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Volume 1

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EMISSION TEST REPORT
WESTERN ENGINEERING ASPHALT CONCRETE PLANT
LINCOLN, NEBRASKA

Final Report

Volume 1

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SECTION 1.0

INTRODUCTION

On March 7, 1974, New Source Performance Standards (NSPS) were promulgated for the asphal: concrete industry. They established a limit on particulate matter of 0.04 grams per dry standard cubic foot and a visible emission limit of 20 percent opacity. The standards were reviewed in 1979 and no revisions were proposed. Another review was initiated in 1982 with the purpose of investigating the opacity limit of facilities utilizing recycled asphalt pavement (RAP). The National Asphalt Pavement Association (NAPA) requested this review because of concern from members that emissions could be higher during RAP production.

Reportedly, the utilization of RAP produces a "Blue Haze" plume due to the emission of condensible hydrocarbons. Emission data from selected, representative sources would be used in the development and/or review of the NSPS regulations for the asphalt concrete industry. The Western Engineering Company's facility was selected as an emission test program site based on the following rationale:

- The plant was suitable for testing and obtaining useful data;
- The plant has been successfully tested for compliance with the NSPS;
- The facility is a typical design of a major vendor; and
- Western had a known production schedule producing RAP mixes.

1.1 OBJECTIVES

The objectives of this test program were to obtain and evaluate data on particulate emissions, total organic carbon (TOC), and visible emissions from a facility utilizing recycled asphalt pavement. The Western Engineering facility was selected and tested during both RAP and conventional production modes. A series of simultaneous Method 5E emission tests were conducted both at the inlet and outlet of the control device, in this case a baghouse. These tests were conducted to provide a comparison of particulate, TOC, and visible emissions during the two types of production.

1.2 BRIEF PROCESS DESCRIPTION

Figure 1-1 is a layout of a typical asphalt concrete process. During conventional production, virgin aggregate from any of 4 storage bins, is loaded onto a conveyor. The quantity of aggregate from each bin is controlled by a computer located in the control room. The virgin aggregate is fed to the burner end of the drum mixer. Liquid asphalt is injected into the drum mixer 2/3 of the drum length from the burner end and is mixed with the aggregate material. As the asphalt concrete mix falls from the drum it is conveyed to a storage silo for truck load-out. The gaseous emissions enter a knockout chamber that reduces the gas velocity and promotes particle settling. From the knockout chamber, the gas is drawn through a baghouse that traps the fine particulate. The flue-gas is then exhausted to the atmosphere through a 12 foot high rectangular stack.

Recycle operation differs from conventional operation in that a percentage of the virgin aggregate is replaced by recycled asphalt pavement and a different asphalt cement is used. The RAP is fed to a collar located at the center of the drum mixer from a separate bin. The rest of the RAP process is the same as the conventional process.

1.3 EMISSIONS MEASUREMENT PROGRAM

The test program was conducted at the Western Engineering Company's mobile CMI asphalt concrete plant. The mobile facility was located on Route 34, 12 miles west of Lincoln, Nebraska during the last week of September 1984. The test program was designed to quantify uncontrolled (baghouse inlet) and controlled (baghouse outlet) emissions during conventional and recycle operations. GCA personnel were responsible for sampling and analyzing process emissions except for TOC analyses which was performed by Pollution Control Science of Miamisburg, Ohio. Midwest Research Institute (MRI) was responsible for coordinating the test program with plant personnel to insure that process conditions and control equipment were suitable for testing. MRI was also responsible for the monitoring and recording of necessary data on process and control equipment.

1.3.1 Particulate Mass

Total particulate loading measurements were performed at the baghouse inlet and outlet, concurrently. The tests were conducted in accordance with EPA Method 5E. Four particulate runs, for both uncontrolled and controlled emissions, were performed during conventional operation. Three uncontrolled and two controlled runs were performed during recycle operation.

1.3.2 Total Organic Carbon

Total organic carbon (TOC) samples were concurrently collected at the inlet and outlet to the baghouse. They were collected during the EPA Method 5E tests mentioned above. Each sample consisted of organics that were collected in the impinger solutions downstream of the filter holder. The

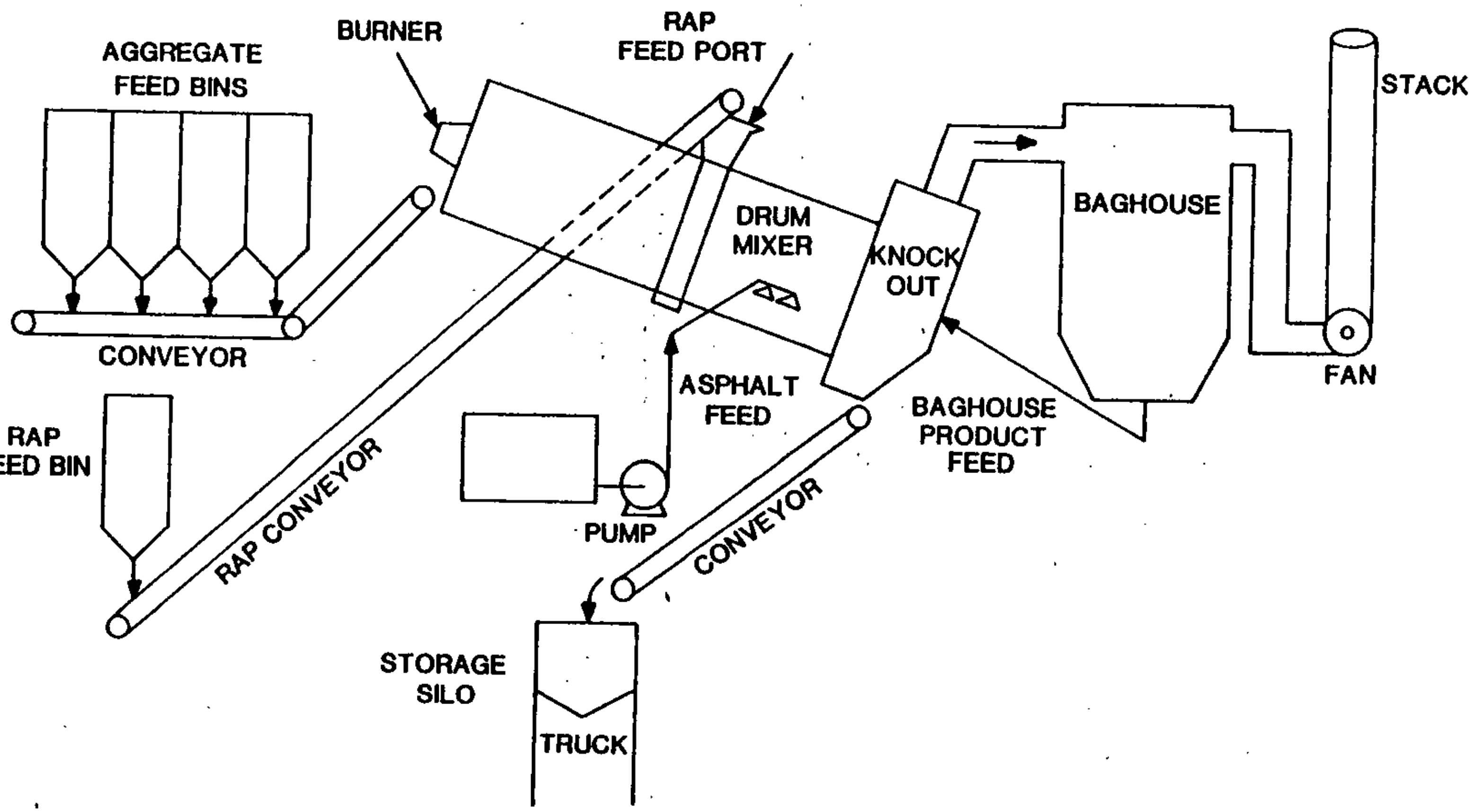


Figure 1-1. Asphalt concrete process.

impinger solutions were made up of 0.1 N NaOH. In addition to the impinger solutions, the acetone rinses of the impingers were dried to a constant weight and gravimetrically analyzed.

1.3.3 Gas Stream Analysis

The concentrations of CO_2 and O_2 in the gas stream at the inlet and outlet locations were determined by collecting an integrated sample in a Tedlar bag and analyzing the sample with an Orsat analyzer. The analyses were in accordance with EPA Reference Method 3.

1.3.4 Polynuclear Aromatic Hydrocarbons

The test program called for one inlet and one outlet test for Polynuclear Aromatic Hydrocarbons (PAH). It was originally believed, at the time of the pre-site survey, that there was sufficient reserves of recycled asphalt pavement for three Method 5E tests and one Modified Method 5E test for PAH. However, due to scheduling changes, most of the RAP was utilized before the test program began. Therefore, no PAH testing was performed.

1.3.5 Visible Emission Observations

Visible emission observations for opacity were performed concurrently with the Method 5E runs. However, due to background interference (i.e. clouds) not all of the runs have concurrent visible emission readings. Readings representative of both operational modes are included in the report.

1.3.6 Process Sample Collection and Monitoring

Discrete grab samples of RAP, virgin aggregate, asphalt cement and fuel oil were obtained during this test program. The virgin aggregate samples were analyzed for moisture content. The RAP samples were analyzed for moisture and smoke point. Smoke point, flash point and viscosity analysis of the asphalt cement samples were also conducted. The fuel oil sample is being held for future analysis. Monitoring and recording the pressure drop across the baghouse, along with all other pertinent process parameters, was the responsibility of Midwest Research Institute (MRI).

1.4 DESCRIPTION OF REPORT SECTIONS

The remaining sections contain the summary and discussion of results in Section 2.0, Process Description and Operation in Section 3.0, Sampling locations in Section 4.0, Sampling and Analytical Equipment and Procedures in Section 5.0, and Quality Assurance in Section 6.0.

SECTION 2.0

SUMMARY AND DISCUSSION OF RESULTS

This section discusses the results of the emission test program conducted at Western Engineering Company's asphalt concrete plant outside Lincoln, Nebraska. Controlled and uncontrolled emissions were tested. The testing was conducted during the production of conventional mix and 50 percent recycled asphalt pavement mix. Problems encountered during this test program are discussed in Section 6.0.

2.1 EMISSION PROGRAM RESULTS

The following subsections contain narrative, tables, graphs and figures pertaining to the specific tests performed. Each subsection also contains a discussion of the data.

2.1.1 Particulate Mass Emission Results

A modified version of EPA reference Method 5E was used to collect both uncontrolled and controlled emissions concurrently during conventional and recycle production. The results are discussed in the following sections. Additional information, field data sheets and lab analysis sheets can be found in Appendices A and D.

2.1.1.1 Conventional Operation--

Summaries of particulate and total organic carbon emissions for both controlled and uncontrolled emissions during conventional operation are presented in Table 2-1 (English units) and Table 2-2 (metric units). Four controlled and uncontrolled sampling runs were performed. The test plan originally called for three concurrent runs. However, problems with Run No. 2 necessitated an additional conventional run as a precautionary measure. The four conventional operation runs are designated as 1, 2, 3 and 4. The uncontrolled particulate mass loading were 45.700, 112.660, 86.836 and 53.500 grains per dry standard cubic foot, respectively. The corresponding controlled particulate loadings were 0.008, 0.025, 0.028 and 0.022 for 1, 2, 3 and 4, respectively. The average controlled particulate loading was 0.021 gr/dscf which is below the present NSPS standard of 0.04 gr/dscf. The collection efficiencies of the baghouse for these runs was 99.98, 99.97, 99.96 and 99.95, respectively. A breakdown of uncontrolled and controlled conventional emissions can be found in Tables 2-3 and 2-4.

TABLE 2-1. SUMMARY OF PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING CONVENTIONAL OPERATION (ENGLISH UNITS)

Date	09/24/84		09/25/84		09/26/84		09/27/84			
Run	1		2		3		4		Average	
Emission Type	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled
Baghouse Pressure Drop (in/H_2O)	5.5		5.6		5.6		5.0		5.4	
Production Rate (tons/hour)	310		311		308		267		299	
Process Mix Type	Conventional		Conventional		Conventional		Conventional		Conventional	
Average Opacity (%) (mean, range)	N/A		0.25 (0-1.25)		N/A		N/A		0.25 (0-1.25)	
Particulate and Total Organic Carbon (TOC) Results										
Front Half Catch-Particulate (probe, cyclone and filter)										
mg - mass	160499.84	48.40	183371.87[a]	123.35	147755.98	171.63	84957.36	126.73	144672.15	117.528
gr/dscf	45.700	0.008	112.660	0.025	86.836	0.028	53.500	0.022	75.081	0.021
lb/hr	8089.37	2.115	22849.019	6.860	18457.072	7.486	10835.32	5.721	15084.340	5.545
lb/ton production	26.095	0.007	76.470	0.022	59.920	0.024	40.580	0.021	50.450	0.019
Collection Efficiency Percent[b]	99.98		99.97		99.96		99.95		99.96	
Back Half Catch - TOC (impinger solutions and rinses)										
mg - mass	c	115.20	80.52	100.50	37.10	106.70	74.16	101.92	63.93	106.08
gr/dscf		0.020	0.049	0.021	0.022	0.017	0.047	0.017	0.039	0.019
lb/hr		5.035	10.033	5.589	4.634	4.661	9.459	4.601	8.042	4.971
lb/ton production		0.162	0.032	0.018	0.015	0.015	0.035	0.017	0.027	0.017
Collection Efficiency Percent	N/A		44.58		0		50.85		38.52	
Total Catch Particulate - TOC										
mg - mass	160499.84	163.60	183452.39	223.85	147793.08	278.33	85031.52	228.65	144736.08	223.61
gr/dscf	45.700	0.028	112.709	0.046	86.860	0.045	53.547	0.039	75.120	0.039
lb/hr	8089.37	7.15	22859.05	12.45	18461.71	12.14	108365.32	10.32	15092.38	10.52
lb/ton production	26.095	0.023	76.500	0.040	59.930	0.039	40.610	0.038	50.470	0.035
Collection Efficiency Percent	99.92		99.95		99.94		99.91		99.97	

[a]Invalid run torn filter.
[b]CEP based on lb/hr values.
[c]Contaminated sample.

TABLE 2-2. SUMMARY OF PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING CONVENTIONAL OPERATION (METRIC UNITS)

Date	09/24/84		09/25/84		09/26/84		09/27/84			
Run	1		2		3		4		Average	
Emission Type	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled
Baghouse Pressure Drop (in/H_2O)	5.5		5.6		5.6		5.0		5.4	
Production Rate (kg/s)	78.1		78.4		76.6		67.6		75.3	
Process Mix Type	Conventional		Conventional		Conventional		Conventional		Conventional	
Average Opacity (%) (mean, range)	N/A		0.25 (0-1.25)		N/A		N/A		0.25 (0-1.25)	
Particulate and Total Organic Carbon (TOC) Results										
Front Half Catch-Particulate (probe, cyclone and filter)										
mg - mass	160499.84	48.40	183371.87[a]	123.35	147755.98	171.63	84957.36	126.73	144672.15	117.53
mg/dscm	104546.17	18.30	257728.04	57.19	198651.45	64.05	122389.94	50.33	171759.98	47.47
g/s	1019.240	0.266	2878.913	0.864	2325.539	0.943	1365.289	0.721	1900.580	0.698
g/kg production	13.220	0.003	36.720	0.110	30.360	0.012	20.190	0.011	25.240	0.009
Collection Efficiency Percent[b]	99.98		99.97		99.96		99.95		99.96	
Back Half Catch - TOC (impinger solutions and rinses)										
mg - mass	c	115.20	80.52	100.50	37.10	106.70	74.16	101.92	63.93	106.08
mg/dscm		45.75	112.09	48.04	50.33	38.89	107.52	38.89	89.90	42.78
g/s		0.634	1.264	0.704	0.584	0.587	1.190	0.560	1.013	0.626
g/kg production		0.008	0.016	0.009	0.008	0.008	0.018	0.008	0.013	0.008
Collection Efficiency Percent	N/A		44.58		0		50.85		38.52	
Total Catch Particulate - TOC										
mg - mass	160499.84	163.60	183452.39	223.85	147793.08	278.33	85031.52	228.65	144736.08	223.61
mg/dscm	104546.17	64.05	257840.13	105.23	198701.78	102.94	122497.46	89.22	171849.88	90.25
g/s	1019.24	0.90	2880.17	1.57	2326.12	1.53	1366.48	1.28	1901.59	1.32
g/kg production	13.22	0.011	36.74	0.12	30.37	0.02	20.21	0.019	25.25	0.017
Collection Efficiency Percent	99.92		99.95		99.94		99.91		99.97	

[a]Invalid run torn filter.
[b]CEP based on lb/hr values.
[c]Contaminated sample.

