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# Asphalt Concrete Industry

# Emission Test Report T.J. Campbell Company Oklahoma City Oklahoma

## Volume 1

## Addendum

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# EMISSION TEST REPORT
# T.J. CAMPBELL ASPHALT CONCRETE PLANT
# OKLAHOMA CITY, OKLAHOMA

## Addendum

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# INTRODUCTION

This addendum presents revisions and new data to be included with the report, "Emission Test Report T.J. Campbell Company, Oklahoma City, Oklahoma" (EMB Report 83-ASP-4). The purpose of this addendum is threefold:

- to present smoke point/flash point results for the recycled asphalt pavement and asphalt cement which were not available when the report was published;
- to include total organic carbon (TOC) results determined according to the analytical protocol of EPA Method 5E; and
- to separate condensible hydrocarbons data from the extractable organics data presented in the report.

The term condensible hydrocarbons is new to the report. As explained in the original report, extractable organics are related to the gravimetric analysis of the ether/chloroform extract of the 0.1 N NaOH impinger solutions. The extractable organics results in the original report included the gravimetric analysis of the trichloroethane (TCE) rinse of the impingers glassware. In this addendum, condensible hydrocarbon results are from the gravimetric analysis of the TCE rinse. The gravimetric analysis results of the TCE rinse have been removed from the extractable organics presentation.

Because of the above revisions, several sections of the report have been rewritten. Section 2.2, Total Organic Carbon Results, has been revised to present TOC results determined by the EPA Method 5E analytical protocol. Tables 2-1, 2-2, 2-3, and 2-4 contain the revised TOC values. Section 2.3, Extractable Organics Emissions Results, contains results from the 0.1N NaOH impinger solution ether/chloroform extract only. Tables 2-7, 2-8, 2-9, and 2-10 contain the revised extractable organic emission results. Section 2.4, Comparison of TOC and Extractable Organic Emission Results, reflects the EPA Method 5E TOC results and ether/chloroform extract results. Section 5.2,

Analytical Methodology, discusses the new or revised methods for TOC and extractable organics analysis. Table 6-2 has been addended to include TOC quality control data for the 0.1N NaOH impinger solutions reanalysis.

In addition, three new sections have been added. Section 2.11 contains a discussion of the flash point and smoke point data which are presented in Table 2-24. Section 2.12 contains a discussion of the condensible hydrocarbon results which are presented in Table 2-25. Section 2.13 contains a comparison of the two analytical methodologies used to analyze the 0.1N NaOH impinger solutions for TOC. The data are presented in Table 2-26.

## 2.2 TOTAL ORGANIC CARBON RESULTS

Controlled and uncontrolled total organic carbon (TOC) mass samples were collected simultaneously with particulate mass samples using the modified EPA Method 5E sampling train. The TOC content of the 0.1N NaOH impinger and rinse solutions were analyzed directly using an instrumental technique. TOC results, identified in the data tables as the "back-half catch," are presented and discussed in this section.

### 2.2.1 Conventional Operation TOC Emission Results

Uncontrolled and controlled TOC results for conventional operation are presented in Table 2-1 (English units) and Table 2-2 (metric units). Uncontrolled TOC loadings were 0.242, 0.0512, and 0.0562 gr/DSCF for Runs C-1, C-2, and C-3, respectively. The controlled TOC loadings were 0.0410, 0.0501, and 0.0494 gr/DSCF for Runs C-1, C-2, and C-3, respectively. The TOC (back-half catch) collection efficiency of the wet venturi scrubber was 83.1, 0.39, and 15.0 percent for Runs C-1, C-2, and C-3, respectively.

### 2.2.2 Recycle Operation TOC Emission Results

Table 2-3 (English units) and Table 2-4 (metric units) present results of the uncontrolled and controlled TOC measurements performed during recycle operation. Uncontrolled TOC loadings were 0.0534, 0.0523, and 0.389 gr/DSCF for Runs R-1, R-2, and R-3, respectively. The controlled TOC loadings were 0.0643, 0.0421, and 0.0185 gr/DSCF for Runs R-1, R-2, and R-3, respectively. The TOC collection efficiency of the wet venturi scrubber was 6.65, 12.9, and 95.2 percent for Runs R-1, R-2, and R-3, respectively.

