38 percent by weight).

3.3.11 Stock Standard Urea Solution. Dissolve 5.000 g of urea in 500 ml of deionized distilled water in a 1-liter flask and dilute to exactly 1 liter with deionized distilled water.

3.3.12 Urea Color Reagent. Prepare the color reagent by dissolving 2.000 g of P-dimethylaminobenzaldehyde in a mixture of 100 ml of 95 percent ethyl alcohol and 10 ml of hydrochloric acid.

4. Procedure

4.1 Sampling. Because of the complexity of this method, testers should be trained and experienced with the test procedure to insure reliable results.

4.1.1 Pretest Preparation. Follow the general procedure given in Method 5, section 4.1.1, except omit the directions for the filter.

4.1.2 Preliminary Determinations. Follow the general procedure given in Method 5, section 4.1.2.

4.1.3 Preparation of Sampling Train. Follow the general procedure given in Method 5, section 4.1.3, except place 100 ml of deionized distilled water in each of the first two impingers, place 100 ml of 1 N H_2SO_4 in the third impinger, leave the fourth impinger empty, and place the preweighed silica gel in the fifth impinger. Assemble the train as shown in Figure 1.

4.1.4 Leak Check Procedures. Follow the leak-check procedures given in Method 5, sections 4.1.4.1 (Pretest Leak Check), 4.1.4.2 (Leak-Check During Sampling Run) and 4.1.4.3 (Post-Test Leak-Check).

4.1.5 Sampling Training Operation. Follow the general procedure given in Method 5, section 4.1.5. For each run, record the data required on a data sheet such as the one shown in Method 5, Figure 5-2.

4.1.6 Calculation of Percent Isokinetic. Same as Method 5, section 4.1.6.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it to prevent losing or gaining particulate matter. Do not cap off the probe tip tightly while the sampling train is cooling down as this would create a vacuum in the filter holder, thus drawing water from the impingers into the filter holder.

Before moving the sampling train to the cleanup site, remove the probe from the sample train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate that might be present. Wipe off the silicone grease from the impinger inlet where the probe was fastened and cap it. Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used between the first impinger or condenser and the probe, disconnect the line at the probe and let any condensed water or liquid drain into the impingers or condenser. Either ground-glass stoppers, plastic caps, or serum caps may be used to close these openings.

Transfer the probe-impinger assembly to the cleanup area. This area should be clean and protected from the wind so that the chances of contaminating or losing the sample will be minimized.

Save a portion of the deionized distilled water used for cleanup as a blank. Take 200 ml of this water directly from the wash bottle being used and place it in a glass sample container labeled "water blank."

Inspect the train prior to and during disassembly and note any abnormal conditions. Treat the samples as follows:

Container No. 1. Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, probe fitting, and probe liner, by washing these components with water and placing the wash in a glass container. Perform the water rinses as follows:

Carefully remove the probe nozzle and clean the inside surface by rinsing with water from a wash bottle and brushing with a Nylon bristle brush. Brush until the water rinse shows no visible particles, after which make a final rinse of the inside surface with water.

Brush and rinse the inside parts of the Swagelok fitting with water in a similar way until no visible particles remain.

Rinse the probe liner with water by tilting and rotating the probe while squirting water into its upper end so that all inside surfaces will be wetted with water. Let the water drain from the lower end into the sample container. A funnel (glass or polyethylene) may be used to aid in transferring liquid washes to the container. Follow the water rinse with a probe brush. Hold the probe in an inclined position, squirt water into the upper end as the probe brush is being pushed with a twisting action through the probe; hold a sample container underneath the lower end of the probe, and catch any water and particulate matter which is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter is carried out with the water or until none remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since metal probes have small crevices in which particulate matter can be entrapped. Rinse the brush with water, and quantitatively collect these washings in the sample container. After brushing, make a final water rinse of the probe as described above.

It is recommended that two people be used to clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contamination.

Container No. 2. Measure and record the volume of the first two impingers. Then transfer the contents to the container. Rinse the first two impingers and the connecting glassware with water and add the rinse water to the container. Mark the level of the liquid on the container and identify the sample container.

Impingers Nos. 3 and 4. Measure and record the volume of the third and fourth impingers. Discard the liquid.

Container No. 3. Note the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the impinger wall and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure for container No. 3 in section 4.3.

4.3 Analysis. Record the data required on a sheet such as the one shown in Figure 5-3. Handle each sample container as follows:

4.3.1 Container Nos. 1 and 2. Note the level of liquid and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject-to the approval of the Administrator, to correct the final results. Measure the liquid either volumetrically to ± 1 ml or gravimetrically to ± 1.0 g and record on the data sheet. Combine the contents of both containers in a 500-ml volumetric flask and dilute to exactly 500 ml with deionized distilled water. Distill the sample following the procedure in 4.3.4.

4.3.2 Container No. 3. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. This step may be conducted in the field.

4.3.3 "Water Blank" Container. Measure water in this container either volumetrically or gravimetrically and record on the data sheet. Distill the sample following the procedure in 4.3.4.

4.3.4 Sample Distillation. Treat the combined sample 1 and 2 and the water blank as follows:

4.3.4.1 Preparation of Sample. Pipette a 100-ml aliquot of sample into a 1-liter flask or beaker and add 400 ml of deionized distilled water. Then add 25 ml of borate buffer and adjust the pH to 9.5 with 6N NaOH using short-range pH paper to measure the pH. Heat the flask to boiling and boil until the volume is reduced to about 75 ml. (Caution: This step should be conducted under a hood.) Transfer the remaining sample to a

100-ml volumetric flask and dilute to exactly 100 ml with deionized distilled water.

4.3.4.2 Analysis. Pipette 10 ml of this solution into a 25-ml volumetric flask and add 10 ml of the urea color reagent. Dilute to exactly 25 ml with deionized distilled water. Mix well and allow to stand for at least 10 minutes for full color development. Measure the absorbance of the solution at 420 nm using the blank solution (section 5.5) as a zero reference. If the absorbance exceeds that of the 5.00 mg urea standard, prepare another sample using less than a 10-ml aliquot.

5. Calibrations

5.1 Sampling Train. Calibrate the sampling train components according to the indicated section of Method 5. Probe Nozzle (5.1); Pitot Tube (5.2); Metering System (5.3); Temperature Gauge (5.5); Leak-Check of the Metering System (5.6); and Barometer (5.7).

5.2 Determination of Spectrophotometer Calibration Factor K. Add 0.0, 5.0, 10.0, 15.0, 20.0 and 25.0 ml of the stock standard urea solution to a series of six 250-ml volumetric flasks. Then follow the distillation and analysis procedures described for the samples in section 4.3.4 of this method. Each standard at the time of analysis will contain 0, 1.00, 2.00, 3.00, 4.00, and 5.00 mg respectively. The calibration procedure must be repeated each day that samples are analyzed. Calculate the spectrophotometer calibration factor as follows:

$$K_c = 1.00 \frac{A_1 + 2A_2 + 3A_3 + 4A_4 + 5A_5}{A_1^2 + A_2^2 + A_3^2 + A_4^2 + A_5^2}$$

Where:

K_c = Calibration factor.

A_1 = Absorbance of the 1.00 mg standard.

A_2 = Absorbance of the 2.00 mg standard.

A_3 = Absorbance of the 3.00 mg standard.

A_4 = Absorbance of the 4.00 mg standard.

A_5 = Absorbance of the 5.00 mg standard.

6. Calculations

6.1 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop, Dry Gas Volume, Volume of Water Vapor, Moisture Content, Isokinetic Variation, and Acceptable Results. Using data from this test, same as Method 5, sections 6.2, 6.3, 6.4, 6.5, 6.11, and 6.12 respectively.

6.2 Mass of Urea. Calculate the total weight of urea collected in the sample by Equation 1.

$$M = K_c \left(A_s \frac{V_{soln}}{V_{al}} - A_w \frac{V_w}{V_b}\right) \qquad \text{Eq. 1.}$$

Where:

M = Mass of urea collected, mg.

K_c = Spectrophotometer calibration factor.

A_s = Absorbance of sample.

A_w = Absorbance of the water blank

V_{al} = Volume of sample aliquot analyzed, ml.

V_b = Volume of water-blank aliquot analyzed, ml.

V_{soln} = Total volume of solution in which the sample is contained, ml.

V_w = Volume of sample returned for analysis, ml.

6.3 Particulate Concentration: Calculate the particulate (urea) concentration as follows:

$$c = K_2 \frac{M}{V_{m(std)}} 10^{-6} \qquad \text{Eq. 2}$$

Where:

c = Particulate (urea) concentration at dry standard conditions, g/dscm (gr/dscf).

M = Mass of urea collected, g.

$V_{m(std)}$ = Volume of gas sample measured by dry gas meter, corrected to standard conditions, dscm (dscf).

K = 1.0 for metric units.

= 0.4370 for English units.

7. Bibliography

1. Standard Methods for the Examination of Water and Wastewater, 13th Edition. American Public Health Association, Washington, D.C., pp. 226-232, 1974.

2. Watt, George W. and Joseph D. Chrisp. Spectrophotometric Method for Determination of Urea. Analytical Chemistry. 26:452-453, 1954.