TABLE 2-3. SUMMARY OF UNCONTROLLED PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING CONVENTIONAL OPERATION

Run Number	1	2[a]	3	4	Average
Date	9/24/84	9/25/84	9/26/84	9/27/84	
Volume Gas Sampled (dscf)	56.116	24.816	25.810	23.924	32.66
Stack Gas Flow Rate (dscfm)	20,638	23,662	24,798	23,630	23,182
Stack Temperature, °F	279	284	263	271	274
Percent Moisture by Volume	22.3	20.9	20.0	18.6	20.4
Percent Isokinetic	89.1	100.5	101.7	99.8	99.8
Production Rate (ton/hr)	310	311	308	267	299
Process Mix Type	Conventional	Conventional	Conventional	Conventional	Conventional
<u>Particulate and Total Organic Carbon (TOC) Results</u>					
Front Half Catch-Particulate (probe, cyclone and filter)					
mg	160499.84	183371.87	147755.98	84957.36	144672.15
gr/dscf	45.70	112.66	86.84	53.50	75.08
lb/hr	8089.367	22849.019	18457.072	10835.866	15084.40
lb/ton production	26.10	76.47	59.92	40.58	50.45
Back Half Catch - TOC (impinger solutions and rinses)					
mg - mass	b	80.52	37.10	74.16	63.93
gr/dscf		0.049	0.022	0.047	0.039
lb/hr		10.033	4.634	9.459	8.042
lb/ton production		0.032	0.015	0.035	0.027

[a]Invalid run torn filter.

[b]Contaminated sample.

TABLE 2-4. SUMMARY OF CONTROLLED PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING CONVENTIONAL OPERATION

Run Number	1	2*	3	4	Average
Date	9/24/84	9/25/84	9/26/84	9/27/84	
Volume Gas Sampled (dscf)	90.500	74.098	93.270	90.568	87.109
Stack Gas Flow Rate (dscfm)	29,597	31,448	31,527	31,032	30,901
Stack Temperature, °F	256	253	248	253	252
Percent Moisture by Volume	19.0	17.7	17.9	16.9	17.9
Percent Isokinetic	98.7	101.1	101.3	97.9	99.8
Production Rate (ton/hr)	310	311	308	267	299
Process Mix Type	Conventional	Conventional	Conventional	Conventional	Conventional
<u>Particulate and Total Organic Carbon (TOC) Results</u>					
Front Half Catch-Particulate (probe, cyclone and filter)					
mg	48.40	123.35	171.63	126.73	117.53
gr/dscf	0.008	0.025	0.028	0.022	0.021
lb/hr	2.115	6.860	7.486	5.721	5.540
lb/ton production	0.007	0.022	0.024	0.021	0.019
Back Half Catch - TOC (impinger solutions and rinses)					
mg - mass	115.20	100.50	106.70	101.92	106.08
gr/dscf	0.020	0.021	0.017	0.017	0.019
lb/hr	5.035	5.589	4.661	4.601	4.971
lb/ton production	0.162	0.018	0.015	0.0172	0.017

*Invalid run torn filter.

2.1.1.2 Recycle Operation--

Table 2-5 \ glish units) and Table 2-6 (metric units) present the results of uncontrolled and controlled emission testing during recycle operation. The three uncontrolled and two controlled recycle operation test runs are designated 5, 6 and 7 (uncontrolled only). Uncontrolled particulate mass loadings for the respective runs were 7.085, 10.939 and 8.655 gr/dscf the corresponding controlled particulate loadings were 0.008 gr/dscf for 5 and 0.006 gr/dscf for 6. The average controlled emissions during recycle operation was 0.007/dscf which is well below the NSPS limit of 0.04 gr/dscf. The collection efficiencies for 5 and 6 were both above 99.9 percent. Tables 2-7 and 2-8 provide additional information on uncontrolled and controlled recycle emissions.

2.1.1.3 Breakdown of Sampling Run Weight Gains--

A breakdown of the sampling run weight gains for both conventional and recycle operation is presented in Table 2-9. This table provides the weight gain from the filter, front half and the acetone blank correction factor. This correction factor is calculated from the weight gain of a spectro grade acetone blank per ml and multiplied by the amount of acetone wash used in the dry down procedure.

2.1.1.4 Discussion of Particulate Emissions During Conventional and Recycle Production--

One of the objectives of this test program was to compare the particulate loadings during conventional and recycle production modes. Several general observations were made based on the data presented in Tables 2-1 through 2-8. These include:

- Compliance with the NSPS particulate emission standards of 0.04 gr/dscf was met for all runs.

- The collection efficiency of particulate by the baghouse was above 99.9 percent for all sampling runs.

During conventional operation, the uncontrolled emissions were much higher than during recycle operation. This is due to the use of much finer material, mostly sand, being used during conventional production. During recycle production, 50 percent of the material fed to the drum was recycled asphalt pavement.

One conclusion that can be drawn for these data is that during conventional operation, the particulate loadings are higher than during recycle operation. Therefore, any increase in opacity during recycle operation cannot be attributed to particulate.

2.1.2 Total Organic Carbon Results

Total Organic Carbon (TOC) samples were collected simultaneously with the particulate mass samples from the uncontrolled and controlled locations utilizing the Modified Method 5E sampling train. The 0.1 N NaOH impinger solutions and rinses were analyzed for TOC using a Beckman Model 915

TABLE 2-5. SUMMARY OF PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING RECYCLE OPERATION (ENGLISH UNITS)

Date	9/28/84		9/28/84		9/28/84			
Run	5		6		7		Average	
Emission Type	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled[a]	Uncontrolled	Controlled
Baghouse Pressure Drop (in/H_2O)	4.3		4.7		4.7		4.6	
Production Rate (tons/hour)	329		313		307		316	
Process Mix Type	RAP		RAP		RAP		RAP	
Average Opacity (%) (mean, range)	4.5 (3.5-5)		N/A		N/A		4.5 (3.5-5)	
Particulate and Total Organic Carbon (TOC) Results								
Front Half Catch-Particulate (probe, cyclone and filter)								
mg - mass	11507.23	40.46	17136.08	35.23	13817.09		14153.47	37.84
gr/dscf	7.085	0.008	10.939	0.006	8.655		8.890	0.007
lb/hr	1414.622	1.674	2085.637	1.483	1648.721		1716.330	1.578
lb/ton production	4.300	0.005	6.660	0.005	5.370		5.426	0.005
Collection Efficiency Percent[b]	99.9		99.9		N/A		99.9	
Back Half Catch - TOC (impinger solutions and rinses)								
mg - mass	54.53	321.90	173.24	295.55	63.84		97.21	308.72
gr/dscf	0.034	0.062	0.111	0.053	0.040		0.062	0.057
lb/hr	6.704	13.319	21.085	12.440	7.617		11.802	12.879
lb/ton production	0.020	0.040	0.067	0.038	0.025		0.037	0.040
Collection Efficiency Percent	-49.25		41.01		N/A		-6.98	
Total Catch Particulate - TOC								
mg - mass	11561.76	362.36	17309.32	330.78	13880.93		14250.68	346.56
gr/dscf	7.119	0.070	11.050	0.059	8.695		8.950	0.064
lb/hr	1421.33	14.99	2106.72	13.92	1656.34		1728.13	14.46
lb/ton production	4.320	0.045	6.730	0.043	5.395		5.460	0.045
Collection Efficiency Percent	98.96		99.35		N/A		99.18	

[a]No controlled run conducted.
[b]CEP based on lb/hr values.

TABLE 2-6. SUMMARY OF PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING RECYCLE OPERATION (METRIC UNITS)

Date	9/28/84		9/28/84		9/28/84			
Run	5		6		7		Average	
Emission Type	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled[a]	Uncontrolled	Controlled
Baghouse Pressure Drop (in/H_2O)	4.3		4.7		4.7		4.6	
Production Rate (kg/s)	82.9		78.9		77.4		79.7	
Process Mix Type	RAP		RAP		RAP		RAP	
Average Opacity (%) (mean, range)	4.5 (3.5-5)		N/A		N/A		4.5 (3.5-5)	
Particulate and Total Organic Carbon (TOC) Results								
Front Half Catch-Particulate (probe, cyclone and filter)								
mg - mass	11507.23	40.46	17136.08	35.23	13817.09		14153.47	37.84
ng/dscm	16208.08	18.30	25013.30	13.73	19799.72		20340.37	16.01
g/s	178.238	0.211	262.780	0.187	207.734		216.251	0.198
g/kg production	2.150	0.0025	3.330	0.0023	2.680		2.713	0.0025
Collection Efficiency Percent[b]	99.9		99.9		N/A		99.9	
Back Half Catch - TOC (impinger solutions and rinses)								
mg - mass	54.53	321.90	173.24	295.55	63.84		97.21	308.72
ng/dscm	77.78	141.83	253.93	121.25	91.51		140.92	130.85
g/s	0.845	1.678	2.660	1.567	0.960		1.487	1.623
g/kg production	0.010	0.020	0.034	0.020	0.012		0.019	0.020
Collection Efficiency Percent	-49.25		41.01		N/A		-6.98	
Total Catch Particulate - TOC								
mg - mass	11561.76	362.36	17309.32	330.78	13880.93		14250.68	346.56
mg/dscm	16285.86	160.13	25267.23	134.98	19891.23		20481.29	146.86
g/s	179.083	1.889	265.440	1.754	208.694		217.740	1.821
g/kg production	2.160	0.023	3.364	0.022	2.692		2.730	0.023
Collection Efficiency Percent	98.96		99.35		N/A		99.18	

[a]No controlled run conducted.

[b]CEP based on g/s values.

TABLE 2-7. SUMMARY OF UNCONTROLLED PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING RECYCLE OPERATION

Run Number	5	6	7	Average
Date	9/28/84	9/28/84	9/28/84	
Volume Gas Sampled (dscf)	24.315	24.279	24.917	24.503
Stack Gas Flow Rate (dscfm)	23,294	22,244	21,194	22,244
Stack Temperature, °F	340	346	349	345
Percent Moisture by Volume	20.5	21.1	23.1	21.56
Percent Isokinetic	103.5	104.6	106.7	104.93
Production Rate (ton/hr)	329	313	307	316
Process Mix Type	RAP	RAP	RAP	RAP
<u>Particulate and Total Organic Carbon (TOC) Results</u>				
Front Half Catch-Particulate (probe, cyclone and filter)				
mg	11507.23	17136.08	13817.09	14153.47
gr/dscf	7.085	10.939	8.655	8.890
lb/hr	1414.622	2085.637	1648.721	1716.330
lb/ton production	4.30	6.66	5.37	5.426
Back Half Catch - TOC (impinger solutions and rinses)				
mg - mass	54.53	173.24	63.84	97.21
gr/dscf	0.034	0.111	0.040	0.062
lb/hr	6.704	21.085	7.617	11.802
lb/ton production	0.020	0.067	0.025	0.037

TABLE 2-8. SUMMARY OF CONTROLLED PARTICULATE AND TOTAL ORGANIC CARBON EMISSION DURING RECYCLE OPERATION

Run Number	5	6	7	Average
Date	9/28/84	9/28/84	N/A	
Volume Gas Sampled (dscf)	80.787	89.495		85.141
Stack Gas Flow Rate (dscfm)	25,087	27,567		26.327
Stack Temperature, °F	302.2	315		308.6
Percent Moisture by Volume	21.1	21.6		21.35
Percent Isokinetic	106.8	105.0		105.9
Production Rate (ton/hr)	329	313		321
Process Mix Type	RAP	RAP		RAP
<u>Particulate and Total Organic Carbon (TOC) Results</u>				
Front Half Catch-Particulate (probe, cyclone and filter)				
mg	40.46	35.23		37.84
gr/dscf	0.008	0.006	N/A	0.007
lb/hr	1.674	1.483		1.578
lb/ton production	0.005	0.005		0.005
Back Half Catch - TOC (impinger solutions and rinses)				
mg - mass	321.90	295.55		308.72
gr/dscf	0.062	0.053		0.057
lb/hr	13.319	12.440		12.879
lb/ton production	0.040	0.038		0.040

TABLE 2-9. BREAKDOWN OF SAMPLING RUN WEIGHT GAINS

Date	Time	Sample description	Filter wt. (g)	Front half weight gain (g)	Blank corr. acetone (g)	Filter & front half wt. (g)	Acetone wash volume (ml)	Total (g)
			Conventional Controlled Air Emissions					
9/24/84	1330-1601	LI-BO-M5E/I-1	0.01535	0.03413	0.001	0.04948	325	0.04848
9/25/84	1254-1830	LI-BO-M5E/I-2	0.09207	0.03208	0.0008	0.12415	285	0.12335
9/26/84	0932-1154	LI-BO-M5E-I-3	0.1123	0.06043	0.0011	0.17273	375	0.17163
9/27/84	0906-1641	LI-BO-M5E/I-4	0.07726	0.05077	0.0013	0.12803	450	0.12673
			Conventional Uncontrolled Air Emissions					
9/24/84	1337-1715	LI-BI-M5E/I-1	0.37783	160.12961	0.0076	160.50744	2565	160.49984
9/25/84	1256-1526	LI-BI-M5E/I-2	0.26053	183.11814	0.0068	183.37867	2250	183.37187
9/26/84	1007-1102	LI-BI-M5E/I-3	0.27436	147.48802	0.0064	147.76238	2125	147.75598
9/27/84	0904-1408	LI-BI-M5E/I-4	0.71857	84.24214	0.00335	84.96071	1100	84.95736
			Unconventional Controlled Air Emissions					
9/28/84	0815-1204	LI-BO-M5E/I-5	0.01334	0.02932	0.001	0.04266	325	0.04166
9/28/84	1231-1450	LI-BO-M5E/I6-6	0.02145	0.01438	0.0006	0.03583	200	0.03523
			Unconventional Uncontrolled Air Emissions					
9/24/84	0820-1043	LI-BI-M5E/I-5	0.65816	10.85087	0.0018	11.50903	610	11.50723
9/28/84	1126-1302	LI-BI-M5E/I-6	0.40776	16.73242	0.0041	17.14018	1400	17.13608
9/28/84	1334-1429	LI-BI-M5E/I-7	0.44267	13.37652	0.0021	13.81919	700	13.81709

analyzer. The analyses were performed by Pollution Control Sciences Inc. in Miamisburg, Ohio. The TOC results are designated as back half catches in Data Tables 2-1 through 2-8 and are discussed in this section.

2.1.2.1 Conventional Operation--

Table 2-1 (english units) and Table 2-2 (metric units) present the TOC results for both uncontrolled and controlled operation during conventional production. For uncontrolled operation the TOC loadings were 0.049, 0.022 and 0.047 gr/dscf for Runs 2, 3 and 4, respectively. Run No. 1 at the uncontrolled location was voided because of a contaminated sample. No TOC results for this test are presented in the data tables. The controlled TOC loadings during conventional operation were 0.020, 0.021, 0.017 and 0.017 for Runs 1, 2, 3 and 4, respectively. It should be noted that, for run No. 2 only about 75 percent of the sampling points were tested due to process shut down. It is believed that this had a minimal affect on the quality of the data. The collection efficiencies of the baghouse for Run 2, 3 and 4 were 44.6, 0 and 50.8, respectively. Tables 2-3 and 2-4 present more detailed uncontrolled and controlled data for TOC emissions.

2.1.2.2 Recycle Operation--

TOC results for uncontrolled and controlled emissions during recycle operation are presented in Table 2-5 (english units) and Table 2-6 (metric units). Additional TOC information for uncontrolled and controlled emission can be found in Tables 2-7 and 2-8. The uncontrolled TOC loadings were 0.034, 0.111 and 0.040 for Run 5, 6 and 7, respectively. Time constraints permitted the collection of only two controlled emission samples. The results of these TOC test were 0.062 gr/dscf for Run 5 and 0.053 gr/dscf for Run 6. The collection efficiencies for Run 5 and 6 were -49.2 and 41.0, respectively as shown in Table 2-6.