### 2.2.3 Discussion of TOC Test Results

The uncontrolled TOC loadings varied from 0.0521 to 0.242 gr/DSCF during conventional operation and from 0.0523 to 0.389 gr/DSCF during recycle operation. The controlled TOC loadings varied from 0.0410 to 0.0501

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

| Date | 11/12 | | 11/13 | | 11/14 | | Average | |
|---|---|---|---|---|---|---|---|---|
| Run Number | C-1 | | C-2 | | C-3 | | | |
| Type Emissions | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled |
| Scrubber Pressure Drop (in. $H_2O$) | 13.5 | | 13.4 | | 13.5 | | 13.5 | |
| Scrubber Water Flow Rate (GPM) | 219 | | 219 | | 215 | | 218 | |
| Production Rate (ton/hr) | 244 | | 235 | | 213 | | 231 | |
| Process Mix Type | B-Mix | | B/C Mix | | M-Mix | | --- | |
| Average Opacity (Percent) Mean, Range | 0 (0-1.5) | | 0 (-0-) | | N/A | | 0 | |
| Particulate and Total Organic Carbon (TOC) Results | | | | | | | | |
| Front Half Catch - Particulate (probe, cyclone, and filter) | | | | | | | | |
| mg-mass | 9360 | 172 | 10,800 | 244 | 6950 | 104 | 9040 | 173 |
| gr/DSCF | 7.60 | 0.0550 | 8.49 | 0.0814 | 5.58 | 0.0332 | 7.22 | 0.0565 |
| lbs/hr* | 762 | 5.53 | 910 | 8.29 | 599 | 3.45 | 757 | 5.76 |
| lbs/ton production | 3.12 | 0.0226 | 3.87 | 0.0353 | 2.81 | 0.0162 | 3.27 | 0.0247 |
| Collection Efficiency Percent** | 99.3 | | 99.1 | | 99.4 | | 99.2 | |
| Back Half Catch - TOC (impinger solutions and rinses) | | | | | | | | |
| mg-mass | 299 | 128 | 65 | 150 | 70 | 155 | 145 | 144 |
| gr/DSCF | 0.242 | 0.0410 | 0.0512 | 0.0501 | 0.0562 | 0.0494 | 0.116 | 0.0468 |
| lbs/hr* | 24.3 | 4.11 | 5.13 | 5.11 | 6.01 | 5.11 | 11.8 | 4.78 |
| lbs/ton production | 0.0995 | 0.0168 | 0.0218 | 0.0217 | 0.0282 | 0.0240 | 0.0498 | 0.0208 |
| Collection Efficiency Percent** | 83.1 | | 0.39 | | 15.0 | | 59.5 | |
| Total Catch | | | | | | | | |
| mg-mass | 9660 | 300 | 10,900 | 394 | 7020 | 259 | 9190 | 318 |
| gr/DSCF | 7.84 | 0.0961 | 8.53 | 0.132 | 5.64 | 0.0823 | 7.34 | 0.103 |
| lbs/hr* | 785 | 9.63 | 855 | 13.4 | 604 | 8.53 | 748 | 10.5 |
| lbs/ton production | 3.22 | 0.0395 | 3.64 | 0.0571 | 2.83 | 0.0400 | 3.23 | 0.0455 |
| Collection Efficiency Percent** | 98.8 | | 98.4 | | 98.6 | | 98.6 | |

Average emission rate of concentration and area-ratio methods (Table 2-10)
N/A = not available
*lbs/hr controlled emission rate based on gas flow rate using saturation volume for the moisture content of the gas
**Collection efficiency percent determined using lbs/hr values