3. Same as Method 5, Citation/through 9 of section 7.

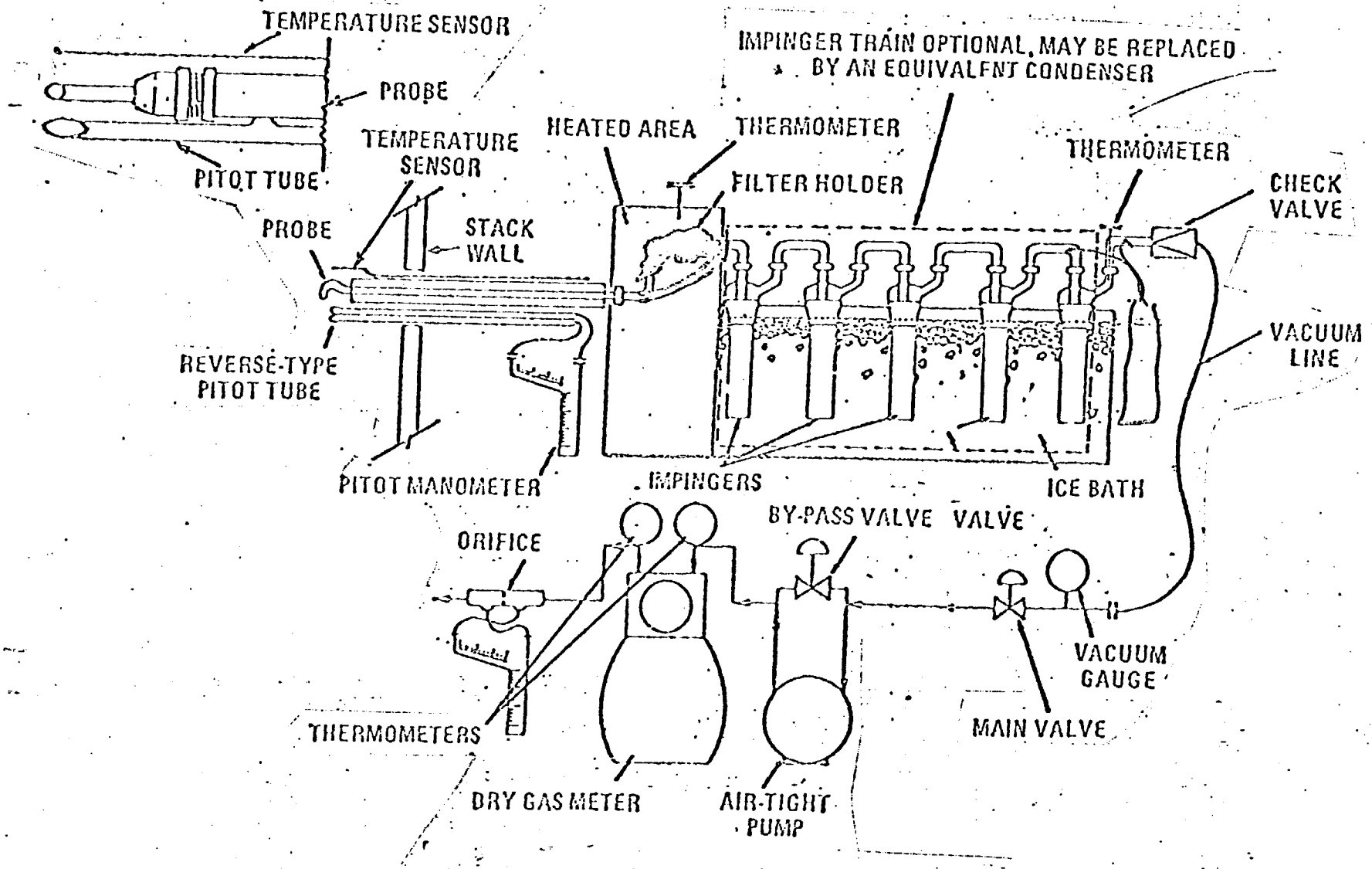


Figure 1. Particulate sampling train

APPENDIX K-2

EPA PROCEDURES FOR AMMONIA

DETERMINATION OF AMMONIA

1. Principle and Applicability

1.1 Principle. A gas sample is extracted from the stack and the ammonia is collected in impingers containing sulfuric acid solution. The collected ammonia is reacted to form a colored complex whose intensity is measured by a spectrophotometer.

1.2 This method is applicable for the determination of ammonia emissions from nitrogen fertilizer plants. The minimum detectable ammonia concentration is 30 µg/l. The upper limit is 5000 µg/l, but this may be extended by diluting the sample.

Possible interferences are calcium, magnesium, iron and sulfide.

2. Apparatus

2.1 Sampling. The sampling train is shown in Figure 1 and component parts are discussed below.

The tester has the option of determining NH_3 simultaneously with particulate matter and moisture determination by replacing the water in a Method 5 impinger system with 1.0 N sulfuric acid.

2.1.1 Probe. Borosilicate glass, or stainless steel (other materials of construction may be used, subject to the approval of the Administrator), approximately 6-mm inside diameter, with a heating system to prevent water condensation and a filter (either in-stack or heated out-stack) to remove particulate matter, including sulfuric acid mist. A ½ inch plug of lightly packed glass wool is a satisfactory filter.

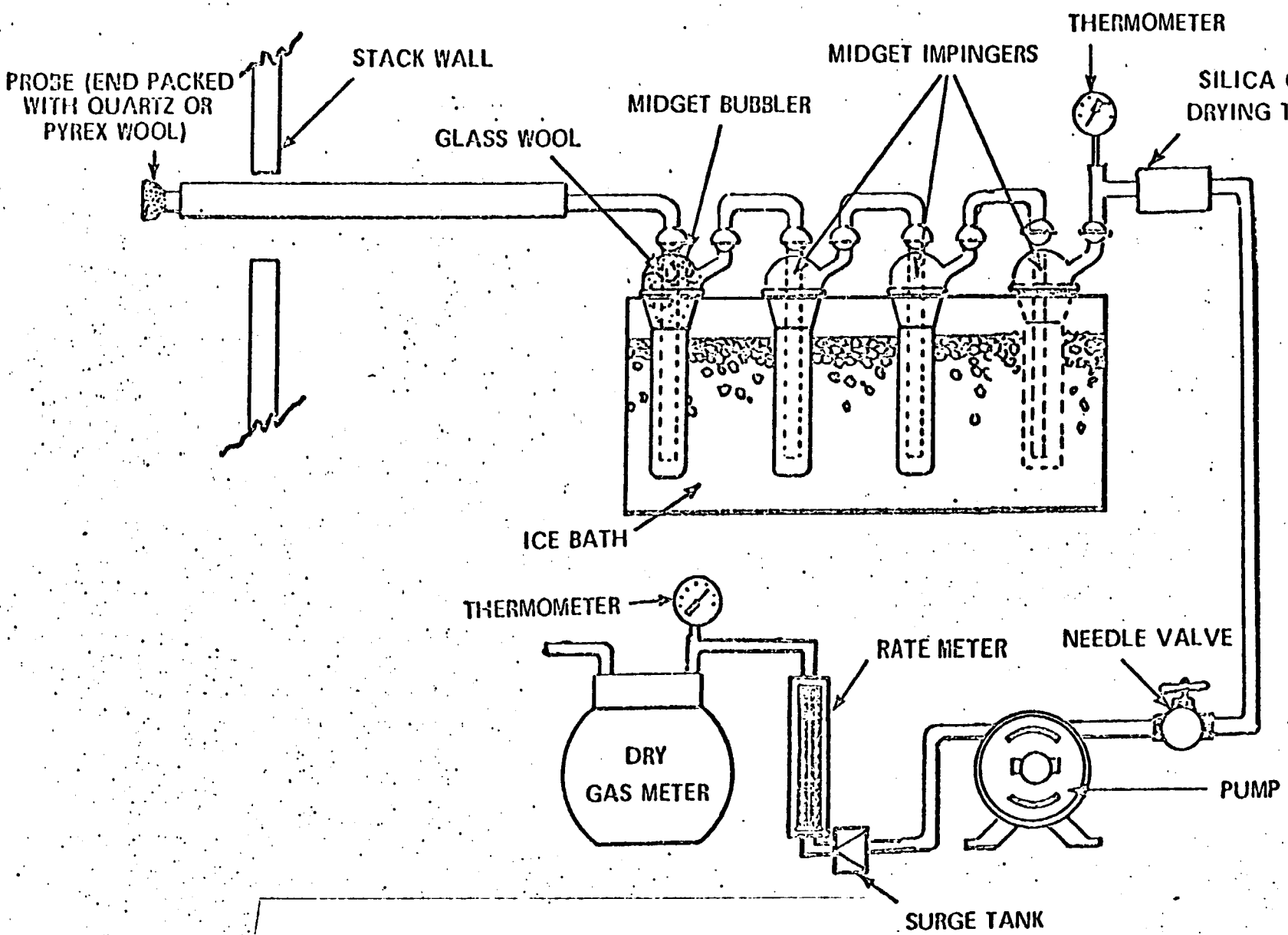


Figure 1, NH_3 sampling train.

2.1.2 Impingers. Four 30-ml midget impingers. The midget impingers must be connected in series with leak-free glass connectors. Silicone grease may be used, if necessary, to prevent leakage.

Other collection absorbers and flow rates may be used, but are subject to the approval of the Administrator. Also, collection efficency must be shown to be at least 99 percent for each test run and must be documented in the report. If the efficiency is found to be acceptable after a series of three tests, further documentation is not required. To conduct the efficiency test, an extra absorber must be added in series and analyzed separately. This extra absorber must not contain more than 1 percent of the total NH_3 mass.

2.1.3 Glass Wool. Borosilicate or quartz.

2.1.4 Stopcock Grease. Acetone-insoluble, heat-stable silicone grease may be used, if necessary.

2.1.5 Temperature Gauge. Dial thermometer, or equivalent, to measure temperature of gas leaving impinger train to within 1°C (2°F).

2.1.6 Drying Tube. Tube packed with 6- to 16-mesh indicating-type silica gel, or equivalent, to dry the gas sample and to protect the meter and pump. If the silica gel has been used previously, dry at 175°C (350°F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to approval of the Administrator.

2.1.7 Valve. Needle valve, to regulate sample gas flow rate.

2.1.8 Pump. Leak-free diaphragm pump, or equivalent, to pull gas through the train. Install a small surge tank between the pump and rate meter to eliminate the pulsation effect of the diaphragm pump on the rotameter.

2.1.9 Rate Meter. Rotameter, or equivalent, capable of measuring flow rate to within 2 percent of the selected flow rate of about 1000 cc/min.