2.1.2.3 Discussion of Results--

The TOC results for uncontrolled emissions during conventional operation ranged from 0.022 to 0.049 gr/dscf. The average TOC loadings was 0.039 gr/dscf. For controlled conventional emissions, the loadings only varied from 0.017 to 0.020 with an average loading of 0.019 gr/dscf. For uncontrolled emission during recycle operation the TOC loading results ranged from 0.034 gr/dscf to 0.111 gr/dscf. The average value was 0.062 gr/dscf. The controlled emissions varied from 0.053 to 0.062 gr/dscf.

The average TOC loading at the controlled locations increased from 0.019 gr/dscf during conventional operation to 0.057 during recycle operation. It was expected that there would be a similar elevation in TOC at the uncontrolled location during recycle operation. The data did not show this expected rise in TOC loading. This inconsistency can be explained as follows.

For controlled Runs 5 and 6 and for uncontrolled Run 5, replicate TOC samples were analyzed 9 times each to establish a 95 percent confidence interval. The results of these tests indicate that the TOC results of this test program could vary an average of $\pm$22.8 mg/l. This value corresponds to 9 percent to 65 percent of the TOC sample results. The highest variability in results were encountered with the sample with the lowest concentrations. The

TABLE 2-10. SUMMARIES OF IMPINGER BACK HALF RESULTS DURING CONVENTIONAL OPERATION UNCONTROLLED TOTAL ORGANIC CARBON AND IMPINGER ACETONE RINSE VALUES

Run	1			2			3			4			Average		
Date	9/24/84			9/25/84			9/26/84			9/27/84					
Volume Gas Sampled (dscf)	56.116			24.816			25.810			23.924			32.66		
Stack Gas Flow Rate (dscfm)	20,638			23,662			24,798			23,630			23,182		
Production Rate (tons/hr)	310			311			308			267			299		
Process Mix Type	CON			CON			CON			CON			CON		
Back Half Impinger Catch	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total[b]
mg	[a]	109.93	109.93	80.52	75.89	156.41	37.1	43.37	80.47	74.16	412.63	486.79	63.93	177.30	241.23
gr/dscf		0.031	0.031	0.049	0.047	0.096	0.022	0.025	0.047	0.047	0.260	0.307	0.039	0.110	0.149
lb/hr		5.541	5.541	10.033	9.456	19.490	4.634	5.418	10.052	9.459	52.629	62.088	8.042	22.501	30.540
lb/ton production		0.018	0.018	0.032	0.030	0.062	0.015	0.018	0.033	0.035	0.197	0.232	0.027	0.082	0.108
Percent Acetone Rinse Catch of Total Impinger Catch		N/A			48.48			53.99			84.96			75.5	

[a]Contaminated sample.

[b]Does not include run 1.

TABLE 2-11. SUMMARIES OF IMPINGER BACK HALF RESULTS DURING CONVENTIONAL OPERATION CONTROLLED TOTAL ORGANIC CARBON AND IMPINGER ACETONE RINSE VALUES

Run		1			2			3			4			Average	
Date		9/24/84			9/25/84			9/26/84			9/27/84				
Volume Gas Sampled (dscf)		90.500			74.098			93.270			90.568			87.109	
Stack Gas Flow Rate (dscfm)		29,597			31,448			31,527			31,032			30,901	
Production Rate (tons/hr)		310			311			308			267			299	
Process Mix Type		Conventional			Conventional			Conventional			Conventional			Conventional	
Back Half Impinger Catch	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total
mg	115.2	55.32	170.52	100.5	104.58	205.08	106.7	61.61	168.31	101.92	49.74	151.66	106.08	67.81	173.89
gr/dscf	0.020	0.010	0.030	0.021	0.022	0.043	0.017	0.010	0.017	0.017	0.008	0.025	0.019	0.0125	0.0315
lb/hr	5.035	2.418	7.453	5.589	5.816	11.40	4.661	2.691	7.352	4.601	2.245	6.846	4.971	3.292	8.263
lb/ton production	0.016	0.008	0.024	0.018	0.019	0.043	0.015	0.009	0.024	0.017	0.008	0.026	0.017	0.011	0.028
Percent Acetone Rinse Catch of Total Impinger Catch		32.5			43.79			36.71			32.81			39.85	

TABLE 2-12. SUMMARIES OF IMPINGER BACK HALF RESULTS DURING RECYCLE OPERATION UNCONTROLLED TOTAL ORGANIC CARBON AND IMPINGER ACETONE RINSE VALUES

Run	5			6			7			Average		
Date	9/28/84			9/28/84			9/28/84					
Volume Gas Sampled (dscf)	24.315			24.279			24.917			24.503		
Stack Gas Flow Rate (dscfm)	23,294			22,244			21,194			22,244		
Production Rate (tons/hr)	329			313			307			316.3		
Process Mix Type	RAP			RAP			RAP			RAP		
Back Half Impinger Catch	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total
mg	54.43	26.31	80.84	173.24	58.05	231.29	63.84	153.10	216.94	97.21	79.15	176.36
gr/dscf	0.034	0.061	0.095	0.111	0.037	0.148	0.040	0.096	0.136	0.062	0.065	0.126
0.126 lb/hr	6.704	3.230	9.934	21.085	7.065	28.150	7.617	18.261	25.880	11.802	9.518	21.320
lb/ton production	0.020	0.010	0.030	0.067	0.023	0.090	0.025	0.059	0.084	0.037	0.030	0.0670
Percent Acetone Rinse Catch of Total Impinger Catch	32.55			25.03			70.58			42.77		

EPA audit TOC sample results also show high variability at low concentrations. The 95 percent confidence interval for Run 6 uncontrolled was ±28.3 mg/l. If similar confidence intervals were applied to the remainder of the test samples, then a accurate interpretation of the TOC data cannot be made. Based on this fact and the limited quantity of data, no conclusions or correlations between convention and recycle operations can be made. The back half emissions section provides explanations for inconsistencies in TOC data including the negative removal efficiencies.

Additional information on lab results, TOC audit sample results and confidence interval determination can be found in Appendix G.

2.1.3 Impinger Residue Film

These samples consisted of the impinger acetone rinses which were used to remove the black film material condensed on the impingers and glassware. The acetone rinses were dried to a constant weight and added to the TOC values. These results for the conventional and recycle operation are discussed in the following sections.

2.1.3.1 Conventional Back Half Emissions--

Table 2-10 contains back half emission data for conventional uncontrolled operation. The total TOC loadings for Runs 2, 3 and 4 were 0.096, 0.047 and 0.307 gr/dscf, respectively. No TOC value was obtained for Run 1 because of a contaminated sample. The average back half TOC loading for conventional operation was 0.149 gr/dscf with an average of 75.5 percent of the loading coming from the acetone rinses of the glassware. The corresponding conventional controlled data is presented in Table 2-11. For Runs 1, 2, 3 and 4 the back half TOC loadings were 0.30, 0.043, 0.017 and 0.025 gr/dscf, respectively. The average controlled back half TOC loading for conventional operation was 0.031 gr/dscf with an average of 39.8 percent resulting from the acetone rinses.

2.1.3.2 Recycle Back Half Emissions--

Back half TOC loadings for uncontrolled recycle operation are presented in Table 2-12. The TOC loadings were 0.095, 0.148 and 0.136 gr/dscf for Run 5, 6 and 7, respectively. The average total loading was 0.126 gr/dscf with an average of 42.8 percent of the load found in the acetone rinses. Only two controlled recycle runs were conducted. The back half results for these two runs were 0.108 and 0.068 gr/dscf for Runs 5 and 6, respectively. The average controlled back half loading was 0.088 gr/dscf. The average loading found in the acetone rinse was 34.2 percent. Results for controlled back half emissions can be found on Table 2-13.

2.1.3.3 Discussion of Impinger Back Half Results--

The back half TOC results are difficult to interpret. The back half emission results show that from 20 to 85 percent of the total load can adhere to the glassware and must be rinsed off with acetone. Data Tables 2-1 through 2-8 do not account for this fact and present only the TOC values obtained from the impinger solutions. In addition to this, the 95 percent confidence interval established for some of the TOC samples show high variability. Based on these facts, the conclusion can be made that the data

TABLE 2-13. SUMMARIES OF IMPINGER BACK HALF RESULTS DURING RECYCLE OPERATION CONTROLLED TOTAL ORGANIC CARBON AND IMPINGER ACETONE RINSE VALUES

Run	5			6			7[a]			Average		
Date	9/28/84			9/28/84								
Volume Gas Sampled (dscf)	80.787			89.495			N/A			85.14		
Stack Gas Flow Rate (dscfm)	25,087			27,567						26,327		
Production Rate (tons/hr)	329			313						321		
Process Mix Type	RAP			RAP						RAP		
Back Half Impinger Catch	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total	TOC	Acetone Rinse	Total
mg	321.90	238.86	560.76	295.55	82.59	378.14				308.72	160.72	469.44
gr/dscf	0.062	0.046	0.108	0.053	0.015	0.068				0.057	0.031	0.088
lb/hr	13.319	9.883	23.202	12.440	3.476	15.916		N/A		12.879	6.679	19.558
lb/ton production	0.040	0.030	0.070	0.038	0.011	0.049				0.040	0.021	0.061
Percent Acetone Rinse Catch of Total Impinger Catch		42.85			21.84						34.15	

[a]No controlled run conducted.

for TOC shown in Data Tables 2-1 through 2-8 are highly questionable. The fact that varying amounts of TOC can adhere to the glassware helps explain the inconsistencies in the TOC data including the negative removal efficiencies. The back half emission results in Tables 2-9 through 2-12 probably gives a better indication of TOC loading than those provided in Tables 2-1 through 2-8.

2.1.4 Visible Emission Results

Visible emission observation reading were taken by a certified reader. The opacity of a plume can be assigned the greatest degree of accuracy when viewed under conditions where a contrasting background is present. During most of the test week overcast skies, creating a bad background, prevented readings from being taken. Readings for both conventional and recycle production that were obtained are discussed below.

2.1.4.1 Visible Emissions During Conventional Operation--

Opacity readings were performed during conventional test Run 2. Approximately 3 hours of readings were conducted. Table 2-14 present the 6 minute averages for this time period. The results are also represented graphically in Figure 2-1. The average opacity during this conventional test was 0.25 percent. The maximum 6 minute opacity was 1.25 percent. Field data sheets for these readings can be found in Appendix A.

2.1.4.2 Visible Emissions During Recycle Operation--

Table 2-15 presents the results of the visible emission observation readings conducted during recycle production. Graphic representation of these results is shown in Figure 2-2. These readings were performed during recycle test 5 and continued into Run 6 and 7. The average 6 minute average opacity during these readings was 4.50 percent. The maximum 6 minute average opacity for this period was 5.0 percent. Field data sheet for these opacity readings can be found in Appendix A.

2.1.4.3 Discussion of Visible Emission Results--

The average opacity rose from 0.25 percent during conventional opertion to 4.5 during recycle operation. The particulate emissions data show that the controlled particulate emission during recycle operation are well below the controlled particulate emissions during conventional operation. Therefore, the increase in opacity during recycle operation is not due to particulate emissions and probably due to an increase in condensible hydrocarbon emissions.

2.1.5 Moisture Determinations of Process Samples

Discrete grab samples of virgin aggregate and recycled asphalt pavement were obtained during each of the sampling runs. A representative portion of these samples was weighed, dried and reweighed to determine weight loss due to moisture.

2.1.5.1 Conventional Operation Moisture Results--

A total of four samples of virgin aggregate were taken one for each conventional run. The samples were obtained directly from the feed conveyors. Table 2-16A presents the moisture determination result for

TABLE 2-14. SUMMARY OF VISIBLE EMISSION OBSERVATIONS DURING CONVENTIONAL OPERATION

Date	Run No.	Time	Average opacity for 6 minutes	
9-25-84	2	1300	1.25	
		1312	0.625	
		1318	0.625	
		1500	0	
		1506	0.208	
		1512	0	
		1518	0.416	
		1524	0	
		1530	0	
		1536	0	
		1542	0	
		1548	0.208	
		1554	0.208	
		1600	0.208	
		1606	0	
		1612	0.416	
		1618	0	
		1624	0.208	
		1630	0.208	
		1636	0	
		1642	0.208	
		1648	0	
		1654	0.416	
		1700	0.833	
		1706	0.208	
		1712	0.416	
		1718	0.208	
		1724	0.208	
		1730	0.208	
		1736	0.625	AVE 0.25

TABLE 2-15. SUMMARY OF VISIBLE EMISSION OBSERVATIONS DURING RECYCLE OPERATION

Date	Run No.	Time	Average opacity for 6 minutes
9-28-84	5	1032	3.54
		1038	4.58
		1044	4.37
		1050	4.79
		1056	5.0
		1102	4.37
		1108	5.0
		1117	5.0
		1122	4.79
		1128	4.16
		1134	4.79
		1140	4.58
		1146	4.79
		1152	4.58
		1158	4.37
		1204	4.58
		1210	4.37
		1216	4.32
		1222	4.58
	6	1228	4.58
		1239	4.79
		1245	4.58
		1251	4.79
		1257	4.37
		1303	4.58
		1309	4.58
		1315	4.79
		1327	4.79
	7	1333	4.58
		1339	5.0
		1357	4.79
		1403	4.79
		1409	4.37
		1415	5.0
		1421	4.58
		1427	4.79
		1433	4.58
		1439	4.37
		1445	4.79
		1451	4.37
		1457	5.0 AVG. 4.50

conventional operation. The average moisture content of virgin aggregate during conventional testing was 2.4 percent. The field data sheets can be found in Appendix D.

2.1.5.2 Recycle Operation Moisture Results--

A total of 4 samples were taken for moisture determination during recycle production. One virgin aggregate sample and one RAP sample for each recycle test run. No sample was taken for 7 uncontrolled. The results of these tests are presented in Table 2-16B. The average moisture content of the virgin aggregate during recycle operation was 3.3 percent. The average moisture content of the recycled asphalt pavement samples was 3.1 percent. FIeld data sheet for these determinations are in Appendix D.

2.1.6 Smoke Point Determinations

Two recycled asphalt pavement samples were collected during recycle production. The results of the smoke point tests are shown in Table 2-17. The average smoke point temperature for the RAP samples was 352°F.

2.1.7 Flash Point Determinations

Two different types of asphalt cement are used during production, one is used during conventional production, the other during recycle production. One asphalt cement sample was taken for each production mode. The results of the flash point testing are presented in Table 2-18.

2.1.8 Viscosity of Asphalt Cement Samples

The two asphalt cement samples were also analyzed for viscosity. The viscosity results are presented in Table 2-19.

2.1.9 Fuel Oil Sample

One fuel oil sample was taken and retained for possible analysis.