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

| Date | 11/12 | | 11/13 | | 11/14 | | Average | |
|---|---|---|---|---|---|---|---|---|
| Run Number | C-1 | | C-2 | | C-3 | | | |
| Type Emissions | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled |
| Scrubber Pressure Drop (in. $H_2O$) | 34.3 | | 34.0 | | 34.3 | | 34.3 | |
| Scrubber Water Flow Rate (LPS) | 13.8 | | 13.8 | | 13.6 | | 13.7 | |
| Production Rate (Kg/S) | 61.5 | | 59.2 | | 53.7 | | 58.1 | |
| Process Mix Type | B-Mix | | B/C Mix | | M-Mix | | --- | |
| Average Opacity (Percent) Mean, Range | 0 (0-1.5) | | 0 (-0-) | | N/A | | 0 | |
| Particulate and Total Organic Carbon (TOC) Results | | | | | | | | |
| Front Half Catch - Particulate (probe, cyclone, and filter) | | | | | | | | |
| mg-mass | 9360 | 172 | 10,800 | 244 | 6950 | 104 | 9040 | 173 |
| mg/DSCM | 17,400 | 126 | 19,400 | 186 | 12,800 | 76.0 | 16,500 | 129 |
| g/s* | 96.1 | 0.697 | 115 | 1.05 | 75.5 | 0.435 | 95.5 | 0.726 |
| g/kg production | 1.56 | 0.0113 | 1.94 | 0.0177 | 1.41 | 0.00810 | 1.64 | 0.0125 |
| Collection Efficiency Percent** | 99.3 | | 99.1 | | 99.4 | | 99.2 | |
| Back Half Catch - TOC (impinger solutions and rinses) | | | | | | | | |
| mg-mass | 299 | 128 | 65 | 150 | 70 | 155 | 145 | 144 |
| mg/DSCM | 554 | 93.8 | 117 | 115 | 129 | 113 | 265 | 107 |
| g/s* | 3.06 | 0.518 | 0.647 | 0.644 | 0.758 | 0.644 | 1.49 | 0.602 |
| g/kg production | 0.0498 | 0.0084 | 0.0109 | 0.0108 | 0.0141 | 0.0120 | 0.0249 | 0.0104 |
| Collection Efficiency Percent** | 83.1 | | 0.39 | | 15.0 | | 59.5 | |
| Total Catch | | | | | | | | |
| mg-mass | 9660 | 300 | 10,900 | 394 | 7020 | 259 | 9190 | 318 |
| mg/DSCM | 17,900 | 220 | 19,500 | 302 | 12,900 | 188 | 16,800 | 236 |
| g/s* | 99.0 | 1.21 | 108 | 1.69 | 76.2 | 1.08 | 94.3 | 1.32 |
| g/kg production | 1.61 | 0.0198 | 1.82 | 0.0286 | 1.42 | 0.0200 | 1.62 | 0.0228 |
| Collection Efficiency Percent** | 98.8 | | 98.4 | | 98.6 | | 98.6 | |

Average emission rate of concentration and area-ratio methods (Table 2-10)
N/A = not available
*g/s controlled emission rate based on gas flow rate using saturation volume for the moisture content of the gas
**Collection efficiency percent determined using g/s values

TABLE 2-3. SUMMARY OF PARTICULATE AND TOTAL ORGANIC CARBON EMISSIONS DURING RECYCLE OPERATION (ENGLISH UNITS)