2.1.10 Volume Meter. Dry gas meter, sufficiently accurate to measure the sample volume within 2 percent, calibrated at the selected flow rate and conditions actually encountered during sampling, and equipped with a temperature gauge (dial thermometer, or equivalent) capable of measuring temperature to within 3°C (5.4°F).

2.1.11 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases the barometric reading may be obtained from a nearby national weather service station, in which case the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.12 Vacuum Gauge and Votameter. At least 760 mm Hg (30 in. Hg) gauge and 0-40 cc/min rotameter to be used for leak check of the sampling train.

2.2 Sample Recovery.

2.2.1 Wash Bottles. Polyethylene or glass, 500 ml, two.

2.2.2 Storage Bottles. Polyethylene, 100 ml, to store impinger samples (one per sample).

2.3 Analysis.

2.3.1 Pipettes. Volumetric type 0.5-ml, 1-ml, 2-ml, 5-ml, 8.0-ml, 10.0-ml, 20-ml (one per sample), and 25-ml sizes.

2.3.2 Volumetric Flasks. 100-ml size (one per sample), 1000-ml size, and 25-ml size.

2.3.3 Graduated Cylinder. 100-ml size.

2.3.4 Spectrophotometer. To measure absorbance at 405 nanometers.

2.3.5 Sample Cells. Two matched absorbance cells to fit the spectrophotometer.

3. Reagents

Unless otherwise indicated, all reagents must conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society. Where such specifications are not available, use the best available grade.

3.1 Sampling.

3.1.1 Water. Deionized, distilled to conform to ASTM specification D1193-74, Type 3. At the option of the analyst, the $KMNO_4$ test for oxidizable organic matter may be omitted when high concentrations of organic matter are not expected to be present.

3.1.2 Sulfuric Acid, 1.0 N. Dilute 28 ml of concentrated, ACS grade sulfuric acid to 1 liter with deionized, distilled water.

3.2 Sample Recovery.

3.2.1 Water. Deionized, distilled, as in 3.1.1.

3.2.2 Sulfuric Acid, 1.0 N. As in 3.1.2.

3.3 Analysis.

3.3.1 Water. Deionized, distilled, as in 3.1.1.

3.3.2 Annhydrous Mercuric Iodide (H_sI_2). ACS grade.

3.3.3 Potassium Iodide (KI). ACS grade.

3.3.4 Sodium Hydroxide (NaOH). ACS grade.

3.3.5 Stock Standard Ammonium Chloride Solution. Dissolve 3.141 g of ammonium chloride (NH_4Cl) in 1.0N H_2SO_4 in a 1-liter volumetric flask and dilute to exactly 1 liter with 1.0N H_2SO_4. One milliliter of this solution contains 1.0 mg of ammonia (NH_3).

3.3.6 Working Standard Ammonium Chloride Solution. Dilute 10 ml of the stock standard solution to 1 liter with 1.0 N H_2SO_4 in a 1-liter volumetric flask. One milliliter of this solution contains 10 µg of ammonia (NH_3).

3.3.7 Sodium Hydroxide, 10 N. Dissolve 40 grams of NaOH in a 100-ml volumetric flask and dilute exactly to 100-ml with deionized distilled water.

3.3.8 Nessler Reagent. Dissolve 160 g of NaOH in 500 ml of deionized distilled water in a 1-liter volumetric flask. Allow to cool. Dissolve 100 g of mercuric iodide and 70 g of potassium iodide in a small volume of deionized distilled water and while stirring add to the sodium hydroxide solution. Dilute to exactly 1 liter with deionized distilled water. This reagent is stable up to 1 year.

4. Procedure

4.1 Sampling.

4.1.1 Preparation of Collection Train. Measure 15 ml of 1.0 N sulfuric acid into each of the first three midget impingers. Leave the final midget impinger dry. Assemble the train as shown in Figure 1. Adjust the probe heater to a temperature sufficient to prevent water condensation. Place crushed ice and water around the impingers.

4.1.2 Leak-check Procedure. A leak check prior to the sampling run is optional; however, a leak check after the sampling run is mandatory. The leak-check procedure is as follows:

Temporarily attach a suitable (e.g., 0-40 cc/min) rotameter to the outlet of the dry gas meter and place a vacuum gauge at or near the probe inlet. Plug the probe inlet, pull a vacuum of at least 250 mm Hg (10 in. Hg), and note the flow rate as indicated by the rotameter. A leakage rate not in excess of 2 percent of the average sampling rate is acceptable. Note: carefully release the probe inlet plug before turning off the pump.

It is suggested (not mandatory) that the pump be leak-checked separately, either prior to or after the sampling run. If done prior to the sampling run, the pump leak-check shall precede the leak check of the sampling train described immediately above; if done after the sampling run, the pump leak-check shall follow the train leak-check. To leak check the pump, proceed as follows: Disconnect the drying tube from the probe-impinger assembly. Place a vacuum gauge at the inlet to either the drying tube or the pump, pull a vacuum of 250 mm (10 in.) Hg, plug or pinch off the outlet of the flow meter and then turn off the pump. The vacuum should remain stable for at least 30 seconds.

4.1.3 Sample Collection. Record the initial dry gas meter reading and barometric pressure. To begin sampling, position the tip of the probe at the sampling point, connect the probe to the bubbler, and start the pump. Adjust the sample flow to a constant rate of approximately 1.0 liter/min as indicated by the rotameter. Maintain this constant rate (±10 percent) during the entire sampling run. Take readings (dry gas meter, temperatures at dry gas meter and at impinger outlet and rate meter) at least every 5 minutes. Add more ice during the run to keep the temperature of the gases leaving the last impinger at 20°C (68°F) or less. At the conclusion of each run, turn off the pump, remove probe from the stack, and record the final readings. Conduct a leak check as in Section 4.1.2. (This leak check is mandatory.) If a leak is found, in excess of 2% of the avg sampling rate void the test run. Use procedures acceptable to the Administrator to adjust the sample volume for the leakage below 2% of the avg sample rate.

4.2 Sample Recovery. Disconnect the impingers after purging. Pour the contents of the midget impingers into a leak-free polyethylene bottle for shipment. Rinse the impingers and connecting glassware with deionized distilled water and add the washings to the same storage container. Mark the fluid level. Seal and identify the sample container.

4.3 Sample Analysis. Note the level of the liquid in the container and confirm whether or not any sample was lost during shipment; note this on the analytical data sheet. If a noticeable amount of leakage has occurred either void the sample or use methods, subject to the approval of the Administrator, to correct the final results.
Note level not measure volume

Quantitatively transfer the contents of the shipping container to a 1-liter volumetric flask. Rinse the container and cap with several portions of 1.0N sulfuric acid and transfer to the flask. Dilute to exactly 1 liter with 1.0N sulfuric acid. Pipet 10 ml of the sample from the 1-liter flask into a 500 ml-volumetric flask and dilute to exactly 500 ml with 1.0 N H_2SO_4. Pipet 20 ml of this solution into a 25-ml volumetric flask. Add 10 N sodium hydroxide dropwise to the flask until the pH is between eight and ten. Then add 0.5 ml of Nessler reagent and dilute to exactly 25 ml with deionized distilled water. Mix well and allow to stand for the same amount of time as the standards used for calibration. Measure the absorbance at 405 nm using the blank solution as a zero reference. Dilute the sample and the blank with equal amounts of deionized distilled water if the absorbance exceeds that of the 100 µg NH_3 solution.

5. Calibration

5.1 Metering System.

5.1.1 Initial Calibration. Before its initial use in the field, first leak check the metering system (drying tube, needle valve, pump, rotameter, and dry gas meter) as follows: place a vacuum gauge at the inlet to the drying tube and pull a vacuum of 250 mm (10 in.) Hg; plug or pinch off the outlet of the flow meter, and then turn off the pump. The vacuum shall remain stable for at least 30 seconds. CArefully release the vacuum gauge before releasing the flow meter end.

Next, calibrate the metering system (at the sampling flow rate specified by the method) as follows: connect an appropriately sized

wet test meter (e.g., 1 liter per revolution) to the inlet of the drying tube. Make three independent calibration runs, using at least five revolutions of the dry gas meter per run. Calculate the calibration factor, Y (wet test meter calibration volume divided by the dry gas meter volume, both volumes adjusted to the same reference temperature and pressure), for each run, and average the results. If any Y value deviates by more than 2 percent from the average, the metering system is unacceptable for use. Otherwise, use the average as the calibration factor for subsequent test runs.

5.1.2 Post-Test Calibration Check. After each field test series, conduct a calibration check as in Section 5.1.1 above, except for the following variations: (a) the leak check is not to be conducted, (b) three, or more revolutions of the dry gas meter may be used, and (c) only two independent runs need be made. If the calibration factor does not deviate by more than 5 percent from the initial calibration factor (determined in Section 5.1.1), then the dry gas meter volumes obtained during the test series are acceptable. If the calibration factor deviates by more than 5 percent, recalibrate the metering system as in Section 5.1.1, and for the calculations, use the calibration factor (initial or recalibration) that yields the lower gas volume for each test run.

5.2 Thermometers. Calibrate against mercury-in-glass thermometers.

5.3 Rotameter. The rotameter need not be calibrated, but should be cleaned and maintained according to the manufacturer's instruction.

5.4 Barometer. Calibrate against a mercury barometer.

5.5 Determination of Spectrophotometer Calibration Factor K. Add 0.0, 1.0, 2.0, 5.0, 8.0, and 10.0 ml of working standard ammonium chloride solution to a series of six 25-ml volumetric flasks. Adjust the total volume of solution in each to 20 ml using 1.0 N H_2SO_4. Adding 10 N NaOH dropwise, adjust the pH to between 8 and 10. Pipette exactly 0.5 ml of Nessler reagent into each flask and filute to exactly 25 ml with deionized distilled water. Mix well and allow each to stand for 10 to 30 minutes for color development. Note the time allowed for color development of the standards and use the same time for the samples. Measure the absorbance of each standard at 405 nm. The calibration procedure must be repeated each day that samples are analyzed. Calculate the spectrophotometer calibration factor as follows:

$$K_c = 100 \frac{A_1 + 2A_2 + 5A_3 + 8A_4 + 10A_5}{A_1^2 + A_2^2 + A_3^2 + A_4^2 + A_5^2}$$

Where:

K_c = Calbiration factor.