TABLE 2-16. SUMMARY OF PROCESS SAMPLE MOISTURE MEASUREMENTS

TABLE 2-16A. CONVENTION OPERATION

		Virgin aggregate		
Run No.	Date	Time	Sample wt. g	Moisture by weight %
C-1	9-24-84	1436	314.5	2.1
C-2	9-25-84	1520	274.7	2.0
C-3	9-26-84	1045	224.6	2.3
C-4	9-27-84	1015	217.2	3.2

TABLE 2-16B. RECYCLE OPERATION

		Virgin aggregate			Recycle asphalt pavement		
Run No.	Date	Time	Sample wt. g	Moisture by weight %	Time	Sample wt. g	Moisture by weight %
R-1	9-28-84	0920	212.5	4.8	0925	214.3	2.0
R-2	9-28-84	1355	217.1	1.7	1358	203.5	4.1

TABLE 2-17. SUMMARY OF SMOKE POINT DETERMINATIONS

Run	Collection date	Time	Sample type	Smoke point temperature °F
R-1	9-28-84	0925	RAP	344
R-2	9-28-84	1358	RAP	360

TABLE 2-18. SUMMARY OF FLASH POINT DETERMINATIONS

Run	Date	Time	Sample type	Flash point temperature °C
Conventional	9-24-84	1422	Asphalt cement	244°C
Recycle	9-28-84	1356	Asphalt cement	218°C

TABLE 2-19. VISCOSITY RESULTS OF ASPHALT CEMENT SAMPLES

Sample	Temp. °F	Vacuum (mm of Hg)	Viscosity (poises)
Conventional	140	300	1,153
Recycle	140	300	876

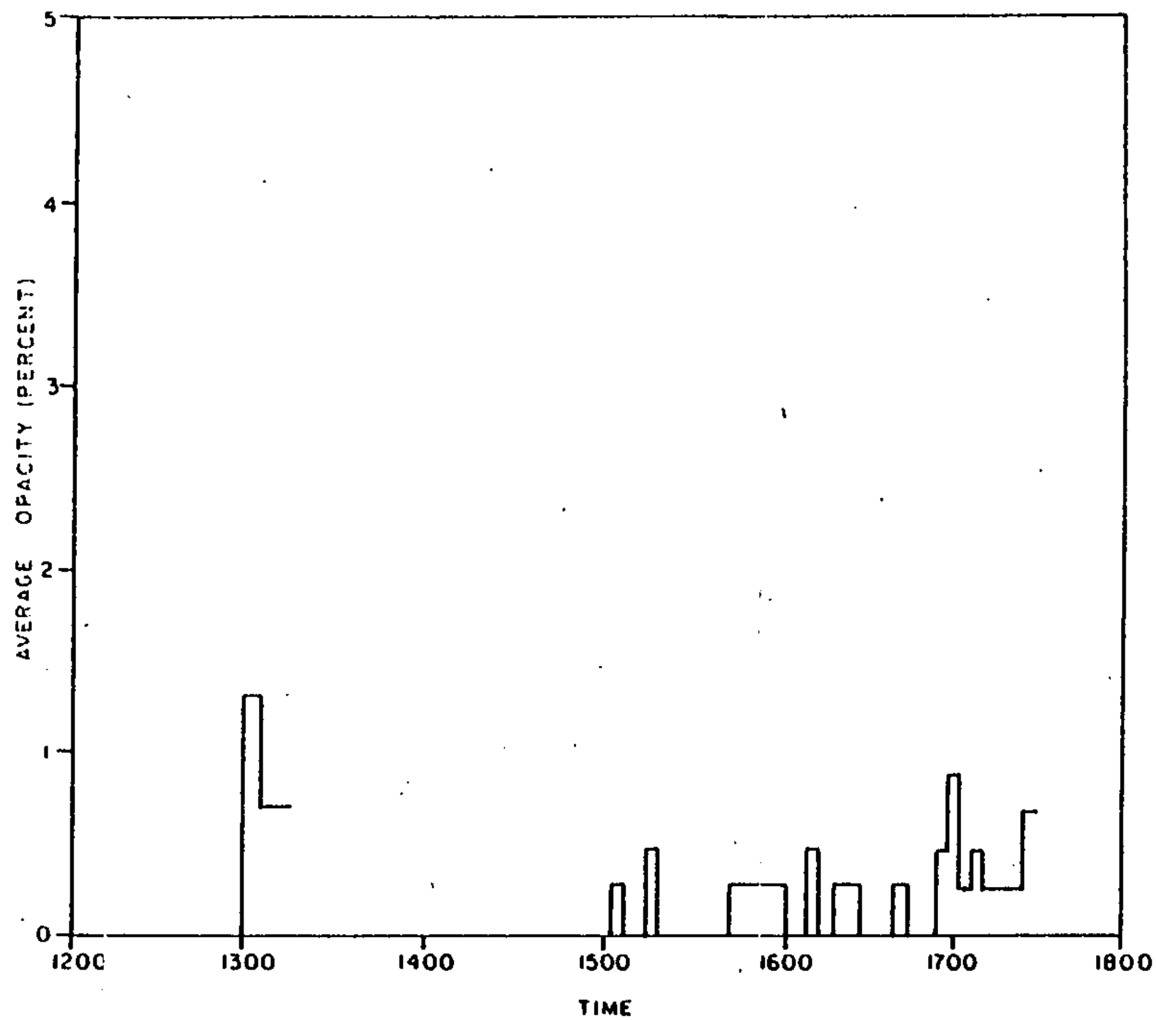


Figure 2-1. Six-minute average opacity during conventional operation.

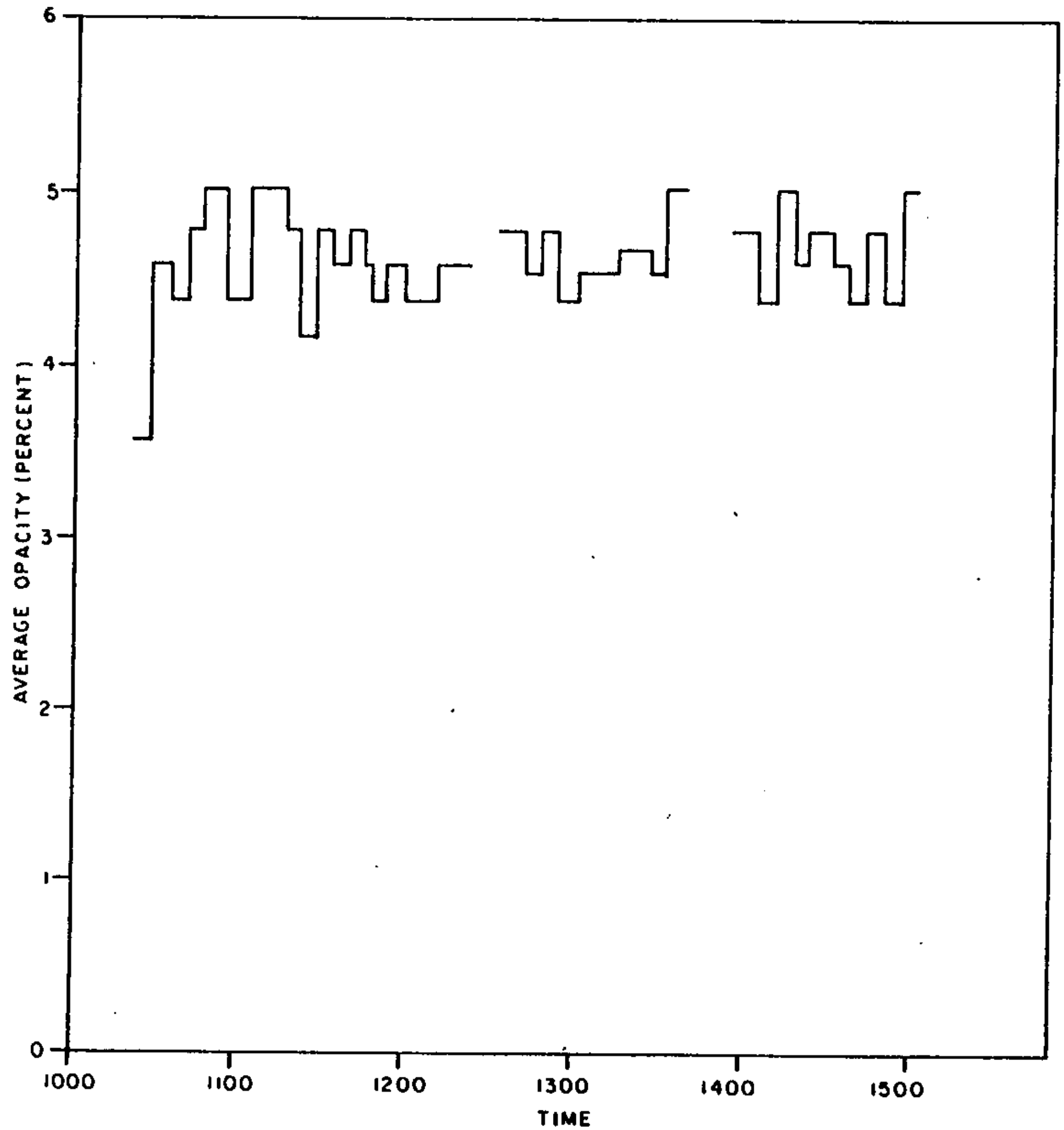


Figure 2-2. Graphic representation of visual emission observations.

SECTION 3.0

PROCESS DESCRIPTION AND OPERATION

This section provides a brief description of the asphalt concrete plant operated by Western Engineering Company, Inc., (Western) near Lincoln, Nebraska. The procedures used to monitor the operation of the asphalt concrete plant during both conventional and recycle operation are also presented in this section.

3.1 PROCESS DESCRIPTION

A description of the Western asphalt concrete plant (including the emissions control system) is presented in this section.

3.1.1 Process Equipment Description

Western operates a portable CMI plant presently located on Highway 34 between Lincoln and Seward, Nebraska. The plant normally operates 11 to 12 hours per day, 6 days per week. Technical data on the plant are presented in Table 3-1.

The operation of this plant is typical of drum-mix plants. Figure 3-1 is a schematic of the production process for a typical drum-mix asphalt concrete plant. Western has four feed bins for virgin aggregate and one feed bin for the recycled asphalt pavement (RAP). Aggregate from each bin is metered onto a conveyor according to the type of mix desired and transported to the burner end of the rotating drum. The programmable controller unit automatically delivers the proper amount of each aggregate to the feed belt. The aggregate is heated and moves down the drum as the drum rotates. When mixes containing RAP are produced, the RAP is added tangentially to the drum midway between the burner end and the terminal end. The RAP is mixed with the heated virgin aggregate; then the asphalt cement is injected into the drum countercurrent to the direction of the aggregate flow at a point about 5 feet down the drum from the RAP entry point. No recycling agents are used by Western. (The Nebraska Department of Transportation specifies that a 120 to 150 penetration grade asphalt cement be used in mixes containing RAP). The final product drops out the terminal end of the drum at a temperature of about 290°F for RAP mixes or about 305°F for conventional mixes. The final product is lifted to a 100-ton-capacity surge bin that is insulated but not heated.

TABLE 3-1. TECHNICAL DATA ON ASPHALT CONCRETE PLANT WESTERN ENGINEERING COMPANY, INC.

Plant designation	
Type plant	Drum-mix
Mobility	Portable
Plant manufacturer	CMI
Model UDM-1900	
Date purchased	1978[a]
Capacity--rated/typical, tons/h (see text)	430/300-350
Dryer fuel	No. 5 fuel
Burner--manufacturer	Hauck
model No.	JB 630-133
rating, million Btu's	133.7
blower, scfm	7,300
Drum size--diameter, ft	9.5/8.5[b]
length, ft	40
Product temperature--conventional, °F	275-290
length, ft	40
Asphalt--No. of tanks	1
storage capacity, gal	30,000 gal
grade	85-1000 or 120-150 pen.[c]
heater fuel	No. 2 fuel
Storage--capacity, tons	100
type	Surge bin
insulated	Yes

[a]Drum modified in February or March 1983.

[b]Burner end of drum has larger diameter.

[c]85-100 penetration grade asphalt cement used for conventional mix; 120-150 penetration grade asphalt cement used for recycle mix.

This plant is rated at 430 tons/h at 4.5 percent moisture removal but is usually operated at about 300 to 350 tons/h. The actual production capacity of an asphalt concrete plant is influenced by weather, type mix produced, moisture content of aggregate and RAP, and usage rate of the paving crew.

During this testing at the Western plant, the highest production rate that could be maintained was approximately 310 tons/hr which was actually slightly below the normal usage rate of the paving crew. Plant personnel indicated that the most important factor in this lower production capacity was probably the cold and windy weather conditions experienced during the testing. These conditions caused more of the heat from the flame to be lost to the surroundings as radiant and convective heat from the outside surface of the drum than would be lost during warmer and less windy weather. Also, more heat was required to heat the cold aggregate and inlet air than would be required under summer conditions.

At a production rate of 310 tons/h, the dust return mechanism between the baghouse and the dryer-drum at the Western plant was overloaded when conventional surface mixed was produced. The excess dust overflowed onto the ground and had to be manually removed. Dust overloading was less during production of mixes containing RAP.

3.1.2 Emission Control System Description

The process emissions from the drum-mix plant are evacuated from the discharge end of the drum and go through a knockout chamber to remove large particles and to slow the exhaust gas stream. From the knockout chamber, the emissions are ducted to a negative-pressure baghouse. The specifications for the baghouse are presented in Table 3-2.

At startup, the baghouse is preheated for several 30-second intervals before aggregate is fed into the drum. The shutdown procedures involve allowing the baghouse to run through its normal cleaning cycle while the drum is cooling and the surge bin is being unloaded.

The bags in the baghouse were laundered and about 25 percent were replaced when the plant was moved to its present site in August 1984. Since that time, new seals have been installed on all the bags to ensure that no air leaks would occur. The baghouse was "visolite" inspected on September 19, several bags were replaced, and the baghouse was again "visolite" inspected on September 20 before testing began on September 24.

3.2 PROCESS MONITORING

The operation of the drum-mix plant and the baghouse was monitored during testing on September 24, 25, 26, 27, and 28. Tables 3-3 through 3-7 provide a list of the process and control device information that was obtained during this period.

Although the design production rate of this plant is reported by CMI to be 430 tons/hr at 4.5 percent moisture removal, during this testing the highest production rate that could be maintained was approximately 310 tons/h

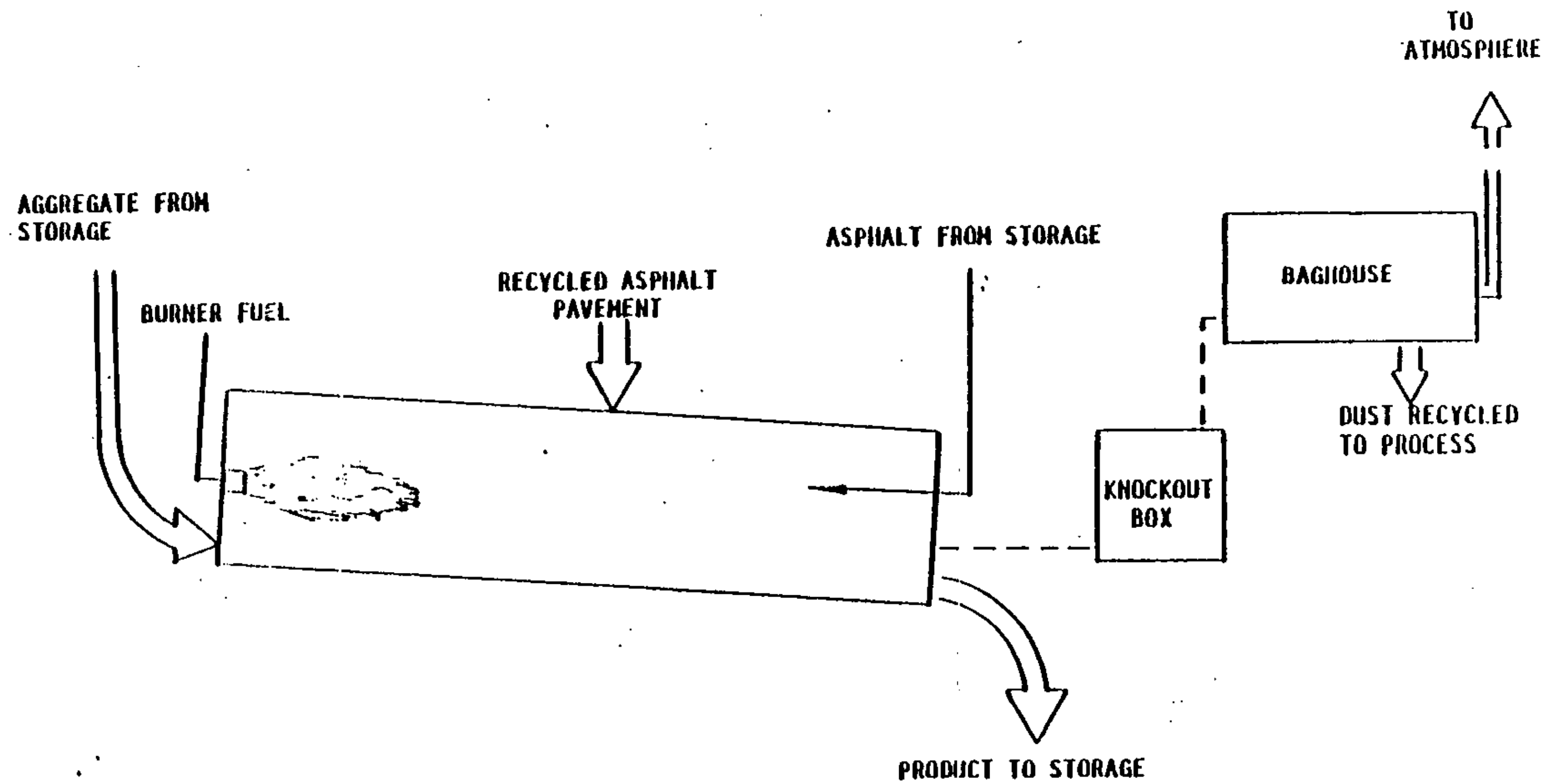


Figure 3-1. Schematic of asphalt concrete drum-mix plant.