| Date | 11/11 | | 11/11 | | 11/12 | | Average | |
|---|---|---|---|---|---|---|---|---|
| Run Number | R-1 | | R-2 | | R-3 | | | |
| Type Emissions | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled |
| Scrubber Pressure Drop (in. $H_2O$) | 13.8 | | 13.8 | | 13.9 | | 13.8 | |
| Scrubber Water Flow Rate (GPM) | 223 | | 220 | | 219 | | 221 | |
| Production Rate (ton/hr) | 229 | | 250 | | 236 | | 238 | |
| Process Mix Type | Recycle-A | | Recycle-A | | Recycle-A | | --- | |
| Average Opacity (Percent) Mean, Range | 1.4 (0-5.8) | | 0.3 (0-1.7) | | N/A | | 0.85 | |
| Particulate and Total Organic Carbon (TOC) Results | | | | | | | | |
| Front Half Catch - Particulate (probe, cyclone, and filter) | | | | | | | | |
| mg-mass | 4380 | 84.0 | 5,260 | 88.2 | 5570 | 111 | 5070 | 94.5 |
| gr/DSCF | 3.24 | 0.0227 | 4.37 | 0.0229 | 3.75 | 0.0286 | 3.79 | 0.0247 |
| lbs/hr | 411 | 2.72 | 499 | 2.76 | 474 | 3.42 | 461 | 2.97 |
| lbs/ton production | 1.79 | 0.0119 | 2.00 | 0.0110 | 2.01 | 0.0145 | 1.94 | 0.0125 |
| Collection Efficiency Percent** | 99.3 | | 99.4 | | 99.3 | | 99.4 | |
| Back Half Catch - TOC (impinger solutions and rinses) | | | | | | | | |
| mg-mass | 72.0 | 238 | 63.0 | 162 | 576 | 72.0 | 237 | 157 |
| gr/DSCF | 0.0534 | 0.0643 | 0.0523 | 0.0421 | 0.389 | 0.0185 | 0.165 | 0.0416 |
| lbs/hr | 6.77 | 7.22 | 5.51 | 4.80 | 46.6 | 2.22 | 19.6 | 4.91 |
| lbs/ton production | 0.0296 | 0.0337 | 0.0220 | 0.0192 | 0.198 | 0.0094 | 0.0832 | 0.0208 |
| Collection Efficiency Percent** | -6.65 | | 12.9 | | 95.2 | | 74.9 | |
| Total Catch | | | | | | | | |
| mg-mass | 4450 | 322 | 5320 | 250 | 6150 | 183 | 5310 | 252 |
| gr/DSCF | 3.30 | 0.0870 | 4.42 | 0.0650 | 4.14 | 0.0470 | 3.95 | 0.0663 |
| lbs/hr | 418 | 10.4 | 466 | 7.41 | 496 | 5.63 | 460 | 7.81 |
| lbs/ton production | 1.82 | 0.0456 | 1.86 | 0.0296 | 2.10 | 0.0239 | 1.93 | 0.0330 |
| Collection Efficiency Percent** | 97.5 | | 98.4 | | 98.9 | | 98.3 | |

Average emission rate of concentration and area-ratio methods (Table 2-10)
N/A = not available
*lbs/hr controlled emission rate based on gas flow rate using saturation volume for the moisture content of the gas
**Collection efficiency percent determined using lbs/hr values

TABLE 2-4. SUMMARY OF PARTICULATE AND TOTAL ORGANIC CARBON EMISSIONS DURING RECYCLE OPERATION (METRIC UNITS)

| Date | 11/11 | | 11/11 | | 11/12 | | Average | |
|---|---|---|---|---|---|---|---|---|
| Run Number | R-1 | | R-2 | | R-3 | | | |
| Type Emissions | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled | Uncontrolled | Controlled |
| Scrubber Pressure Drop (in. $H_2O$) | 5.43 | | 5.43 | | 5.47 | | 5.44 | |
| Scrubber Water Flow Rate (LPS) | 14.1 | | 13.9 | | 13.8 | | 13.9 | |
| Production Rate (Kg/S) | 57.8 | | 63.1 | | 59.6 | | 60.2 | |
| Process Mix Type | Recycle-A | | Recycle-A | | Recycle-A | | --- | |
| Average Opacity (Percent) Mean, Range | 1.4 (0-5.8) | | 0.3 (0-1.7) | | N/A | | 0.85 | |
| Particulate and Total Organic Carbon (TOC) Results | | | | | | | | |
| Front Half Catch - Particulate (probe, cyclone, and filter) | | | | | | | | |
| mg-mass | 4380 | 84.0 | 5,260 | 88.2 | 5570 | 111 | 5070 | 94.5 |
| mg/DSCM | 7420 | 51.9 | 10,000 | 52.5 | 8590 | 65.4 | 8670 | 56.6 |
| g/s* | 51.8 | 0.343 | 62.9 | 0.348 | 59.8 | 0.431 | 58.2 | 0.374 |
| g/kg production | 0.896 | 0.00593 | 0.919 | 0.00550 | 1.01 | 0.00726 | 0.942 | 0.00622 |
| Collection Efficiency Percent** | 99.3 | | 99.4 | | 99.3 | | 99.4 | |
| Back Half Catch - TOC (impinger solutions and rinses) | | | | | | | | |
| mg-mass | 72.0 | 238 | 63.0 | 162 | 576 | 72.0 | 237 | 157 |
| mg-DSCM | 122 | 147 | 120 | 96.4 | 890 | 42.3 | 378 | 95.2 |
| g/s* | 0.854 | 0.910 | 0.965 | 0.605 | 5.88 | 0.280 | 2.47 | 0.619 |
| g/kg production | 0.0148 | 0.0168 | 0.0110 | 0.0096 | 0.0990 | 0.0047 | 0.0416 | 0.0104 |
| Collection Efficiency Percent** | -6.65 | | 12.9 | | 95.2 | | 74.9 | |
| Total Catch | | | | | | | | |
| mg-mass | 4450 | 322 | 5320 | 250 | 6150 | 183 | 5310 | 252 |
| mg/DSCM | 7550 | 199 | 10,100 | 149 | 9480 | 108 | 9040 | 152 |
| g/s* | 52.7 | 1.31 | 58.8 | 0.934 | 62.6 | 0.710 | 58.0 | 0.985 |
| g/kg production | 0.910 | 0.0228 | 0.930 | 0.0148 | 1.05 | 0.0120 | 0.965 | 0.0165 |
| Collection Efficiency Percent** | 97.5 | | 98.4 | | 98.9 | | 98.3 | |