A_1 = Absorbance of the 10 µg standard.

A_2 = Absorbance of the 20 µg standard.

A_3 = Absorbance of the 50 µg standard.

A_4 = Absorbance of the 80 µg standard.

A_5 = Absorbance of the 100 µg standard.

6. Calculation

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculation.

6.1 Nomenclature.

A = Absorbance of sample.

C_{NH_3} = Concentration of ammonia dry basis corrected to standard condition, mg/dscm (lb/dscf).

F = Dilution factor (i.e., 25/5, 25/10, etc. required only if sample dilution was needed to reduce the absorbance into the range of calibration).

K_c = Spectrophotometer calibration factor.

m = Mass of ammonia in gas sample, µg.

P_{bar} = Barometric pressure at the exit orifice of the dry gas meter, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

T_m = Average dry gas meter absolute temperature, °K (°R).

T_{std} = Standard absolute temperature, 293°K (528°R).

V_a = Volume of sample aliquot analyzed, ml.

V_m = Dry gas volume as measured by the dry gas meter, dcm (dcf).

$V_{m(std)}$ = Dry gas volume measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

V_{soln} = Total volume of solution in which the ammonia sample is contained, 1000 ml.

Y = Dry gas meter calibration factor.

6.2 Dry sample gas volume, corrected to standard conditions:

$$V_{m(std)} = V_m Y \frac{T_{std}}{T_n} \frac{P_{bar}}{P_{std}} = K_1 Y \frac{V_m P_{bar}}{T_m}$$

Equation 2

Where:

K_1 = 0.3858 °K/mm Hg for metric units.

= 17.64 °R/in. Hg for English units.

6.3 Total µg NH_3 per sample.

$$m = 2 K_c AF \frac{V_a}{V_{soln}} \qquad \text{Equation 3}$$

6.4 Sample concentration, dry basis, corrected to standard condition:

$$C = K_2 \frac{m}{V_{sc}}$$

Where:

$K_2 = 10^3 \frac{mg/m^3}{\mu g/ml}$ for metric units.

$= 6.243 \times 10^{-5} \frac{lb/scf}{\mu g/ml}$ for English units.

7. Bibliography

1. Patton, W. F. and J. A. Brink, Jr. New equipment and Techniques for Sampling Chemical Process Gases. Air Pollution Control Association. 13:162, 1963.

2. Rom, J. J. Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment. Office of Air Programs, Environmental Protection Agency. Research Triangle Park, N. C. APTD-0576, March, 1972.

3. Standard Methods for the Examination of Water and Wastewater, 13th Edition. American Public Health Association, Washington, D.C., 1974. pp. 226-232.

APPENDIX K-3

EPA DRAFT METHOD FOR FORMALDEHYDE

TENTATIVE METHOD FOR
ISOKINETIC DETERMINATION OF POLLUTANT LEVELS
IN THE EFFLUENT OF FORMALDEHYDE MANUFACTURING FACILITIES

1. Principle:

1.1 General: An air sample is drawn isokinetically through an impinger train containing water as the scrubbing medium. Formaldehyde methanol and dimethyl ether are scrubbed from the gas. A glass bomb is connected after the scrubbing impingers and before the silica gel so that any non-condensible pollutants may be collected in a grab sample.

1.2 Formaldehyde: The analysis consists of reacting an aliquot of the impinger solution with chromotropic - sulfuric acid reagent to form a purple chromogen. The resulting solution is analyzed colorimetrically using a spectrophotometer at 580 nm; the absorbance of the colored solution is proportional to the quantity of formaldehyde in the solution.

1.3 Methanol: An aliquot of the scrubber solution is reacted with potassium permanganate oxidizing all methanol present to formaldehyde. The total formaldehyde is then determined colorimetrically. The background formaldehyde content as determined by (1.2) is then subtracted out and the methanol content determined.

1.4 Dimethyl ether: An aliquot of the scrubber solution is analyzed for dimethyl ether using a gas chromatograph with a flame ionization detector.

1.5 Grab sample: Using a Hamilton syringe, 20 ml of water is injected into the glass bomb. The bomb is shaken and the liquid removed and analyzed for methanol, formaldehyde, and dimethyl ether to check impinger efficiency. A sample of the remaining gas is analyzed for dimethyl ether.

2. Applicability:

2.1 This method is applicable for the determination of formaldehyde, methanol and dimethyl ether in the effluent of formaldehyde manufacturing facilities.

3. Range:

3.1 Formaldehyde: .05 µg/ml - 2.0 µg/ml; based on impinger solution of 600 ml and 60 Ft^3 gas collected: 6 - 240 ppm; upper limit is easily extended by diluting aliquot taken.

4. Sensitivity: unknown

5. Precision:

5.1 Formaldehyde: ± 5%

6. Collection Efficiency

6.1 Formaldehyde 95%

7. Interferences

7.1 Formaldehyde: This method is specific for formaldehyde although other hydrocarbons in concentrations in excess of formaldehyde to the order of 10:1 will give interferences in absorbance readings:

Saturated Aldehydes	<.01%	(+)
Unsaturated Aldehydes	1 - 2%	(+)
Ethanol, High Alcohols, Olefins		(-)
Phenols (8:1 excess)	10-20%	(-)
Ethylene, Propylene (10:1 excess)	5 - 10	(-)
Aromatics (15:1 excess)	15%	(-)
Methanol (10,000:1 excess)	None	
Nitrogen Oxides*		(-)

*Use of Aqueous bisulfite solution as the scrubbing medium will reduce interference of nitrogen oxides.

7.2 Methanol: same as above

7.3 Dimethyl ether: unknown

8. Apparatus:

8.1 Sampling:

8.1.1 Stainless steel nozzle

8.1.2 Pyrex probe - heated

8.1.3 Pitot tube: s - type

8.1.4 Glass impingers: 2 Greenburg-Smith, 1 modified Greenberg-Smith, 1 silica gel.

8.1.5 Glass sample tube with side adapter for syringe; 250 ml. (Fisher Catalog #11-134-190)

8.1.6 Metering - Vacuum System as required to maintain an isokinetic sampling rate.

8.1.7 Metering - Vacuum System as required to obtain grab sample.

8.2 Sample recovery

8.2.1 Probe brush

8.2.2 Wash bottle

8.2.3 Graduated cylinder

8.2.4 Glass sample storage jars

8.3 Analysis

8.3.1 Spectrometer capable of measuring absorbance of the color developed solution at 580 nm.

8.3.2 Hamilton syringe for removal of sample from grab sample bomb

8.3.3 Gas chromotograph

8.3.4 Flame ionization detector

8.3.5 Recorder

9. Reagents:

9.1 Sampling

9.1.1 Distilled water

9.1.2 Silica gel

9.1.3 Crushed ice

9.2 Sample recovery

9.2.1 Distilled water

9.3 Analysis: Formaldehyde

9.3.1 Chromotropic acid reagent: Dissolve 0.10 g of 4,5 dihydroxy-2, 7 - naphthalene-disulfonic acid disodium salt (Eastman Kodak Co. Cat. No. P230) in water and dilute to 10 ml. Filter, if necessary: store in brown bottle. Make fresh weekly.

9.3.2 Sulfuric acid: Concentrated reagent grade

9.3.3 Formaldehyde standard solution "A": (1 mg/ml). Dissolve 4.4703 g sodium formaldehyde bisulfite (Eastman PG 450) in distilled water and dilute to 1 liter. Stable for one month.

9.3.4 Formaldehyde standard solution "B": (1 µg/ml) Dilute 1 ml of standard solution "A" to 100 ml with distilled water. Make fresh daily.

9.3.5 Iodine (0.1 N, approximate): Dissolve 25 g of potassium iodide in about 25 ml of water. Add 12.7 g of iodine and dilute to 1 liter.

9.3.6 Iodine (0.01 N): Dilute 100 ml of the 0.1 N iodine solution to 1 liter. Standardize against sodium thiosulfate.

9.3.7 Starch solution, 1 percent: Make a paste of 1 g of soluble starch and 2 ml of water. Slowly add the paste to 10 ml of boiling water. Cool, add several ml of chloroform as a preservative, and store in a stoppered bottle. Discard when a mold growth is noticable.

9.3.8 Sodium carbonate buffer solution: Dissolve 80 g of anhydrous sodium carbonate in about 500 ml of water. Slowly add 20 ml of glacial acetic acid and dilute to 1 liter.

9.3.9 Sodium bisulfite, 1 percent: Dissolve 1 g of sodium bisulfite in 100 ml of water. Prepare fresh weekly.

9.4 Analysis: Methanol

9.4.1 Same as formaldehyde analysis (9.3) plus:

9.4.2 Potassium permanganate solution: Dissolve 1 g A.R. potassium permanganate in water and dilute to 100 ml with water.

9.4.3 Ethanol solution: Prepare a 5 percent (volume) solution of methanol - free ethanol in water.

9.4.4 Dilute phosphoric acid: Dilute 25 ml phosphoric acid (85%) to 100 ml with water.

9.4.5 Hydrogen peroxide solution: Prepare a solution containing approximately 1.5 percent w/v H_2O_2 (5 - volumes peroxide).

9.5 Analysis: Dimethyl ether

9.5.1 Chromotographic column: 10% triethyl acetyl citrate.

10. Procedure:

10.1 Sampling

10.1.1 The sample train is assembled as shown in Figure 4. Each of the two impingers (Greenburg-Smith) is filled with 100 ml distilled water. The third impinger is left dry and the fourth impinger contains approximately 200 gm silica gel.