TABLE 3-2. TECHNICAL DATA ON THE AIR POLLUTION CONTROL DEVICE
WESTERN ENGINEERING COMPANY, INC.

Type	Negative pressure baghouse
Manufacturer	Aeropulse
Total air flow rate	56,000 acfm
Age of baghouse	5 years
Number of bags	900
Bag material	14 oz./ft^2 Nomex
Bag dimensions	
diameter	4.5 in.
length	8.5 ft
Total cloth area	9,200 ft^2
Pressure drop	5 in. w.c.
Bag cleaning mechanism	Pulse jet
Date current bags installed	August 1984[a]
Air-to-cloth ratio	6.3:1
Fan motor size	2-100 hp each
Baghouse outlet	Rectangular steel stack
Dust disposal	Recycled to drum

[a]Current bags were installed new in August 1983. They were laundered and reinstalled in August 1984.

TABLE 3-3. PROCESS AND CONTROL INFORMATION--SEPTEMBER 24, 1984

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
1:19	321	306	0	15.1	272	310	100	5.6	46	50	73	29.92	18	E	Cloudy skies. No V.E. readings.
1:30	323	308	0	15.4	275	310	100	5.6							Outlet test began 1:30, inlet test began 1:37.
1:45	319	303	0	14.6	276	310	90	5.6							
2:00	317	302	0	15.1	270	300	100	5.45							Lowered production rate to keep temperature up.
2:15	310	295	0	14.7	272	310	100	5.6							Asphalt cement sample taken at 2:22.
2:30	308	293	0	14.7	273	303	100	5.45	49	55	69	29.92	15	E	Aggregate sample taken at 2:36.
2:45	308	294	0	14.4	275	310	100	5.6							
3:00	313	298	0	14.7	280	315	95	5.4							
3:15	312	297	0	14.8	280	310	100	5.5							
3:30	308	293	0	14.6	280	310	100	5.4	50	56	68	29.92	10	E	Cloudy skies. No V.E. readings.
3:45	309	394	0	14.8	275	305	95	5.4							
4:00	306	292	0	14.4	272	300	98	5.6							Outlet test completed 4:01.
4:15	310	295	0	15.2	272	305	96	5.6							
4:30	289	275	0	14.0	272	305	80	5.6	49	55	69	29.92	15	E	Cloudy skies. No V.E. readings.
4:45	289	300	0	14.4	274	310	90	5.6							
5:00	313	298	0	15.4	272	302	100	5.6							
5:15	319	304	0	15.3	270	300	100	5.6							Inlet test completed 5:15.

Notes:

1. Conventional surface mix.
2. No visible emissions read due to cloudy skies
3. Aggregate moisture content = 2.1 percent.

TABLE 3-4. PROCESS AND CONTROL INFORMATION--SEPTEMBER 25, 1984

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
9:11	305	290	0	14.7	280	320	100	5.6	38	42	73	29.92	30	SE	Plant down from 9:20-12:30 due to bearing on screening deck.
12:54	317	302	0	14.7	274	310	100	5.8							Outlet test began 12:54. 1st inlet test began 12:56.
1:00	315	300	0	15.2	275	312	100	5.6	44	51	57	30.31	30	SE	Mostly clear skies. V.E. readings taken.
1:15	308	293	0	14.6	275	310	100	5.6							Plant down from 1:21-2:45 due to breakdown on road crew.
3:00	305	290	0	14.6	275	312	100	5.6	45	54	48	30.31	25	SE	Clear skies. V.E. readings taken.
3:15	310	295	0	14.5	280	315	100	5.5							Completed 1st inlet test at 3:26. Collected aggregate sample at 3:20.
3:30	312	297	0	14.8	283	320	100	5.6							
3:45	315	300	0	14.6	280	315	90	5.4							2nd inlet test begun at 4:57
4:00	313	298	0	14.8	270	305	100	5.6	45	55	44	30.31	25	SE	Clear skies. V.E. readings taken.
4:15	310	296	0	14.2	300	300	100	5.5							
4:30	309	295	0	14.1	270	303	100	5.7							
4:45	311	296	0	14.6	270	300	100	5.6							
5:00	310	295	0	14.5	268	297	100	5.6	45	55	44	30.33	25	SE	
5:15	312	297	0	14.7	265	296	100	5.7							Completed outlet test at 5:15.
5:30	311	296	0	14.6	260	293	100	5.6							
5:45	304	290	0	14.1	265	295	100	5.6							2nd inlet test completed at 5:49.

(continued)

TABLE 3-4 (continued)

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
6:00	286	273	0	13.1	265	302	100	5.6	42	52	40	30.34	22	SE	Clear skies. V.E. readings taken.
6:15	288	275	0	13.4	275	307	100	5.7							
6:30	291	278	0	13.5	270	300	100	5.6							Plant shut down for day.

Notes:

1. Conventional surface mix.
2. Visible emission reading taken on this date.
3. 1st inlet test invalid due to torn filter.
4. 2nd inlet test invalid due to leaks in sampling train.
5. Fuel feed rate = 7.75 gal/min at 100 percent burner capacity.
6. Aggregate moisture content = 2.0 percent.

TABLE 3-5. PROCESS AND CONTROL INFORMATION--SEPTEMBER 26, 1984

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
9:15	308	294	0	14.3	278	310	100	5.5	38	41	76	30.50	5	NW	Cloudy skies. No V.F. readings taken.
9:30	305	291	0	14.0	275	312	100	5.6							Outlet test begun 9:32.
9:45	305	291	0	14.5	272	305	100	5.5							
10:00	307	293	0	14.3	268	300	100	5.5							Inlet test begun 10:07.
10:15	309	295	0	14.3	266	300	100	5.7	38	43	63	30.52	5	NW	Cloudy skies. No V.E. readings.
10:30	307	293	0	14.1	265	295	100	5.6							
10:45	309	295	0	14.0	260	295	100	5.7							Collected aggregate sample at 10:45.
11:00	307	293	0	14.0	260	290	100	5.5							Inlet test completed at 11:02.
11:15	304	290	0	14.2	270	310	100	5.6	39	45	58	30.50	10	NW	Cloudy skies. No V.E. readings.
11:30	302	298	0	13.9	265	298	100	5.6							
11:45	297	283	0	13.7	265	297	100	5.5							
12:00	301	287	0	13.9	265	300	100	5.5							Outlet test completed at 11:54.
12:30	297	283	0	13.8	270	302	100	5.5	39	47	47	30.48	10	NW	Cloudy skies. No V.E. readings.

Notes:

1. Conventional surface mix.
2. Visible emissions not read due to cloudy skies.
3. Plant down from 12:39-2:00 for repairs (chain off vane feeder).
4. Production rate lowered at 2:00 to control dust at dust return vane feeder.
5. Cancelled test in afternoon due to low production rate and short projected run time.
6. Aggregate moisture content = 2.4 percent.

TABLE 3-6. PROCESS AND CONTROL INFORMATION--SEPTEMBER 27, 1984

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
9:00	268	255	0	12.5	270	305	40	4.7	44	46	86	30.30	5	N	Cloudy skies. No V.E. readings. Inlet test begun 9:04. Outlet test begun 9:06.
9:15	269	256	0	12.5	265	302	45	4.8							
9:30	268	255	0	12.0	300	340	30	4.8							
9:45	265	253	0	12.4	270	300	40	4.8							
10:00	269	254	0	12.6	265	300	40	4.8	46	49	80	30.33	5	N	Cloudy skies. No V.E. readings.
10:15	270	258	0	12.8	265	300	45	5.3							Aggregate sampled at 10:15.
10:30	269	256	0	12.8	270	306	45	5.4							
10:45	268	255	0	12.7	265	295	45	5.1							Production rate lowered due to bulldozer problems. Test stopped from 10:45-2:00.
1:45	264	252	0	12.3	280	308	40	5.6							
2:00	258	246	0	12.2	270	298	40	5.2	46	51	68	30.33	5	N	Cloudy skies. No V.E. readings. Inlet test complete at 2:08.
2:15	269	256	0	13.1	275	310	40	4.9							Plant production rate down from 2:21 until about 3:00 due to bulldozer problems. Plant down from about 3:15-3:30 due to loss of air pressure. Test stopped from 2:21 until 4:03.
3:35	271	258	0	12.9	250	260	50	4.8							
4:00	273	260	0	12.5	265	300	50	5.0	46	54	54	30.33	2	E	Cloudy skies. No V.E. readings.

(continued)

TABLE 3-6 (continued)

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
4:15	276	263	0	12.8	268	295	52	5.0							
4:30	274	262	0	12.1	268	298	50	4.9							
4:40	273	259	0	12.6	265	298	55	4.9							Outlet test complete at 4:41.

<u>Notes</u>:

1. Conventional surface mix.
2. No visible emissions read due to cloudy skies.
3. General production rate lower on this date due to problems with the bulldozer that was used to load aggregate into the feed bins. Test was stopped during two periods when production rate was below 260 tph.
4. Plant down from about 3:15 until 3:30 due to plant air pressure loss.
5. Aggregate moisture content = 3.3 percent.

TABLE 3-7. PROCESS AND CONTROL INFORMATION--SEPTEMBER 28, 1984

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
8:00	354	173	171	10.1	320	280	100	4.8	35	38	71	30.45	5	SE	Cloudy skies. No V.E. readings.
8:15	340	170	160	10.3	320	290	100	4.4							1st outlet test began 8:15. 1st inlet test began 8:15. 1st inlet test began 8:20.
8:30	331	165	166	10.0	320	286	100	4.5							Plant down at 8:38 due to truck shortage.
9:11	326	168	158	10.2	303	290	100	4.0	37	40	67	30.50	8	SE	Clearing skies. Test restarted. Collect aggregate sample at 9:20. Collect RAP sample at 9:25.
9:30	331	165	156	10.3	315	280	100	4.9							Plant down 9:34-10:17 due to truck shortage.
10:25	338	162	166	9.7	348	305	85	4.0	39	45	58	30.52	10	SE	Restart test. Partly cloudy skies. V.E. reading begun at 10:30.
10:35	317	155	152	9.6	355	308	75	4.0							
10:45	321	158	153	9.5	350	285	70	4.0							Complete 1st inlet test at 10:43.
11:00	319	154	155	9.2	350	281	75	4.3							
11:15	309	150	150	8.7	355	295	70	4.2							
11:30	320	150	160	9.2	349	280	65	4.1	39	47	47	30.52	20-25	S	Partly cloudy skies. V.E. readings taken.
11:45	310	150	150	9.1	348	295	60	4.5							
12:00	322	154	158	9.4	347	281	75	4.6							Complete 1st outlet test at 12:04.
12:15	306	145	153	8.3	355	297	75	4.6							

(continued)

TABLE 3-7 (continued)

Time	Production rate, tph	Aggregate, tph	RAP, tph	AC, tph	Baghouse inlet temp., °F	Mix temp., °F	Burner setting, %	ΔP, in. w.c.	Temp. Wet	Temp. Dry	Relative humidity	Barometer, in. Hg	Wind Speed, mph	Wind Dir.	Comments
12:30	319	154	155	9.5	350	295	78	4.7	40	49	43	30.52	25	S	Scattered clouds. 2nd outlet test began 12:31.
12:45	312	151	152	9.2	348	295	74	4.7							
1:00	309	145	155	8.5	350	295	70	4.7							Complete 2nd inlet test at 1:02.
1:15	310	150	152	8.3	345	295	74	4.7							
1:30	313	150	154	9.1	342	290	72	4.7	40	49	43	30.50	25-30	S	Clear skies. Asphalt cement sample taken at 1:30. Begin 3rd inlet test at 1:34.
1:45	306	150	147	9.1	348	294	72	4.9							Aggregate sample taken at 1:55. RAP sample taken at 1:58.
2:00	307	149	149	9.1	340	285	72	5.1							
2:15	315	152	154	9.3	347	284	72	4.7							3rd inlet test completed at 2:29.
2:30	305	147	155	9.1	345	292	79	5.0	40	49	43	30.48	25	S	Scattered clouds.
2:45	301	148	150	8.9	348	288	79	4.8							
2:50	301	150	142	9.1	345	280	79	5.0							Complete 2nd outlet test.

Notes:

1. 50 percent RAP mix.
2. Visible emissions reading taken after 10:30.
3. Three inlet and two outlet tests performed on RAP mix.
4. Two aggregate and two RAP samples taken on this date. Aggregate moisture content = 6.2 percent and 1.7 percent. RAP moisture content = 2.0 percent and 4.3 percent.

(see Section 3.1.1). On September 27, the production rate was lowered to about 270 tons/h due to problems with the loader that was used to fill the feed bins. Assuming 310 tons/h as the maximum production capacity of the plant, then 270 tons/h is 87 percent of capacity.

The baghouse inlet temperature was measured by a thermocouple in the duct between the drum and the baghouse. The mix temperature was measured by a thermocouple at the lower exit end of the drum. It should be noted that the mix temperature for mixes containing RAP is approximately 20° or 30°F lower than that for conventional mixes. Plant personnel reported that a lower mix temperature is usually maintained for RAP mixes to minimize smoking. It should also be noted that while the baghouse inlet temperature is generally lower than the mix temperature when conventional mixes are produced, the reverse is true when RAP mixes are produced. Plant personnel reported that a thermocouple on the drum typically indicated a mid-drum temperature of 600° to 700°F when RAP mixes were produced. However, this thermocouple was inoperable during the test period.

The burner was operated at or close to 100 percent of capacity during most of the test period. A fuel burning rate of 7.75 gal/min of No. 5 fuel oil was reported by plant personnel while the burner was at 100 percent of capacity. This fuel rate was read off a flow meter at the burner. Due to the inaccessability of this flow meter and for safety reasons, only the percent of burner capacity was recorded during testing.

The pressure drop across the baghouse was recorded from a water manometer mounted on the baghouse. This pressure drop varied from 4.0 to 5.8 in. w.c. The low pressure drops were observed during periods of low production or while RAP mixes were being produced. These periods presumably corresponded to periods of lower particulate loading on the filter.

Aggregate sieve/screen analyses and other data on the product mixes Produced on September 24, 25, 26, 27, and 28 are given in Table 3-8. It should be noted that penetration grade 85-100 asphalt cement was reportedly used with conventional mix, and penetration grade 120-150 asphalt cement was reportedly used with RAP mix. Samples of both asphalt cements were taken to determine their viscosity at 140°F and smoke points. Conventional mixes were produced on the first 4 days of testing and were used on the roadway surface. A 50 percent RAP mix was produced on the last day of testing and was used on the shoulder surface. The sieve/screen analysis indicates that the RAP mix contains less material that is greater than 3/8 in. or that is fine enough to pass a No. 200 sieve than does the conventional mix. Plant personnel reported that less of the very fine virgin aggregate is used in RAP mixes than in conventional mixes.

The stack from the baghouse was continuously observed during the testing. Although a steam plume developed when the ambient temperature was below about 50°F, it had no affect on visible emission readings.

A large amount of dust was emitted from the dust return system under the baghouse. This was caused by an overloading of this dust return system and leaks in the dust return auger and pipe. Additional airborne particulate

TABLE 3-8. PRODUCT ASPHALT ANALYSIS

Date	9/24/84	9/25/84	9/26/84	9/27/84	9/28/84
Mix type	Conventional surface	Conventional surface	Conventional surface	Conventional surface	50% recycle
Asphalt grade, penetration	85-100	85-100	85-100	85-100	120-150
Percent asphalt in mix	5.49	4.93	5.02	5.42	5.86
Mix temp., °F	310	310	310	310	290
Sample No.	1	2	3	4	5

Aggregate sieve/screen analysis, % retained

Sample	1	2	3	4	5
1-1 1/4 in.					
1 in.					
3/4 in.		4.6			
3/8 in.	10.9	16.1	16.5	16.5	8.8
No. 4	24.1	29.2	28.9	28.5	29.6
No. 10	51.6	55.0	55.2	54.5	61.9
No. 50	81.6	83.5	83.2	82.6	86.5
No. 100	87.0	88.8	88.5	88.8	91.9
No. 200	89.8	91.2	90.9	89.6	94.7

matter was also observed blowing off the virgin aggregate storage piles and neighboring fields. These were taken into consideration while the visible emissions were being observed.