Average emission rate of concentration and area-ratio methods (Table 2-10)
N/A = not available
*g/s controlled emission rate based on gas flow rate using saturation volume for the moisture content of the gas
**Collection efficiency percent determined using g/s values

gr/DSCF during conventional operation and from 0.0185 to 0.0643 gr/DSCF during recycle operation. With the limited data available, it is difficult to develop any correlations between process operation and the degree of variability in the uncontrolled and controlled TOC emissions during conventional and recycle operation.

The average uncontrolled TOC loading was 29.7 percent greater during recycle operation (0.165 gr/DSCF) than during conventional operation (0.116 gr/DSCF). However, the average controlled TOC loading during recycle operation (0.0416 gr/DSCF) was 14.4 percent less than the average conventional operation loading (0.0486 gr/DSCF). The average removal efficiency of the venturi scrubber was 74.8 percent during recycle operation and 64.1 percent during conventional operation.

## 2.3 EXTRACTABLE ORGANICS EMISSION RESULTS

Analysis for extractable organics was performed on the 0.1N NaOH impinger solutions. Aliquots of the 0.1N NaOH samples were extracted with chloroform and diethyl ether. The solvent was evaporated at room temperature to dryness and the mass of extractable organics determined gravimetrically. Tables 2-7 and 2-8 contain a summary of uncontrolled and controlled extractable organics and particulate emission results. Extractable organics are identified as the "back-half catch" in Tables 2-7 and 2-8.

### 2.3.1 Conventional Operation Extractable Organics Emission Results

Uncontrolled extractable organics loadings were 0.0032, 0.0111, and 0.0169 gr/DSCF for Runs C-1, C-2, and C-3, respectively. The controlled extractable organics loadings were 0.0227, 0.0131, and 0.0193 gr/DSCF for Runs C-1, C-2, and C-3, respectively.

### 2.3.2 Recycle Operation Extractable Organics Emission Results

Uncontrolled extractable organics loadings were 0.0186, 0.0077, and 0.0140 gr/DSCF for Runs R-1, R-2, and R-3, respectively. Controlled extractable organics loadings were 0.0121, 0.0286, and 0.0162 gr/DSCF for Runs R-1, R-2, and R-3, respectively.