10.1.2 A minimum sample of 60 Ft^3 is collected isokinetically as per EPA Method 5 at a rate of 0.5 to 1.0 CFM.

10.1.3 Halfway through the sample run the valve to the glass bomb is opened and the glass bomb is purged at a rate of 1 LPM for two minutes. The stopcocks at both ends of the gas sample tube are simultaneously closed. The vacuum source to the sample tube and the valve to the main sample train are closed off.

10.2 Sample Recovery

10.2.1 The gas sample tube is removed from the sample train and stored.

10.2.2 The liquid from each impinger is stored in a separate sample collection jar.

10.2.3 The probe and impingers are sparingly washed with water (It is important to dilute the sample as little as possible) and the wash from each impinger is added to the sample collection jar for that impinger. The probe wash is stored separately.

10.2.4 The weight gain in the silica gel is recorded.

10.3 Analytical: Formaldehyde

10.3.1 Measure and record the volume of each of the sample solutions.

10.3.2 Pipette a 4 ml aliquot from each of the sampling solutions into glass stoppered test tubes. A blank containing 4 ml of distilled water must also be run. (If the formaldehyde content of the aliquot exceeds the limit of the method a smaller aliquot diluted to 4 ml with distilled water is used.)

10.3.3 Add 0.1 ml of 1 percent chromotropic acid reagent to the solution and mix.

10.3.4 To the solution pipette slowly and cautiously 6 ml of concentrated sulfuric acid. The solution becomes extremely hot during the addition of the sulfuric acid. If the acid is not added slowly, some loss of sample could occur due to spattering.

10.3.5 Allow to cool to room temperature. Read at 580 nm in a suitable spectophotometer using a 1 cm cell.

10.3.6 Determine the formaldehyde content of the sampling solution from a curve previously prepared from standard formaldehyde solutions.

10.4 Analysis: Methanol

10.4.1 Pipette a 4 ml aliquot from each of the sampling solutions into glass stoppered test tubes. A blank containing 4 ml of distilled water must also be run. (If the methanol content exceeds the limit of the method a smaller aliquot diluted to 4 ml with distilled water is used).

10.4.2 Add .5 ml ethanol solution, 2.5 ml potassium permanganate solution, and .5 ml phosphoric acid solution. Mix and allow to stand for 1 hour.

10.4.3 Add hydrogen peroxide solution drop by drop until the solution is colorless.

10.4.4 Proceed with formaldehyde analysis (10.3.3)

10.5 Analysis: Dimethyl ether

10.5.1 Using Hamilton syringe take aliquot of sample solutions and inject into gas chromotograph.

10.6 Analysis: Gas sampling tube

10.6.1 Using Hamilton syringe inject 20 ml of distilled water into the sampling tube. Swirl and shake for 15 minutes.

10.6.2 Remove two 4 ml aliquots using syringe and analyze for formaldehyde and methanol using the already mentioned procedures.

10.6.3 Remove two samples, one liquid and one gas, using the Hamilton syringe and analyze for dimethyl ether by gas chromotography.

11. Calibration:

11.1 Standardization of formaldehyde solution

11.1.1 Pipette 1 ml of formaldehyde standard solution "A" into an iodine flask. Into another flask pipette 1 ml of distilled water. This solution serves as the blank.

11.1.2 Add 10 ml of 1 percent sodium bisulfite and 1 ml of 1 percent starch solution.

11.1.3 Titrate with 0.1 N iodine to a dark blue color.

11.1.4 Destroy the excess iodine with 0.05 N sodium thiosulfate.

11.1.5 Add 0.01 N iodine until a faint blue end point is reached.

11.1.6 The excess inorganic bisulfite is now completely oxidized to sulfate, and the solution is ready for the assay of the formaldehyde bisulfite addition product.

11.1.7 Chill the flask in an ice bath and add 25 ml of chilled sodium carbonate buffer. Titrate the liberated sulfite with 0.01 N iodine, using a microburette, to a faint blue end point. The amount of iodine added in this step must be accurately measured and recorded.

11.1.8 One ml of 0.0100 N iodine is equivalent to 0.15 mg of formaldehyde. Therefore, since 1 ml of formaldehyde standard solution was titrated, the ml of 0.01 N iodine used in the final titration multiplied by 0.15 mg gives the formaldehyde concentration of the standard solution in mg/ml.

11.2 Preparation of standard curve, formaldehyde

11.2.1 Pipette 0, 0.1, 0.3, 0.5, 0.7, 1.0, and 2.0 ml of standard solution "B" into glass stoppered test tubes.

11.2.2 Dilute each standard to 4 ml with distilled water.

11.2.3 Develop the color as described in the analytical procedure (10.3).

11.2.4 Plot absorbance against micrograms of formaldehyde in the color developed solution.

12. Calculations:

12.1 Formaldehyde

12.1.1 Correct the volume of air sampled to the volume at standard conditions.

$$V_s = V \times \left(\frac{P-P_m}{29.92}\right) \times \left(\frac{530}{T+460}\right)$$

12.1.2 Calculate concentrtion of formaldehyde in the sample.

$$\text{ppm (volume)} = \frac{(C) \times (S) \times (24.15)}{(2) \quad (V_s) \quad (MW)}$$

V	=	Volume Sampled, (Liters)
V_s	=	Volume S.T.P. (Liters)
S.T.P.	=	70°F, 29.92"hg
P	=	Barametric Pressure, "Hg
P_m	=	Meter Pressure, "hg
T^m	=	Meter Temp., °F
C	=	µg of formaldehyde in aliquot (from calibrated curve)
S	=	Total ml of sampling solution
A	=	Ml of aliquot taken from sampling solution
MW	=	Molecular weight of formaldehyde, 30.03
24.15	=	Ml of formaldehyde gas in one millimole @ S.T.P.

12.2 Methanol

12.2.1 The total µg formaldehyde read from the absorbance is equal to the formaldehyde originally in the sample plus the formaldehyde formed from oxidation of methanol. Therefore, from the total µg formaldehyde in the aliquot, subtract the µg of background formaldehyde present in a aliquot of equal size (previously determined).

This is the µg formaldehyde in the aliquot formed from the oxidation of methanol.

12.2.2

$$M = FM \left(\frac{30.03}{32.04}\right)$$

12.2.3

$$Mc = \frac{(M) \quad (S) \quad (24.15)}{(A) \quad (V_s) \quad (MW)}$$

Where:

M	=	Methanol content, µg
Mc	=	Methanol concentration of air sample (ppm)
Fm	=	Formaldehyde from oxidation of methanol, µg
S	=	Total volume sample solution, ml
A	=	Aliquot taken from sample solution, ml
V_s	=	Air sample volume @ S.T.P., liters
M_w	=	Molecular weight of methanol, 32.04

S.T.P. = 70°F, 29.92 "Hg

24.15 = ml of methanol gas in one millimole @ S.T.P.

12.3 Dimethyl ether

12.3.1 Not completed yet.

13. Major References:

13.1 Cares, Janet Walker; "Determination of Formaldehyde by the Chromotropic Acid Method in the Presence of Oxides of Nitorgen:" Amer. Ind. Hyg. Jour; July, 1968.

13.2 "Determination of Formaldehyde: Chromotropic Acid Method," PHS Standard Methods.

13.3 "Tentative Method of Analyses for Formaldehyde Content of the Atmosphere (Colorimetric Method); "Health Life Science Journal;" Vol. 7 #1; January, 1970.

13.4 Walker, J.F.; Formaldehyde; Reinhold Publishing Co.: 3rd Edition; 1964.

13.5 Federal Register, Volume 36, Number 247, Part II, December 23, 1971.

13.6 "Method for the Determination of Toxic Substances in Air: Methanol (Adopted 1949); International Union of Pure and Applied Chemistry, London, 1959.

APPENDIX K-4

DISCUSSION OF ANALYTICAL PROCEDURES

Discussion of Analysis Procedures

Standard Methods for the Examination of Water and Wastewater, 14th edition, contains the methods followed for direct and distilled ammonia analyses and for Kjeldahl nitrogen determination. The following is the basic procedure taken from the text with the modifications included. Example calculations are shown at the end of this appendix for all the methods.

I Direct Ammonia

1. Pipet an aliquot of sample into a 50 ml. nessler tube.
2. If 1 ml. of nessler reagent is not sufficient to raise the pH to >10, adjust the pH of the aliquot to 8-10 before diluting to 50 ml. Alternatively, add 2 ml. of nessler reagent to the sample and standards.
3. To the sample diluted to 50 ml., add 1 ml. of nessler reagent and mix thoroughly.
4. Allow the color to develop for a minimum of 10 minutes. Then read the absorbance on a spectrophotometer at 405 mm.
5. A series of standards is made up in 50 ml. nessler tubes to contain 0, 20, 40, 100, 160, and 200 µg/ml. NH_3 is made up of 3.141 gNH_4A/lH_2O.
6. A plot of total μgNH_3 vs. absorbance is prepared from the standards, and equivalent µg for the samples is read from it.
7. Calculations are listed at the end of this appendix.

II Ammonia and Kjeldahl Nitrogen Distillation and Digestion for Nesslerization

1. To a clean Kjeldahl flask, add ~ 300 ml. H_2O, 25 ml. borate buffer, and a few ml. of 1 N N_aOH plus a few glass beads.
2. Connect flask to distillation apparatus and distill over 100-200 ml. to clean the set-up.
3. Meanwhile, pipet an aliquot of sample into a 400 ml. beaker. (Use 25.0 ml. for the outlet stack samples and 5.0 ml. for the inlet stack samples and the scrubber water samples.)

4. Add ~ 350 ml. H_2O and 25 ml. borate buffer. Check the pH with pH paper. If necessary, add 1 N N_aOH to adjust the pH to 9.5.

5. Prepare a collection volumetric flask by adding 50 ml. boric acid solution to a 250 ml. volumetric flask.

6. After the distillation apparatus is clean, disconnect the Kjeldahl flask. Place a delivery tube under the surface of the boric acid solution in the 250 ml. volumetric flask.