3.3 TESTING INFORMATION

The sampling crew from GCA set up equipment and prepared for the test on Saturday and Sunday, September 22 and 23. Due to a last minute schedule change by Western, which MRI was not informed of, the plant produced RAP mix on part of Friday and all of Saturday and Sunday, September 21, 22, and 23. This drastically reduced the available RAP material before testing could begin on Monday, September 23. Plant personnel reported that their contract with the State required that they use all RAP material before conventional mix could be substituted for RAP mix. Although Tom Wagoner, Plant Manager, requested a waiver of this requirement through Pat Pattison, Vice President of Western, the State of Nebraska would not grant a waiver. Because of the diminished RAP supply, one Method 5E test at the outlet of the baghouse and all Polynuclear Aromatic Hydrocarbon (PAH) tests were cancelled.

One Method 5E test at the baghouse inlet and one at the baghouse outlet were performed while the plant was producing conventional mix on Monday, September 24. Weather prevented additional testing on this date.

On Tuesday, September 25, one Method 5E test was run at the outlet, and two Method 5E tests were run at the inlet. Both inlet tests were invalid, however, due to a torn filter on the first run and sampling train leaks on the second run. Only conventional mix was produced on this date.

On Wednesday morning, September 26, one Method 5E test at the baghouse inlet and one at the baghouse outlet were performed while the plant was producing conventional mix. The production rate was lowered in the afternoon to help control overloading of the dust return vane feeder system and the resulting dumping of dust under the baghouse. Due to this lower production rate and projected short plant operating time, no tests were performed on Wednesday afternoon.

On Thursday, September 27, one Method 5E test at the baghouse inlet and one at the outlet were completed. Only conventional mix was produced on this date. As discussed in the process monitoring section of this report, the production rate on this date was lower than that during previous testing. The test was stopped during periods when the production rate dropped below 80 percent of the 310 tons/h capacity observed on September 23, 24, and 25. The plant was also down during part of this day due to a loss of air pressure. The loss of air pressure was caused by a stuck valve in the pulse cleaning mechanism in the baghouse. Compressed air is used throughout the plant to control various gates and valves.

On Friday, September 28, two Method 5E tests were run at the baghouse outlet, and three Method 5E tests were run at the baghouse inlet while 50 percent RAP mix was produced. Due to inadequate RAP material, additional testing was not possible.

The production rate on this date was lowered by about 7 percent at about 10:30 a.m. in order to balance plant production with demand by the paving crew and to slow depletion of the RAP stockpile and thus allow collection of a maximum amount of test data without jeopardizing the quality of the data.

SECTION 4.0

SAMPLING LOCATIONS

A diagram of Western Engineering Company's asphalt cement process is presented in Figure 4-1. The approximate location and the parameters measured at each sampling location is also included in this figure. This section contains a description of the sampling locations used for this emission test program.

4.1 BAGHOUSE INLET SAMPLING LOCATION

Uncontrolled emissions were measured in the duct work between the knockout chamber and the baghouse. The flue gas exits the knockout chamber through a 54" diameter duct. This duct creates a 180° arc between knockout and baghouse as shown in Figure 4-2. A preliminary velocity profile showed minimal cyclonic flow. However, stratification of particulate against the outside wall of the duct was possible. Sampling for particulate, flow rate, moisture, TOC and CO_2-O_2 was performed at the baghouse end of the duct before it diverged into the baghouse. This location was the only possible sampling location. It was 6" upstream and 6" downstream from closest flow disturbances requiring 24 sampling point as per EPA Method 1. Figure 4-3 depicts sampling points for this duct.

4.2 BAGHOUSE OUTLET SAMPLING LOCATION

Controlled emission samples were collected at the outlet stack. Flue gas was drawn through the baghouse by an induced draft fan and exited the fan through a flow control damper located just downstream as depicted by Figure 4-4. The gas then traveled vertically up a 12' rectangular stack. The sampling ports were located 8 ft downstream of the flow control damper and 4 ft upstream of the stack exit. Figure 4-5 shows the seven, 3-inch sampling ports located in the long side of a 39.5 by 52 inch rectangular stack. These ports were used for particulate, TOC, orsat, gas flow rate and moisture measurements.

4.3 VISIBLE EMISSION OBSERVATIONS

Visible emission readings were conducted, at the outlet stack during the sampling runs. However, background interference limited the number of runs that have concurrent readings. Approximately 3 hours of reading were

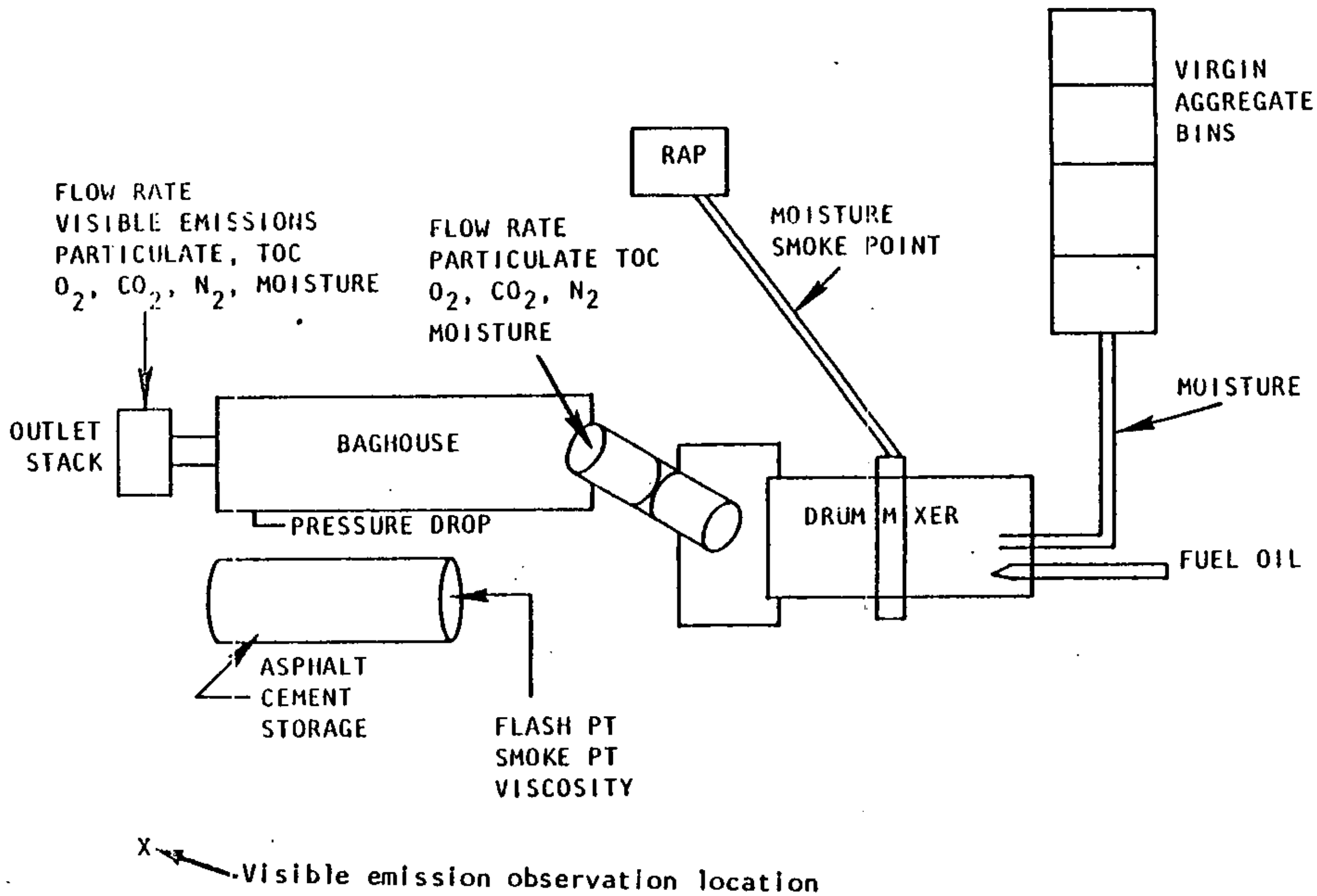


Figure 4-1. Sampling locations and parameters.

Sampling Conducted for:

- particulate
- TOC
- O_2, CO_2, N_2
- Moisture
- Flow Rate

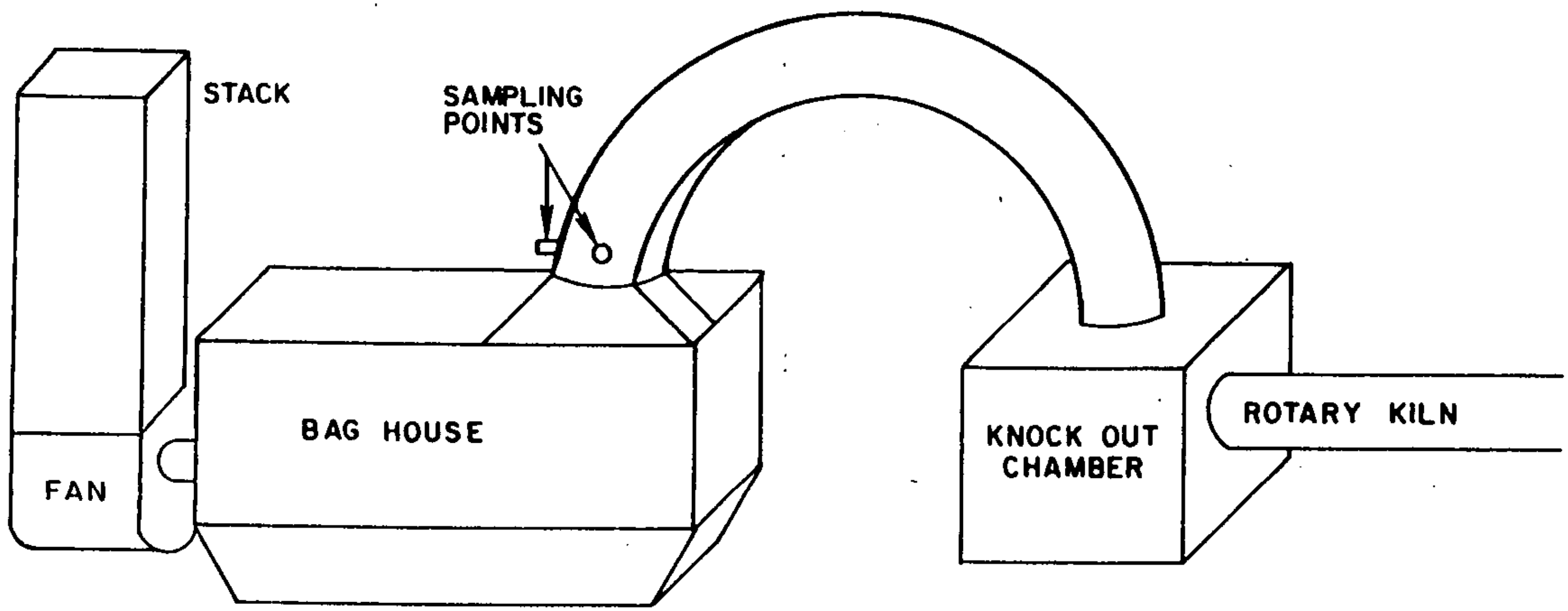


Figure 4-2. Baghouse inlet location.

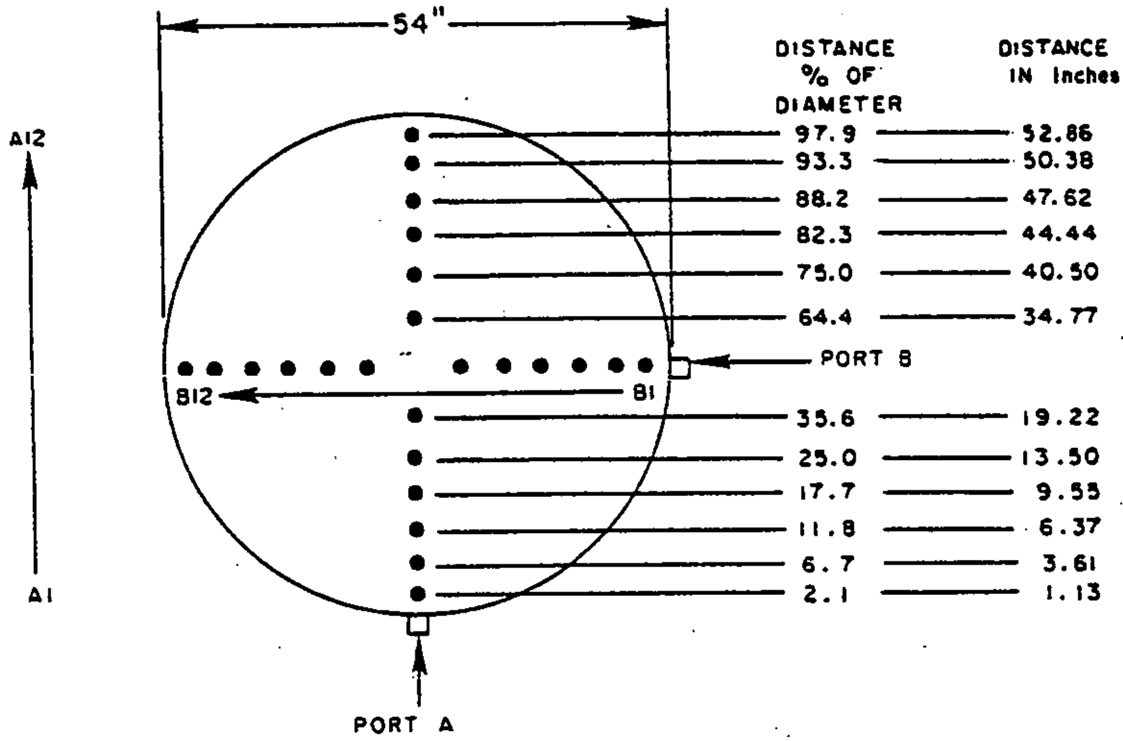


Figure 4-3. Baghouse inlet sampling points.

Sampling Conducted for:

- particulate
- TOC
- O_2, CO_2, N_2
- Moisture
- Flow Rate

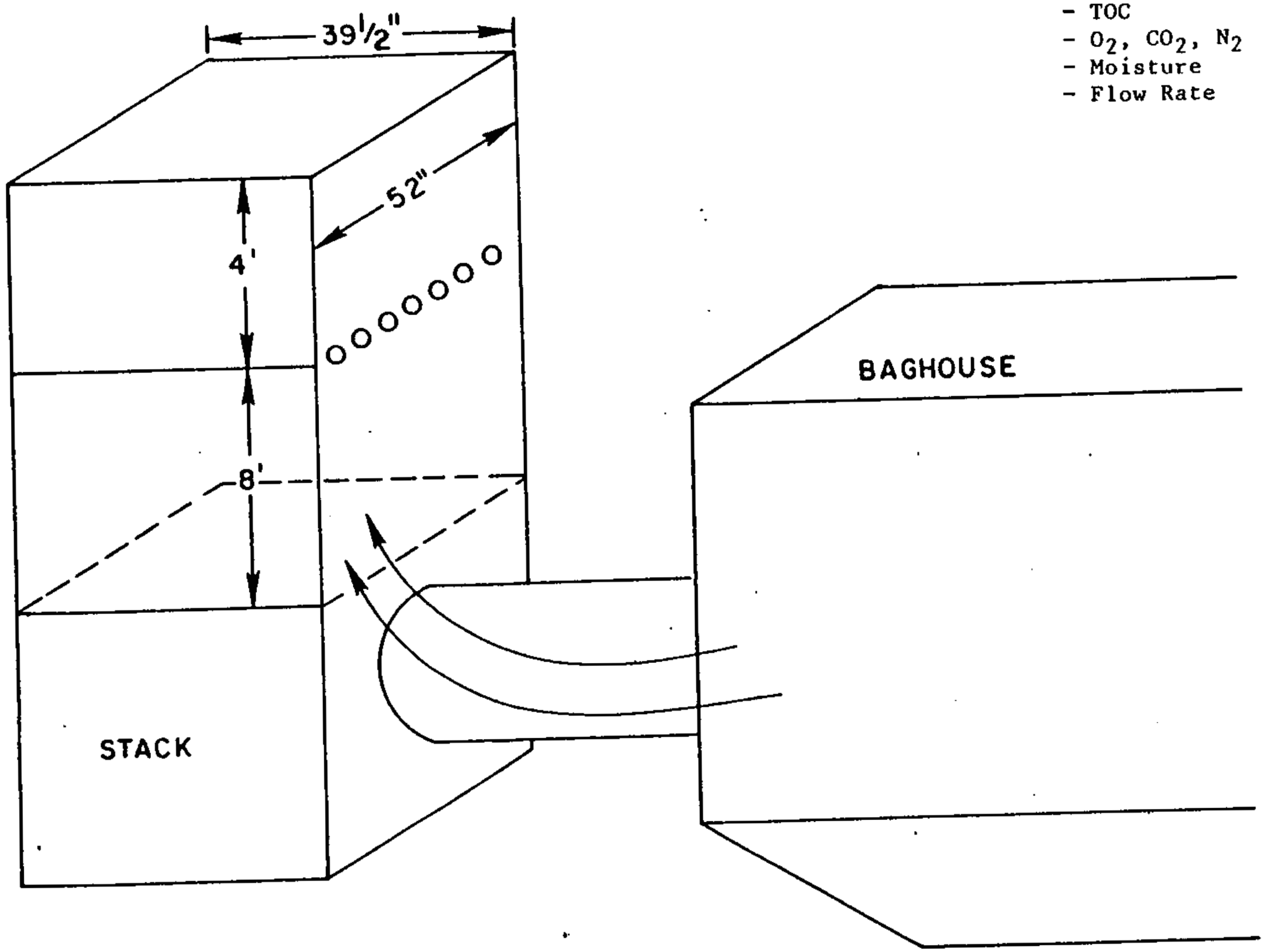


Figure 4-4. Baghouse outlet sampling location.