### 2.3.3 Discussion of Extractable Organics Emission Test Results

The uncontrolled extractable organics loadings varied from 0.0032 to 0.0169 gr/DSCF during conventional operation and from 0.0077 to 0.0186 gr/DSCF during recycle operation. The controlled extractable organics loadings varied from 0.0131 to 0.0227 gr/DSCF during conventional operation and from 0.0121 to 0.0286 gr/DSCF during recycle operation. Based on the limited data available, it is difficult to develop any correlations between process operation and the degree of variability in the uncontrolled and

TABLE 2-7. SUMMARY OF UNCONTROLLED PARTICULATE AND EXTRACTABLE ORGANICS EMISSIONS

| DATE | 11/12 | 11/11 | 11/13 | 11/11 | 11/14 | 11/12 | | |
|---|---|---|---|---|---|---|---|---|
| RUN NO. | C-1 | R-1 | C-2 | R-2 | C-3 | R-3 | | |
| PROCESS OPERATION | CONVENTIONAL | RECYCLE | CONVENTIONAL | RECYCLE | CONVENTIONAL | RECYCLE | CONVENTIONAL | RECYCLE |
| VOLUME GAS SAMPLED (DSCF) | 19.0 | 20.8 | 19.6 | 18.6 | 19.2 | 22.9 | 19.3 | 20.8 |
| STACK GAS FLOW RATE (DSCFM) | 11,700 | 14,800 | 11,700 | 12,300 | 12,500 | 14,000 | 12,000 | 13,700 |
| STACK TEMPERATURE (°F) | 298 | 296 | 289 | 314 | 304 | 317 | 297 | 309 |
| PERCENT MOISTURE BY VOLUME | 38.0 | 24.4 | 39.6 | 31.5 | 36.7 | 27.7 | 38.1 | 27.9 |
| PERCENT ISOKINETIC | 110 | 95 | 113 | 117 | 104 | 111 | 109 | 108 |
| PRODUCTION RATE (tons/hr) | 244 | 229 | 235 | 250 | 213 | 236 | 231 | 238 |
| PARTICULATE - EXTRACTABLE ORGANICS RESULTS | | | | | | | | |
| FRONT HALF CATCH - PARTICULATE (probe, cyclone, and filter) | | | | | | | | |
| mg-mass | 9360 | 4380 | 10,800 | 5260 | 6950 | 5570 | 9040 | 5070 |
| gr/DSCF | 7.60 | 3.24 | 8.49 | 4.37 | 5.58 | 3.75 | 7.22 | 3.79 |
| lbs/hr | 762 | 411 | 910 | 499 | 599 | 474 | 757 | 461 |
| lbs/ton production | 3.12 | 1.79 | 3.87 | 2.00 | 2.81 | 2.01 | 3.28 | 1.94 |
| BACK HALF CATCH - EXTRACTABLE ORGANICS (impinger solutions & rinses) | | | | | | | | |
| mg-mass | 4.0 | 25.1 | 14.1 | 9.3 | 21.1 | 20.8 | 13.1 | 18.4 |
| gr/DSCF | 0.0032 | 0.0186 | 0.0111 | 0.0077 | 0.0169 | 0.0140 | 0.0104 | 0.0134 |
| lbs/hr | 0.325 | 2.36 | 1.11 | 0.811 | 1.81 | 1.68 | 1.08 | 1.62 |
| lbs/ton production | 0.0013 | 0.0103 | 0.0047 | 0.0032 | 0.0085 | 0.0071 | 0.0048 | 0.0069 |
| PERCENT EXTRACTABLE ORGANICS* | 0.04 | 0.57 | 0.12 | 0.16 | 0.30 | 0.35 | 0.14 | 0.35 |

Average emission rate of concentration and area-ratio methods (Table 2-10).
*Percent Extractable Organics determined using lbs/hr values and is the percentage of extractable organics of the total catch.