7. Pour out the water in the flask. Then carefully transfer the sample in the beaker into the Kjeldahl flask. Connect to the still and turn on the heat.

8. When ~ 3/4 of the flask is full, raise delivery tube above the surface of the sample. Continue to distill until it is almost full. Remove the 250 ml. volumetric flask and shut off the still.

9. Dilute the sample to 250.0 ml. Use this for the distilled NH_3 analysis.

10. Add 50.0 ml. of the digestion solution to the remaining residue in the Kjeldahl flask.

11. Digest this solution under a hood for ~ 1½ hours.

12. Allow to cool.

13. Carefully add ~ 400 ml. H_2O to the Kjeldahl flask.

14. Prepare a collection flask as in step 5. Place delivery tube under surface of the boric acid.

15. Add 50 ml. hydroxide - thiosulfate solution down the side of the Kjeldahl flask. Do not shake or stir.

16. Connect the Kjeldahl flask to the still. Swirl to mix.

17. Distill over as in step 8.

18. Dilute to 250.0 ml. Use this solution for the urea analysis.

19. Follow steps 5-7 under Direct NH_3 for the preparation of standards and the calibration plot.

III Formaldehyde

The analytical procedure listed in the EPA Method "Isokinetic Determination of Pollutant Levels in the Effluent of Formaldehyde Manufacturing Facilities" was followed. A copy of this method is provided in Appendix K-3.

Calculations:

1. Direct Ammonia

   a. stack solutions
   total mg $NH_3 = \frac{A-B}{C^*} \times F \times 0.001 \frac{mg}{\mu g}$

   b. scrubber solutions
   mg/ml $NH^3 = \frac{A-B}{C^*} \times 0.001 \frac{mg}{\mu g}$

2. Distilled Ammonia

   a. stack solution
   total mg $NH_3 = \frac{A-B}{C} \times \frac{D}{E} \times F \times 0.001 \frac{mg}{\mu g}$

   b. scrubber solutions
   mg/ml $NH_3 = \frac{A-B}{C} \times \frac{D}{E} \times 0.001 \frac{mg}{\mu g}$

3. Kjeldahl Urea

   a. stack solutions
   total mg urea $= \frac{A-B}{C} \times \frac{D}{E} \times F \times 1.765 \times 0.001 \frac{mg}{\mu g}$

   b. scrubber solutions
   mg/ml urea $= \frac{A-B}{C^*} \times \frac{D}{E} \times 1.765 \times 0.001 \frac{mg}{\mu g}$

4. Formaldehyde

   a. stack solution
   total mg $CH_2O = \frac{A}{C} \times F \times 0.001 \frac{mg}{\mu g}$

   b. scrubber solutions
   ug/mg $CH_2O = \frac{A}{C}$

Codes:

A = μg of NH_3 (or formaldehyde) equivalent to absorbance of sample (from plot of standards vs. absorbance)

B = reagent blank correction = $\frac{A \text{ Blank}}{C \text{ Blank}} \times C$ sample

C = aliquot of sample or distillate analyzed, ml.

D = volume of distillate, ml.

E = aliquot of sample digested, ml.

F = total volume of sample in ml.

1.765 = gravimetric factor to convert $\mu g NH_3$ to μg urea. It is based on the following chemical equation

$$H_2N\text{-}\overset{\overset{O}{\|}}{C}\text{-}NH_2 + H_2O \longrightarrow 2NH_3 + CO_2$$

$$\frac{60 g \text{ urea}}{\text{mole urea}} \longrightarrow \frac{34 \text{ grams } NH_3}{2 \text{ moles } NH_3}$$

APPENDIX K-5

MOISTURE DETERMINATION PROCEDURE

Moisture determinations of the scrubber gas stream were straightforward matter at the scrubber outlet sampling point. Here the impinger weight gain was esentially all due to water collected during each run.

At the scrubber inlet, however, urea comprised most of the impinger weight gain. The laboratory sample analysis methodology consisted of determining total urea from impingers and probe wash while determining impinger weight gain from only the impinger contents. This methodology precluded simply substracting total urea from impinger weight gain to obtain water gain. For this reason, and because water was used to clean nozzles and probes plugged by urea particulate (see Section 5), a separate moisture run was performed at the scrubber inlet. Urea was excluded from the impinger catch by use of a simple figerglass plug in-stack filter arrangement. Ammonia collected in the impingers was a negligible fraction of the water weight collected in this moisture run.

Figure K-1 shows the impinger weight gain data for scrubber gas runs 1 - 3 and Figure K-2 shows the results of the inlet moisture run. Figure K-3 shows the calculated collected water volumes for each scrubber inlet run, assuming the inlet gas stream contained 2.3% water (as determined by the separate moisture run).

FIGURE K-1: SCRUBBER INLET/OUTLET TESTS
SAMPLE WEIGHT GAIN DATA

Test # Silicagel (S) Acid (A) Water (W) Inlet (I) Outlet (O) Container # Key	Final weight (container tare + charge + H_2O) gm	Initial wt., (container tare), gm	Charge wt ., gm		Weight gain, gm
Container*	2	3	4	5	6
1-S-I	256.43	244.54*	--		11.89
1-A-I	526.35	327.07	204.8		-5.52
1-W-I	604.00	327.70	200		76.3
				total	82.67
1-S-O	264.48	242.45*			22.03
1-A-O	527.79	325.08	204.8		-2.09
1-W-O	634.64	327.28	200		107.36
				total	127.3
2-S-I	256.52	242.68*	--		13.84
2-A-I	518.87	327.40	204.8		-13.33
2-W-I	589.00	329.09	200-		59.91
				total	60.42
2-S-O	263.89	243.34*	--		20.55
2-A-O	530.88	327.66	204.8		-1.08
2-W-O	641.36	328.18	200		113.18
				total	132.65
3-S-I	258.88	245.33*	--		13.55
3-A-I	475.47	327.83	204.8		-57.16
3-W-I	596.44	326.25	200		70.19***
				total	26.58
3-S-O	261.74	242.88*	--		18.86
3-A-O	531.72	326.23	204.8		0.69
3-W-O	534.86	325.29	100**		109.57
				total	129.12

*includes 200gm silica gel change
**No H_2O in impinger 2 for test 3=0
***H_2SO_4 impinger sample sucked back to H_2O impinger

FIGURE K-2. % MOISTURE TEST

Firm Name CF Industries Test # Moisture TRC Project # 82988-20

Unit Tested Granulator Scrubber Inlet Date 1/18/79 1615-1649

V_m (final-initial dry gas meter reading, ft^3) = 30.34

P_{bar} (barometric pressure, "Hg) = 30.27

ΔH (average orifice pressure drop, "H_2O) = 2.5

Tm (average dry gas meter gas temperature, °F) = 80.5

$$V_{m\,@\,STP} = 17.65\, V_m \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{Tm + 460} \right) = 17.65 \times 30.34 \left(\frac{30.27 + \frac{2.5}{13.6}}{80.5 + 460} \right)$$

$V_{m\,@\,STP}$ = 30.17 ft^3 corrected to 68°F and 29.92 "Hg.

V_I (total liquid collected in impingers (ml) plus silica gel (gms) = 14.96

$$\%\, H_2O = \frac{4.71\, V_I}{V_{m\,@\,STP} + 0.0471 V_I} = \frac{4.71 \times 14.96}{30.17 + 0.0471 \times 14.9C}$$

$\%\, H_2O$ = 2.28 %

CO_2 (% CO_2 measured by Orsat or Fyrite, %) =

O_2 (% O_2 measured by Orsat or Fyrite, %) =

CO (% CO measured by Orsat, %) =

N_2 (100 - %CO_2 - % O_2 - % CO) % =

$$M_s = 0.44\,(\%\, CO_2) + 0.32\,(\%O_2) + 0.28\,(\%N_2 + \%CO) = \left(1 - \frac{\%H_2O}{100} + 0.18\,(\%H_2O)\right)$$

$$M_s = 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad + \quad)\quad 1 - \frac{\quad}{100} \quad + 0.18\,(\quad)$$

M_s = lbs/lb-mole

FIGURE K-3. INLET TESTS VOL. H_2O CALCULATIONS FROM MOISTURE RUN AT CF INDUSTRIES INC., DONALDSONVILLE, LOUISIANA

$$\% H_2O = \frac{4.71 (V_{imp} + V_{sg})}{V_m @ STP + 0.0471 (V_{imp} + V_{sg})}$$

Test 1 Silica Gel = 11.9g $\%H_2O$ = 2.3% (from moisture run)

$$2.3 = \frac{(4.71) (V_{imp} + 11.9)}{(63.18) + 0.0471 (V_{mp} + 11.9)}$$

$$2.3 = \frac{4.71 \times 4.71 (11.9)}{63.18 + 0.0471 x + (0.0470) (11.9)}$$

$$2.3 (63.18) + 2.3 (0.0471)X + 2.3 (0.0471) (11.9) = 4.71x + 4.71 (11.9)$$

$$x \; 2.3 (0.0471) - 4.71 = (4.71) (11.9) - 2.3 (63.18) - 2.3 (0.0471) (11.9)$$

$$x = \frac{(4.71) (11.9) - 2.3 \; 63.18 - 0.0471 (11.9)}{2.3 (0.0471) - 4.71}$$

$$x = 19.1 \text{ ml}$$

Test 2 $$x = \frac{(4.71) (13.8) - 2.3 \; 65.97 - 0.0471 (13.8)}{2.3 (0.0471) - 4.71}$$

$$x = 18.5 \text{ ml}$$

Test 3 $$x = \frac{(4.71) (13.5) - 2.3 \; 66.45 - 0.0471 (13.5)}{2.3 (0.0471) - 4.71}$$

$$x = 19.1 \text{ ml}$$

APPENDIX L

CLEANUP EVALUATION RESULTS

APPENDIX L

Prior to sampling, the impingers used for the scrubber inlet, scrubber outlet, and the synthesis tower tests at CF Industries, Donaldsonville, Louisiana, were rinsed with deionized distilled water and then charged with water or acid solution as called for in the text procedure. These impinger contents were then analyzed for urea, ammonia, and formaldehyde to determine if there was any contamination from the glassware. A blank deionized distilled water sample was also analyzed similarly. The results of these analyses are presented in Table L-1. These results are corrected for the water blank value. This table shows the absolute level, in milligrams, of each contaminant, as well as the relative level in percent compared to the test result levels.