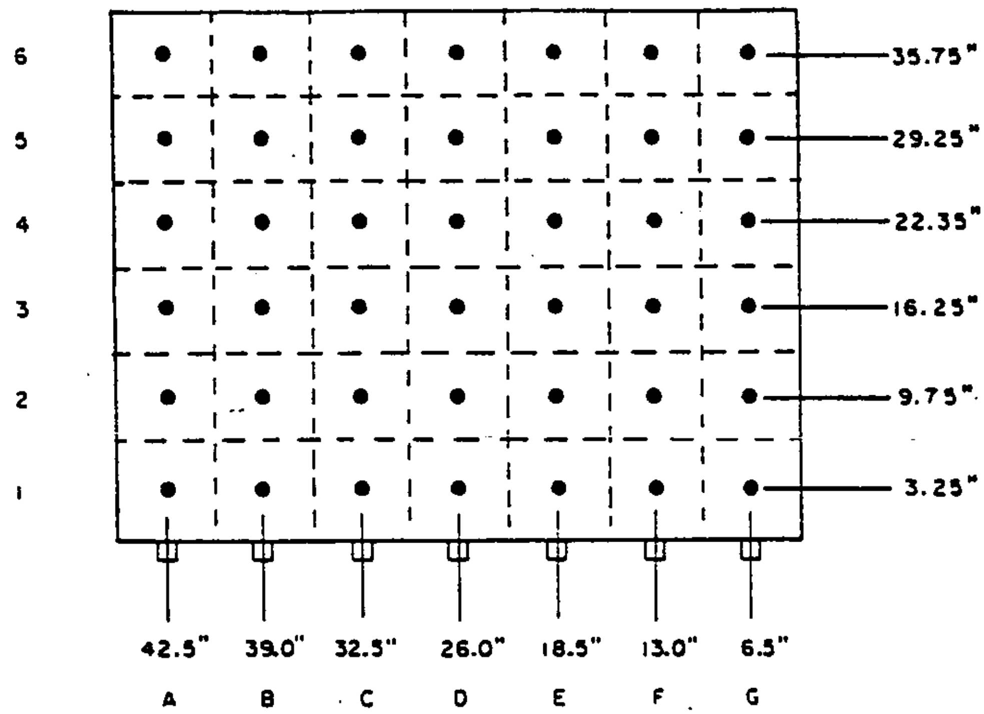


Figure 4-5. Baghouse outlet sampling points.

performed during each production mode as weather permitted. Figure 4-1 shows the approximate location of the observer in relation to the outlet stack during the visible emission readings.

4.4 PROCESS SAMPLE COLLECTION AND MONITORING LOCATIONS

Grab samples of virgin aggregate and recycled asphalt pavement were taken directly off their respective conveyor belts. Figure 4-1 depicted the locations of these belts along with, the sampling locations for asphalt cement and fuel oil. The pressure drop across the baghouse was monitored from a U tube manometer located on the support structure of the baghouse. This manometer was intalled by GCA because the original gauge was unreadable.

SECTION 5.0

SAMPLING AND ANALYTICAL EQUIPMENT AND PROCEDURES

GCA utilized several different sampling procedures to meet the goals of this test program. These techniques included EPA Methods 1 through 5E, Method 9 for visible emission and discrete grab sampling of raw materials. Each procedure is discussed in the following subsections.

5.1 EPA REFERENCE METHODS

5.1.1 Method 1, Traverse Points

Sample traverse points for particulate sampling were determined in accordance to 40CFR60. This was performed using the most recent revision to the method as defined in the Federal Register of September 30, 1983.

5.1.2 Method 2, Velocity and Volumetric Flowrate

A Type-S pitot tube and attached thermocouple was used to determine velocity and volumetric flowrate of the flue gas streams being sampled. This assembly was calibrated as required by the method.

5.1.3 Method 3, Fixed Gases, Excess Air and Dry Molecular Weight

Gas analysis was conducted using a stainless steel sampling probe attached to the Method 5E probe. A gas sample was collected by means of a one way hand pump. The stainless steel sample line was purged prior to the collection of the sample. An integrated sample was collected into a Tedlar bag and analyzed with an Orsat analyzer in accordance with EPA Method 3. Ambient air checks were performed before each orsat analysis as a QC check.

5.1.4 Method 4, Moisture Determination

The moisture determination of the flue gas was performed in conjuncton with the Modified Method 5E tests. The increase in volume of the impingers was used to calculate percent moisture of the gas stream. In addition to this, a wet bulb/dry bulb apparatus was used in conjunction with a psychrometric chart to determine the relative humidity of the flue gas at the inlet and outlet of the baghouse unit. The wet bulb/dry bulb apparatus consisted of two thermocouples attached along side each other. The front end of the first thermocouple extended out about 3 inches further than the second thermocouple. A cloth sock was placed tightly over the front 2 inches of the first thermocouple (wet bulb). Prior to sampling, the cloth sock was saturated with water. The two thermocouples were then inserted into the center of the duct and the temperature of the wet bulb thermocouple was monitored. After the temperature of the wet bulb thermocouple stabilized (reaches equilibrium), the temperature of the dry thermocouple was measured.

5.1.5 Method 5E, Particulate/TOC Concentrations

Reference Method 5E was utilized to collect particulate matter and total organic carbon simultaneously from each of the two flue gas sampling locations, concurrently.

The RAC Stacksamplr™ Method 5E sampling train features: a stainless steel buttonhook nozzle; the required probe with pitot tube and thermocouple attached (as per Method 5 revision of August 18, 1977) and a heated glass liner with a thermocouple connection; a 4-inch glass filter holder containing a Reeve Angel 934 AH glass fiber filter which has a collection efficiency of greater than 99.99 percent, a heated filter hot box with temperature controller and thermocouple unit attached to the back half of the glass filter holder (250 ±10°F), four glass impingers, the first (modified) and second (plated) both containing 100 ml 0.1N NaOH, the third (modified) empty, and the fourth (modified) containing preweighed silica gel; a leakless lubricated vane pump; dry gas meter; and an orifice meter. A schematic of the Method 5E train is shown in Figure 5-1.

A leak check of the entire sampling train was conducted prior to and at the conclusion of each sampling run, and before and after changing or disconnecting any components of the train during the run. Leak checks before the test run and after changing any constituent were conducted at 15-inch Hg vacuum to ensure a leak rate of no more than 0.02 cfm. Leak checks conducted at the end of a run, and prior to making any component changes or disconnecting them to facilitate recovery, were at or above the highest vacuum obtained during the run. The pitot tube assembly were also leak checked prior to and after each sampling run to ensure validity of the velocity data. Cyclonic flow angles were also checked at the inlet to the baghouse prior to the sampling program.

All Method 5E sample recoveries were performed in the GCA High Cube Truck. The sample recovery sequence was as follows:

1. The front-half of the sample train, comprised of the nozzle, probe and front-half of the filter holder was rinsed and brushed three times with spectro grade acetone. (Water was not used as a first rinse as per the request of the EPA Task Officer. This was a modification of Method 5E.) The sample was stored in a precleaned 500 ml amber glass container, sealed and labeled as -FH.

2. The particulate filter and any particulate adhering to the filter holder was removed and placed in its original plastic petri dish. This dish was sealed and labeled as -PF.

3. The contents of each impinger was measured for volume increase, then transferred to precleaned amber glass sample containers. The impingers were then rinsed with 0.1N NaOH. These samples were labeled as -IMP 1 and -IMP 2+3.

4. The impingers, back half filter holder and connecting glassware was then rinsed 3 times with spectro grade acetone. This was stored in another 500 ml amber glass container and labeled -BH.

5. The silica gel impinger was reweighed for moisture gain.

6. After recovery all glassware was flushed three times and rinsed with distilled, deionized water. Then it was baked in a drying oven for 1 hour at 100°C. Following this cleaning procedure, the glassware was reassembled for the next test.

7. Field bias blanks of the acetone, DDI water, filter and 0.1N NaOH were collected prior to the start of the flue gas testing program.

8. The liquid level was marked on all containers.

9. All samples were logged on GCA Chain of Custody Record Form.

10. Stored in cooler for transport.

5.1.6 Method 9, Visible Emissions

Visible emissions from the baghouse outlet were conducted when the conditions permitted. Readings were recorded every 15-seconds during each test period. The plume observer noted the location and distance from the stack that the observations were made. Readings were made by a certified observer. The results are presented as 6-minute averages. The decision to observe the stack plume was made solely by the onsite EPA Task Officer on a test-by-test basis.

5.1.7 Process Stream Sampling

Grab samples were collected from the two conveyor belt streams, the asphalt cement tank and the fuel oil tank. Approximately 2-3 gallons of material from the conveyor belts was collected during each emission run, quartered and the two opposing quarters taken for a 1 gallon sample. Two asphalt cement samples was taken directly from a tank truck. The fuel oil sample was obtained from the storage tank. The analyses conducted on these samples consisted of moisture content in the virgin aggregate and the RAP samples, smoke point for the RAP sample, flash point, smoke point and viscosity on the asphalt cement. The fuel oil is being held pending analysis.

The pressure drop across the baghouse was monitored by MRI personnel utilizing a U-tube manometer installed by GCA. Existing equipment proved faulty nessecitating the installation.

5.2 ANALYTICAL PROCEDURES

The test program produced samples from Method 5E for particulate matter and total organic carbon (TOC), moisture content for virgin aggregate and recycled asphalt pavement samples, viscosity, flash and smoke points for the asphalt cement and smoke point for the RAP samples. A description of each analytical procedure is outlined below.

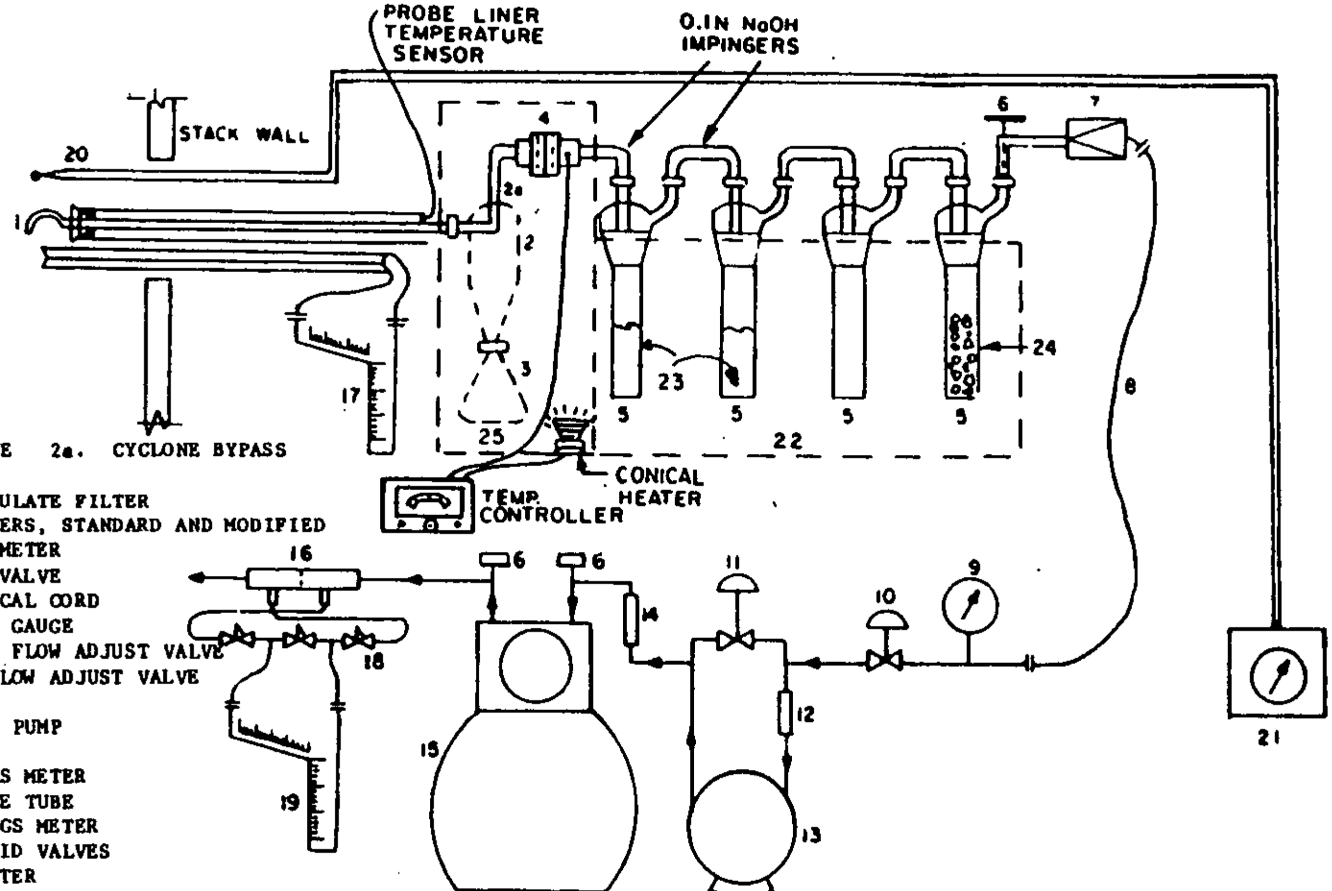
- Method 5E - Particulate--Gravimetric analysis conducted as per EPA reference Method 5 and reference Method 5E. See Figure 5-1 for a breakdown of this train.

- Solids Moisture Analysis--During each particulate and TOC run, one sample of the virgin aggregate and recycled asphalt pavement was collected for moisture analysis. The samples were collected in plastic containers and taken directly to the onsite mobile laboratory for moisture analysis. In the mobile lab, approximately 200 grams of the material was weighed into a tared beaker and dried overnight at 105°C. The remaining sample was placed into 1-gal metal cans. The sample is then desiccated and weighed to within 0.01 gram.

- Flash and Fire Points on Asphalt Cement--An aliquot of the asphalt cement sample analyzed to determine the Flash and Fire points as required by ASTM Designation D92-78.

- Smoke Point for Recycled Asphalt Pavement (RAP)--A reference or standard test procedure for the smoke point has not been established. The smoke point for RAP was conducted as per procedures provided by the EPA Task Officer. Each sample was dried in a 140°F oven to constant weight. 500 grams of sample was placed into a sample bowl. Heat was then applied so that the rate of temperature rise of the sample was 25°F to 30°F per minute. When the temperature of the sample reached 250°F, the heat was decreased so that the rate of temperature rise was only 5 to 10°F per minute. The temperature at which the material starts to smoke was recorded as smoke point.

- Viscosity--The asphalt cement samples were analyzed by E. W. Saybolt Company. The samples were analyzed in accordance with ASTMD 2171 using a vacuum viscometer.



1. PROBE
2. CYCLONE 2a. CYCLONE BYPASS
3. FLASK
4. PARTICULATE FILTER
5. IMPINGERS, STANDARD AND MODIFIED
6. THERMOMETER
7. CHECK VALVE
8. UMBILICAL CORD
9. VACUUM GAUGE
10. COARSE FLOW ADJUST VALVE
11. FINE FLOW ADJUST VALVE
12. OILER
13. VACUUM PUMP
14. FILTER
15. DRY GAS METER
16. ORIFICE TUBE
17. HASTINGS METER
18. SOLENOID VALVES
19. MONOMETER
20. THERMOCOUPLE
21. PYROMETER
22. ICE BATH
23. 0.1N NaOH
24. SILICA GEL DESICCANT
25. HOT BOX

Figure 5-1. Particulate and TOC sampling train.

SECTION 6.0

QUALITY ASSURANCE

A Test/QA Plan was prepared on September 18, 1984 for this test program. Most of the procedures described in the Test/QA Plan were followed. Any deviations from these procedures are noted in this section.

6.1 CALIBRATION PROCEDURES

Calibration of the field sampling equipment was performed prior to, and at the conclusion of the field sampling effort. Copies of the calibration sheets were submitted to the field team leader to take on-site, and for the project file. Calibrations were performed as described in the EPA publication "Quality Assurance Handbook For Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, EPA-600/4-77-027B." Equipment calibrated included the sample metering system, thermocouples, pitot tubes, and nozzles.

6.2 SAMPLE CHAIN OF CUSTODY

GCA follows sample custody procedures based on EPA recommended source sampling procedures. Appendix E presents custody record sheets. The importance of uncontaminated reagents, collection media and sample containers in collecting valid samples was well recognized by GCA. The collection media actually became part of the sample itself.

6.2.1 Field Operations

Preprinted sample tags were used to ensure the required information is entered in the field. Each sample, duplicates and blanks had a completely filled-in sample tag securely attached. Samples were then sealed with tape and the level marked on the container. All samples were logged in the field sample log. Samples were the transported in coolers or trunks which were in the custody of GCA field crew members.

6.2.2 Laboratory Operations

Upon arrival at GCA, the samples and their chain of custody sheets were submitted to the Sample Bank Manager. Each sample was logged into a large bound master log and assigned a GCA Control Number, which was unique to that sample, identifies it and follows it through all operations. All samples were locked in the GCA Sample Bank until required. The Sample Bank Manager initiated a page for each sample in the custody notebook and ensured that each handling of the sample was documented. Each analyst working with the sample provided a record of such actions in the custody book, thereby maintaining the chain of custody on the original sample.

In addition, 39 samples were delivered to Pollution Control Science Inc. in Miamisburg, OH, by two members of the GCA field crew, for TOC analysis. The samples were all contained in 500 ml amber glass bottles and were received immersed in ice. Sample bottle label information was transferred to chain-of-custody forms and were entered into the PCS laboratory log and each bottle assigned a five digit PCS sample number. The samples were then stored at 4°C until removed for analysis.

6.3 DATA REDUCTION AND VALIDATION

Extensive QC measures were used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data was a primary goal in this project.

6.3.1 Data Reduction

Standardized forms were used to record sampling and analysis data. All forms were filled in by the technician performing the work, then checked and initialed by other project participants. Figure 6-1 shows the data flow scheme for this project.

Data reduction performed in the field was limited to EPA Method 5E Testing. Check runs for sample volume, moisture and associated parameters were performed to determine percent isokinetics. Most data reduction was performed using a Compaq portable computer.

6.3.2 Data Validation

Data validation is the process of filtering data and accepting or rejecting it on the basis of sound criteria. Supervisory and QC personnel used validation methods and criteria appropriate to the type of data and the purpose of the measurement.

The following criteria were used to evaluate data:

- Use of approved test procedures.
- Steady-state operation of the process being tested.
- Use of properly operating and calibrated equipment.
- Use of reagents that have passed QC checks.

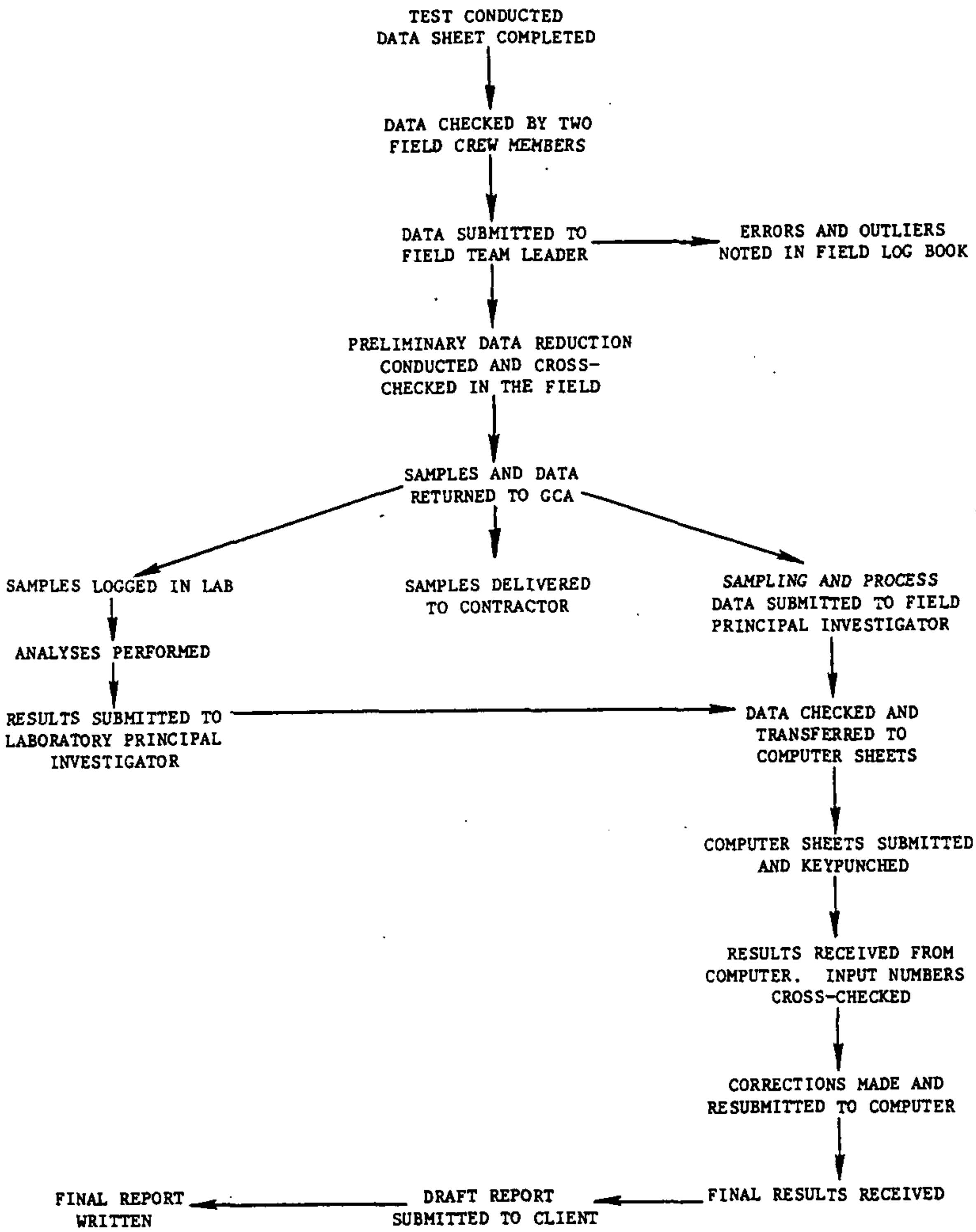


Figure 6-1. Data flow scheme.

- Proper chain of custody maintained.
- Collection of the proper amount of particulate on substrates.
- Collection of the required blanks.

All preliminary data and Rough Draft Reports were edited and checked to insure that the data presented were accurate and had not been transposed or misplaced.

6.4 SAMPLING QC PROCEDURES

The following QC checks were used during the source testing segment of this project.

- <u>Method 2 - Velocity, Flowrate</u>
  - Required use of calibrated pitot tubes
  - Check for cyclonic flow
- <u>Method 3 - Dry Molecular Weight</u>
  - Orsat analysis were conducted in accordance to EPA Method 3
  - The analyzer was leveled and purged with sample gas prior to each analysis
  - Ambient air checks were conducted
  - Analyses were repeated until values agreed within 0.3 percent
- <u>Method 5E - Particulate</u>
  - Sampling was conducted in accordance to Method 5E with modifications as instructed by the EPA Project Officer
  - All appropriate method and field-bias blanks were collected
  - Field bias information can be found in Appendix G
- <u>Method 9 - Visible Emissions</u>
  - The visible emission observer was certified within 6 months of the test program
  - VE's were conducted in accordance to Method 9 Guidelines

6.5 ANALYTICAL QC PROCEDURES

6.5.1 Gravimetric Determinations

- All samples were dessicated and weighed to a constant weight.
- Some gravimetric analyses were conducted in the field, however all applicable QC measures were observed.
- The balance used was checked with Class S weights before and after each weighing session.
- Temperature and relative humidity was recorded during each weighing session.

6.5.2 Total Organic Carbon

TOC sample were analyzed by PCS Inc. Included were 5 EPA audit samples. The results of these analyses are presented in Table 6-1. In addition, several samples were also analyzed in replicate to establish 95 percent confidence intervals. The results of these analyses are presented in Table 6-2.

6.5.3 Clean-up Evaluation

The clean up evaluation results for uncontrolled and controlled method blank trains are presented in Table 6-3. Both blank trains were analyzed for particulate and total organic carbon. The particulate analysis consisted of the weight gain from the filter and the front-half acetone rinse of the sampling train. For uncontrolled operations the front-half rinse consisted of the nozzle, the probe, the cyclone and the front half of the filter house. For controlled operations the front-half rinse consisted of the nozzle, the probe, the cyclone bypass and the front half of the filter house.

The total organic carbon analysis for uncontrolled and controlled operations consisted of a 0.1N sodium hydroxide rinse of the back half of the sampling train. This back-half rinse consisted of the three impingers, back-half filter holder, and connecting glassware for both uncontrolled and controlled operations.

6.5.4 Ignitability

An aliquot of p-xylene was analyzed as a quality control sample. The reported flash point was 28°C. The literature value is 27°C.

6.5.5 Smoke Point

At this time, there is no known quality control sample available to establish the accuracy of smoke point determinations.

TABLE 6-1. RESULTS OF EPA AUDIT SAMPLES PERFORMED BY PCS

Sample ID	Measured TOC (mg/l)	Reference Conc. (mg/l)	Percent Error
EPA-1	95.5	91.5	+4.2
EPA-2	9.6	6.1	+36.5
EPA-3	5.4	6.1	-11.5
EPA-4	96.0	91.5	+4.7
EPA-5	93.8	91.5	+2.5

TABLE 6-2. REPLICATE TOC ANALYSIS RESULTS

PCS Sample # / Test Run	46062-64 / 5-Outlet	47065-67 / 6-Inlet	46068-70 / 6-Outlet
Result 1 (mg/l)	260	125	263
Result 2 (mg/l)	260	113	203
Result 3 (mg/l)	260	200	253
Result 4 (mg/l)	250	105	265
Result 5 (mg/l)	180	215	219
Result 6 (mg/l)	180	190	212
Result 7 (mg/l)	209	105	195
Result 8 (mg/l)	240	125	239
Result 9 (mg/l)	160	104	219
Mean result (mg/l)	222	142	230
Std. Deviation (mg/l)	40.3	45.6	24.6
95% Confidence Interval (mg/l)	± 25.0	± 28.3	± 15.2

TABLE 6-3. SUMMARY OF CLEANUP RESULTS

Particulate total organic carbon blanks	Train 1 uncontrolled	Train 2 controlled
Front half		
Filter (mg)	0.21	0.14
Rinse (mg)	0.73	0.81
Back half		
Total organic carbon(mg)	10.35	12.24

6.6 SITE SPECIFIC QUALITY CONTROL

A new rinse procedure was developed for this test program. It was found in a previous test program that residual acetone remained in the impingers after rinsing, contaminating the total organic carbon samples. To alleviate this problem, additional steps were taken in the sample recovery procedure. The new rinse procedure is presented in Section 5.0 of this report. The new procedure was checked by setting up a sampling train, recovering it, then analyzing the impinger contents for TOC. This was done 3 times. A blank of the NaOH impinger solution was also checked. The results qualifying the new rinse procedure can be found in Table 6-4. Lab analysis sheets can be found in Appendix G.

6.6.1 Test Program Audit

A systems audit was conducted on the western engineering test program to check if appropriate QC measures were followed by the GCA field crew and staff members. The audit concentrated on adherence to the field test/QA plan prepared for the program. A copy of this audit report can be found in Appendix G.

6.7 DISCUSSION OF PROBLEMS WITH EMISSION TESTING

Several problems were encountered during the testing runs. During Run No. 1 at the uncontrolled location, the loading was very high. This required the filter to be changed a total of five times. Each time the filter was changed, the sample volume was noted and the entire system was leak checked. Due to the problems associated with the plugged filters this run was the only run that was out of the required isokinetic range. Isokinetics on this run were 89.1 percent just below the requied range of 90 to 110 percent.

During Run No. 2, the filter at the uncontrolled location ripped therefore voiding the sample for particulate measurement. This sample was still analyzed and presented in the tables. At the controlled location during Run No. 2, a very high vacuum was being drawn by the sample box. An investigation of this problem found that the orifice of a new Andersen, Greenburg-Smith plated impinger was too small causing a very high pressure drop. Locating this problem was time consuming and as a result, testing had to be terminated because production had stopped for the day. Approximately 75 percent of the sampling points were tested. These were the reasons for scheduling the additional conventional run (4).

Other difficulties encountered in the test program included:

- Filter holder did not contain wells for thermocouple.
- A fuse was blown in the sampling box during controlled Runs 3 and 6 controlled.
- A malfunction of the sampling pump during uncontrolled Run 4.

TABLE 6-4. RESULT OF RINSE PROCEDURES CHECK

Run No.	Impinger No.	Concentration mg/l
1	1	4.40
1	2	2.63
2	1	1.53
2	2	2.30
3	1	2.65
3	2	1.52
Probe rinse		1.50
NaOH blank		1.93

- A broken U-tube connector was replaced on Run 6 at the uncontrolled location.

- During Runs 4 and 5, testing had to be halted because plant production fell below the required 80 percent of capacity. Testing was restarted when plant production was appropriate. All of these minor difficulties and problems were dealt with promptly and had no effect on sampling results. The problems encountered are documented in the daily sampling log found in Appendix E.

6.8 DEVIATIONS FROM TEST/QA PLAN

Several deviations and alterations from the original test/QA plan were made. The first change was in the scope of work. Since the raw materials were in limited supply, only 2 recycle runs were recommended. In addition to this, no PAH testing was conducted. The next modification was to the sampling times at the uncontrolled location. Due to extremely high loading, the sampling time was cut from 72 minutes to 48 minutes. The test plan also stated that a wet bulb/dry bulb apparatus would be used to check moisture content. While this was the case, the wet bulb/dry bulb figures were used only as a cross check to the impinger volume increase.

Other deviations made included:

- The second impinger in each train was suppose to be a plated Greenburg-Smith impinger. In some cases, the orifice at the tip of these impingers sustained too high of a pressure drop. The best impingers were chosen and used for the remainder of the test program.

- Visible emission readings were not taken during all runs because of background interference.

- In the recovery of samples, instead of rinsing 6 times with spectrograde acetone, it was done only 3 times.

- TOC analysis was not performed by GCA. It was done by Pollution Control Science in Miamisburg, Ohio.

- Cyclonic flow checks were performed only at the inlet location.

- No baghouse dust was collected.

- No analysis was performed on the fuel oil sample.

All changes and modifications to the QA/Test Plan were accepted and approved by the onsite EPA Task Officer.

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