The associated laboratory summary sheets on the cleanup results are presented in Table L-2 and Table L-3 of this appendix. Raw laboratory data are contained in Appendix J.

TABLE L-1

RESULTS OF ANALYSES ON CLEAN IMPINGER WASHES
WITH RELATIVE PERCENT VALUES FROM TEST DATA

INLET SAMPLES (mg.)	CLEANUP BLANK	RUN 1	RUN 2	RUN 3	RELATIVE %
NH_3 - Direct	0.11	410.	441.	506.	$\underline{<}0.027$
NH_3 - Distilled	0.22	888.	941.	944.	$\underline{<}0.025$
Urea	4.17	23,920.	26,090.	26,258.	$\underline{<}0.017$
Formadehyde	0.024	2.476	1.545	1.341	$\underline{<}1.8$
Outlet Samples (mg.)					
NH_3 - Direct	0.157	450.	694.	387.	$\underline{<}0.04$
NH_3 - Distilled	0.65	438.	426.	388	<.17
Urea	3.14	70.59	73.09	62.27	$\underline{<}5.$
Formaldehyde	0.023	2.523	1.172	1.296	$\underline{<}2.$
Synthesis Tower Samples (mg.)					
NH_3 - Direct	0.157	37,721.	45,839.	57,814.	$\underline{<}0.0004$
NH_3 - Distilled	0.65	37,924.	48,618.	58,232.	$\underline{<}0.002$
Urea	3.14	188.5	197.9	185.4	$\underline{<}1.7$
Formaldehyde	0.023	--	--	--	--

TABLE L-2

INLET

Clean-up Evalution Results

INLET SAMPLES	BLANK ID	VOLUME	µg/ml CONC.	TOTAL MG	
Direct NH_3	BWI	200	0.20 µg/ml vis ~.2	0.04	
	BAI	200	cloudy vis ~.1	0.04	
	BPWI	322	cloudy	0.03	
				0.11	mg NH_3 Direct-Inlet
Distilled NH_3	BWI	200	0.60	0.12	
	BAI	200	0.50 vis ~0	0.10	
	BPWI	322	cloudy	~0	
				0.22	mg NH_3 Distilled-Inlet
Urea	BWI	200	4.24	0.848	
	BAI	200	3.09	0.618	
	BPWI	322	8.39	2.70	
				4.17	mg Urea
Formaldehyde	BWI	200	<.05		
	BAI	200	<.05		
	BPWI	322	0.075	0.024	
				0.024	mg Formaldehyde

TABLE L-3

OUTLET

Clean up Evaluation Results

Outlet Samples	Blank ID	Volume	µg/ml Conc.	Total mg	
Direct NH_3	BWO	200	0.12	0.024	
	BAO	200	0.20 cloudy vis ~.36	0.040	
	BPWO	259	cloudy	0.093	
				0.157	mg NH_3 Direct
Distilled NH_3	BWO	200	0.52	0.104	
	BAO	200	0.60	0.12	
	BPWO	259	1.65	0.43	
				0.65	mg NH_3 Distilled
Urea	BWO	200	2.82	0.564	
	BAO	200	1.94	0.388	
	BPWO	259	8.47	2.19	
				3.14	mg Urea
Formaldehyde	BWO	200	<.05		
	BAO	200	<.05		
	BPWO	259	0.088	0.023	
				0.023	mg Formaldehyde

APPENDIX M

PROJECT PARTICIPANTS

Project Participants

CF Industries, Inc.

Donaldsonville, Louisiana

January 15-19, 1979

TRC

Willard A. Wade, III, Senior Project Manager

Reed W. Cass, Project Engineer - Crew Chief

John Kirzec, Senior Technical Specialist - Team Leader

Steven Richardson, Senior Technical Specialist - Team Leader

David Ringquist, Environmental Engineer - Project Engineer/Team Leader

Denise A. Kearns, Technical Specialist - Team Member

James Canora, Technical Specialist - Clean Up

Carl S. Ekroth, Senior Technical Specialist - Visible Emissions

Margaret Fox, Assistant Project Scientist - Chemist

GCA

Stephen A. Capone

Tim Curtin

EPA Emission Measurement Branch

Clyde E. Riley, Technical Manager

EPA Industrial Studies Branch

Eric A. Noble - Test Process Project Engineer

APPENDIX N

WORK ASSIGNMENT AND TECHNICAL DIRECTIVES

N-1 Copy of Project Work Assignment
N-3 Copy of Project Technical Directives

APPENDIX N-1

COPY OF PROJECT WORK ASSIGNMENT

SOURCE SAMPLING AND ANALYSIS SCHEDULE

See Figure 1

Contract No.: 68-02-2820

78-NHF-6

Company Name: C.F. Industries

Company Location: Donaldsonville, LA

Industry: Ammonium Fertilizer

Process: Urea Solution Formation & Concentration

Control Equipment: None - Main Vent Stack

Sampling Site Figure	Total No. of Samples	Sample Type	Sampling Method	Sample Collected By	Minimum Sampling Time	Minimum Gas Volume Sampled ft^3	Initial Analysis Type	Initial Analysis Method	Initial Analysis By **	Final Analysis Type	Final Analysis Method	Final Analysis By **
3	1	Velocity Profile	EPA-2	CTR	N.A.	N.A.	Flow Profile	EPA-2	CTR			
3	3	Urea Particulate	Modified EPA-5	CTR	15 min	5	Urea Mass	TBD	CTR	NH_3	TBD	CTR
3	3	Visible Emission	EPA-9	CTR	1 hr	N.A.	Avg. 6-min intervals	EPA-9	CTR			
	N/A	Note - Urea and ammonia analysis shall be performed on test site within 24 hours after collection of sample.										

REMARKS:

1. Sampling shall be performed with ± 10% isokinetic conditions.

Industry: Urea Manufacturing

Plant: C.F. Industries, Donaldsonville, Louisiana

Process Step: Drum Granulator

Rationale for Selection:

1. This plant is representative of other urea drum granulators and is state of the art for granulators.

2. There are seven drum granulators at this facility. Three are located on one urea solution line and 4 newer units are located on a second urea solution line. The first three units each have seperate stacks. The last 4 are combined so that 2 units are vented through one stack and the remaining 2 units are vented through a second stack. It is preferred that the newer vents be tested, however if the duct work does not allow for easy sampling, one of the first three units can be tested. Test only B or C granulator of the first three units.

3. Test can be performed in conjunction with others at this plant.

Comments:

1. Grab samples of the scrubber liquor inlet and outlet should be taken several times during the test. Temperature and pH readings should be taken at the time the solution is sampled. Analyses on the composite sample should include % NH_3, % urea, ~~and~~ % solids ~~and~~ & % Formaldehyde.

2. Test during maximum production rate of the granulator.

3. A grab sample of the refrigerated air should be checked for temperature and moisture.

4. All solid samples will be highly hygroscopic.

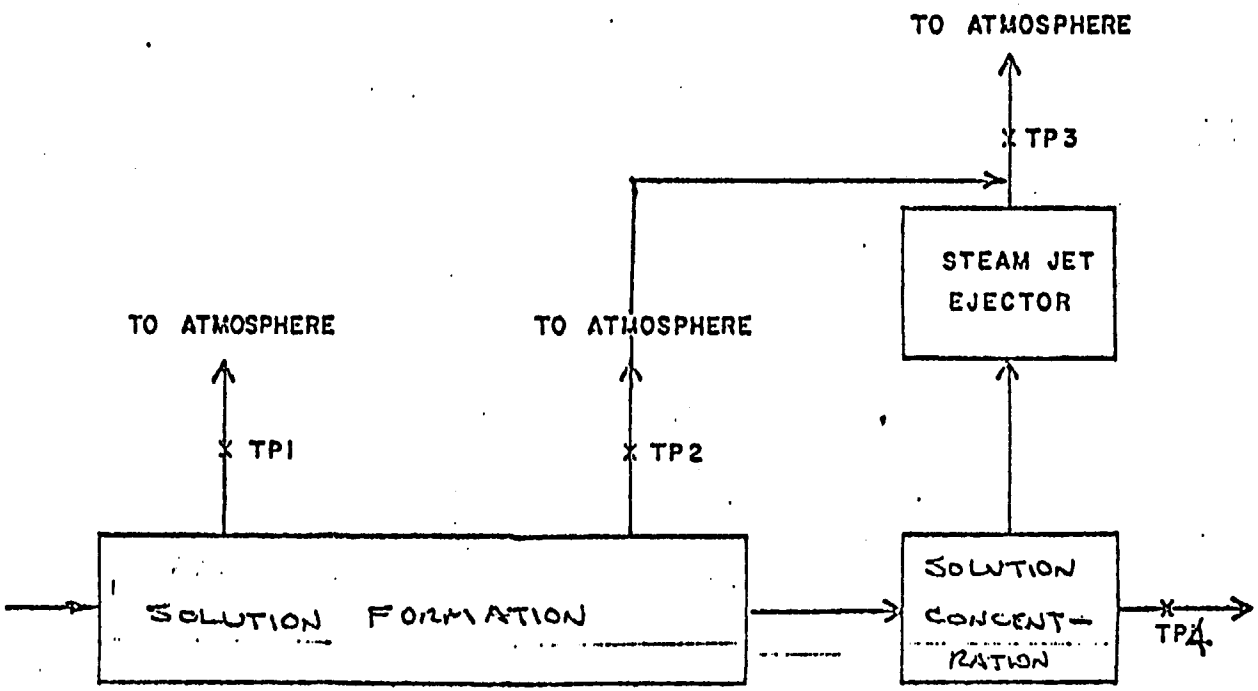


Figure 1. Solution Formation, Urea, C.F. Industries, Donaldsonville, La.

DURCE SAMPLING AND ANALYSIS SCHEDULE

Continued
See Figure 2

Contract No.: 68-02-2820

Assignment Number: 78-NHF-8

Company Name: C. F. Industries

Company Location: Donaldsonville, LA

Industry: Ammonium Fertilizer

Process: B or C Rotary Granulator

Control Equipment: Scrubber

ling t e	Total No. of Samples	Sample Type	Sampling Method	Sample Collected By	Minimum Sampling Time	Minimum Gas Volume Sampled ft³	Initial Analysis Type	Initial Analysis Method	Initial Analysis By **	Final Analysis Type	Final Analysis Method		
1 2	3	Pressure Drop	U. Tube Manometer	CTR	Pressure drop across scrubber shall be measured and recorded every 15 minutes during test periods.								
6	3	Ambient air Temperature	Mercury Thermometer	CTR	Contractor shall measure and record data every 15 minutes during test periods								
6	3	Ambient air Relative Humidity	Wet, Dry Bulb	CTR	"	"	"	"	"	"	"	"	"
		Note - Urea and ammonia analysis shall be performed within 24 hours after collection of sample (stack and scrubber waters).											
	N-6												

REMARKS:

1. Sampling shall be performed with ± 10% isokinetic conditions.
2. Methods are EPA unless indicated otherwise.
3. Impingers and analysis of impinger catch will be per the Federal Register Volume 36 159, II, T , Aug 1971 ss sp ally d by roject er.
4. Sampling time and gas volumes are for each sample.

ult Samp equir
Contractor, EPA-Environmental Protection Agency

SOURCE SAMPLING AND ANALYSIS SCHEDULE

See Figure 2

Contract No.: 68-02-2820 | Assignment Number: 78-NHF-8

Company Name: C. F. Industries | Company Location: Donaldsonville, LA

Industry: Ammonium Fertilizer | Process: B or C Rotary Granulator | Control Equipment: Scrubber

...pling ...t ...re	Total No. of Samples	Sample Type	Sampling Method	Sample Collected By	Minimum Sampling Time	Minimum Gas Volume Sampled ft^3	Initial Analysis Type	Initial Analysis Method	Initial Analysis By **	Final Analysis Type	Final Analysis Method	
1	1*	Velocity Profile	EPA-2	CTR	N.A.	N.A.	Flow Profile	EPA-2	CTR			
2	1*	"	"	"	"	"	"	"	"			
1	1*	Moisture Content	EPA-4	"	15 min.	10	Percent Moisture	EPA-4	"			
2	1*	"	"	"	15 min.	10	"	"	"			
1	1	Cleanup Evaluation	Modified EPA-5	CTR	N.A.	N.A.	Urea Mass	TBD	CTR	NH_3 Formaldehyde	TBD	CTR
2	1	"	"	"	"	"	"	"	"	"	"	"
1*	3	Urea Particulate	Modified EPA-5	CTR	2 hrs	60	Urea Mass	TBD	CTR	NH_3 Formaldehyde	TBD	CTR
2*	3	"	"	"	"	"	"	"	"	"	"	"
1	3	Particle Size	Cascade Impactor	CTR	15 min	N.A.	Particle Distribution	Gravimetric Weighing	CTR			
2*	3	Visible Emissions	EPA-9	CTR	2 hours	N.A.	Summary of 6-min intervals	EPA-9	CTR			
1*	3	Scrubber Solution In	Composite	CTR	2 hours	N.A.	Tempt, pH	Thermometer pH meter	CTR	% Urea, NH_3 %Formaldehyde	TBD	CTR
2*	3	Scrubber Solution Out	Composite	CTR	2 hours	N.A.	Tempt, pH	"	CTR	% Solids "	TBD	CTR
4	~~3~~ 1	Feed melt to granulator	Composite	CTR	N.A.	N.A.	pH	TBD	CTR	% Urea % NH_3 %Formaldehyde	TBD	CTR
5	3	Granulator Unscreened Product	Grab	CTR	N.A.	N.A.	sieve analysis	TBD	CTR	Bulk Density	TBD	CTR
5	~~3~~ 1	"	Composite	CTR	N.A.	N.A.	Tempt, pH % moisture	TBD	CTR	% Urea %Formaldehyde	BD	CTR
7	1	Formaldehyde Additive	Grab	CTR	N.A.	N.A.	Sample to be retained for future analysis					

REMARKS:

1. Sampling shall be performed with ± 10% isokinetic conditions.
2. Methods are EPA unless indicated otherwise.
3. Impingers and analysis of impinger catch will be per the Federal Register, Volume 35, No. 159, Part II, Tuesday, Aug. 17, 1971, unless specified

...ultaneous Sampling Required

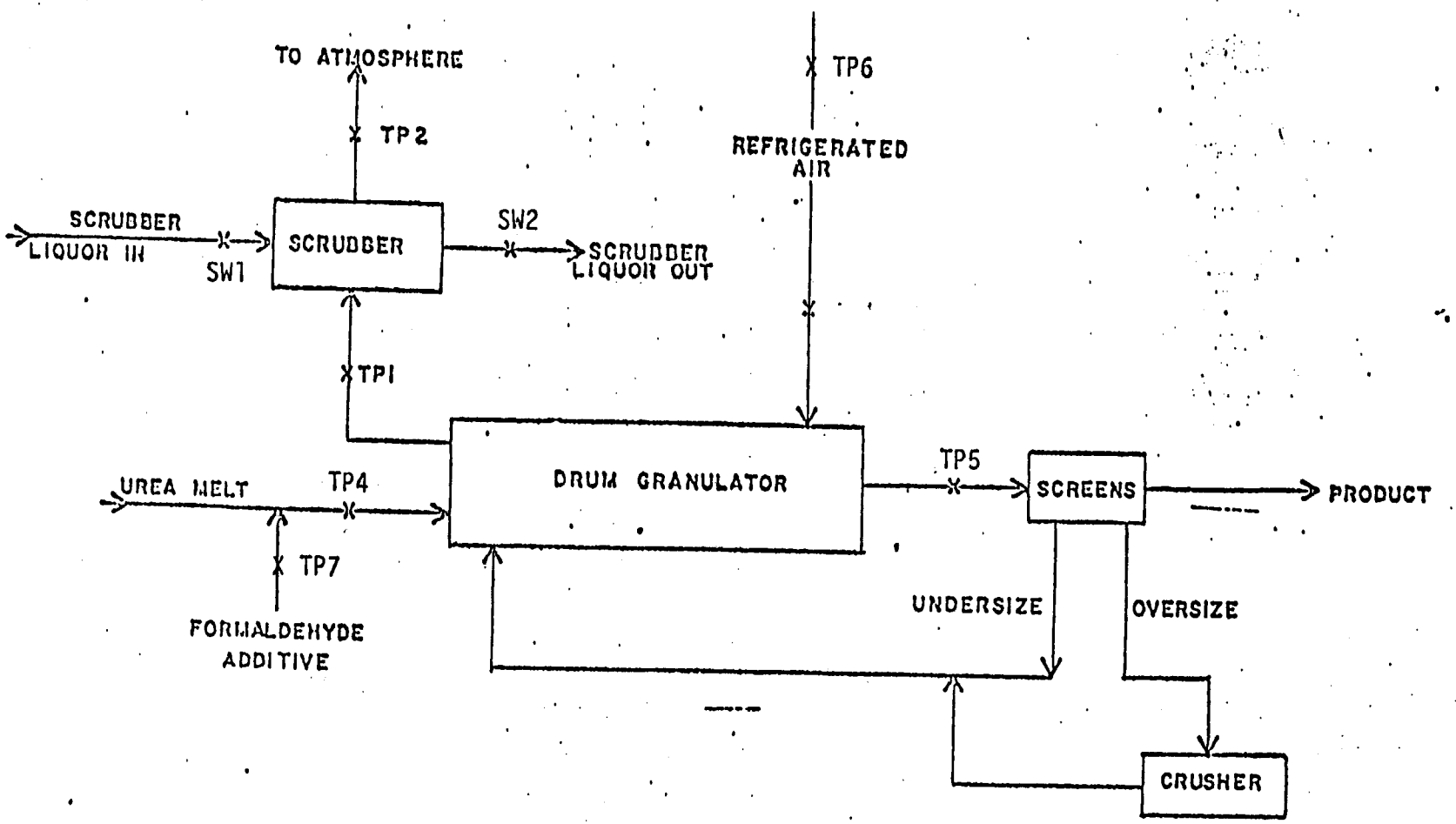


Figure 2. Drum Granulator, Urea, C.F. Industries, Donaldsonville, La.

APPENDIX N-2

COPY OF PROJECT TECHNICIANS DIRECTIVES

EMISSION MEASUREMENT BRANCH

TECHNICAL DIRECTIVE NO. 1

Project Number 78-NHF-8 Date 1-24-79

Contractor TRC of New England

Contract Number 68-02-2820 Work Assignment Number 10

Technical Manager Clyde E. Riley

Verbal Directions Given To Mr. Reed Cass

Directive:

1. Cancel 3 Visible Emission Test to be performed at TP-3 on the main Urea Solution, Formation, and Concentration tower vent.

2. Cancel 1 Formaldehyde Additive sample to be collected at TP-7 of the Rotary Granulator Process.

3. Reduce number of Feed-Melt to Granulator samples at TP-4 from three to one. Single sample shall be analyzed for pH, percent urea, ammonia, and formaldehyde.

4. Reduce number of composite Granulator Unscreened Product samples at TP-5 from three to one. The single sample shall be analyzed for tempt, percent urea, and formaldehyde. Percent moisture and pH data for the unscreened granulator product testing shall be obtained daily from CF Industry personnel.

Clyde E. Riley
Technical Manager, EMB

Section Chief, EMB

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Environmental Protection
Agency

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Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

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