TABLE 2-8. SUMMARY OF CONTROLLED PARTICULATE AND EXTRACTABLE ORGANICS EMISSIONS

| DATE | 11/12 | 11/11 | 11/13 | 11/11 | 11/14 | 11/12 | | |
|---|---|---|---|---|---|---|---|---|
| RUN NO. | C-1 | R-1 | C-2 | R-2 | C-3 | R-3 | | |
| PROCESS OPERATION | CONVENTIONAL | RECYCLE | CONVENTIONAL | RECYCLE | CONVENTIONAL | RECYCLE | CONVENTIONAL | RECYCLE |
| VOLUME GAS SAMPLED (DSCF) | 48.2 | 57.1 | 46.2 | 59.3 | 48.5 | 60.1 | 47.6 | 58.8 |
| STACK GAS FLOW RATE (DSCFM) | 11,700* (11,400) | 14,000 | 11,900 (11,400) | 13,300 (12,700) | 12,100 (11,800) | 14,000 | 11,900 (11,500) | 13,800 (13,600) |
| STACK TEMPERATURE (°F) | 159 | 147 | 155 | 152 | 153 | 143 | 156 | 147 |
| PERCENT MOISTURE BY VOLUME | 32.0 (32.3) | 21.3 | 29.0 (32.3) | 26.6 (30.6) | 27.5 (29.7) | 20.7 | 29.5 (32.1) | 22.9 (24.2) |
| PERCENT ISOKINETIC | 102 (105) | 104 | 96 (100) | 111 (116) | 99 (102) | 107 | 99 (102) | 107 (109) |
| PRODUCTION RATE (tons/hr) | 244 | 229 | 235 | 250 | 213 | 236 | 231 | 238 |
| PARTICULATE - EXTRACTABLE ORGANICS RESULTS | | | | | | | | |
| FRONT HALF CATCH - PARTICULATE (probe, cyclone, and filter) | | | | | | | | |
| mg-mass | 172 | 84.0 | 244 | 88.2 | 104 | 111 | 173 | 94.5 |
| gr/DSCF | 0.0550 | 0.0227 | 0.0814 | 0.0229 | 0.0332 | 0.0286 | 0.0565 | 0.0247 |
| lbs/hr | 5.53 (5.36) | 2.72 | 8.29 (7.95) | 2.76 (2.49) | 3.45 (3.36) | 3.42 | 5.76 (5.56) | 2.97 (2.88) |
| lbs/ton production | 0.0227 (0.0220) | 0.0119 | 0.0353 (0.0338) | 0.0110 (0.0100) | 0.0162 (0.0158) | 0.0145 | 0.0247 (0.0239) | 0.0125 (0.0123) |
| BACK HALF CATCH - EXTRACTABLE ORGANICS (impinger solutions & rinses) | | | | | | | | |
| mg-mass | 71.0 | 44.7 | 39.3 | 110 | 60.7 | 63.0 | 57.0 | 72.6 |
| gr/DSCF | 0.0227 | 0.0121 | 0.0131 | 0.0286 | 0.0193 | 0.0162 | 0.0184 | 0.0190 |
| lbs/hr | 2.28 (2.22) | 1.45 | 1.34 (1.28) | 3.25 (3.11) | 2.00 (1.95) | 1.94 | 1.88 (1.81) | 2.24 (2.21) |
| lbs/ton production | 0.0093 (0.0091) | 0.0063 | 0.0057 (0.0054) | 0.0130 (0.0124) | 0.0094 (0.0092) | 0.0082 | 0.0081 (0.0078) | 0.0094 (0.0093) |
| PERCENT EXTRACTABLE ORGANICS* | 29.2 (29.3) | 34.8 | 13.9 (13.9) | 54.1 (55.5) | 36.7 (36.7) | 36.2 | 24.6 (24.6) | 43.0 (43.4) |

NOTE: Top number based on saturation volume for moisture content of gas: (bottom number) is moisture content calculated using impinger catch indicating the presence of water mist.

Average emission rate of concentration and area-ratio methods (Table 2-10).

Percent Extractable Organics determined using lbs/hr values and is the percentage of extractable organics of the total catch.

controlled extractable organics emissions during conventional and recycle operation.

The average uncontrolled extractable organics loading during recycle operation (0.0134 gr/DSCF) was approximately 22 percent greater than during conventional operation (0.0104 gr/DSCF). The average controlled extractable organics loading during recycle operation (0.0190 gr/DSCF) approximated the average controlled organics loading during conventional operation (0.0184 gr/DSCF).

The average uncontrolled extractable organics loadings are less than the average controlled extractable organics loadings during both recycle and conventional operation. Controlled emissions of extractable organics were 27.7 percent higher than uncontrolled emissions during recycle operation and 42.6 percent higher during conventional operation. A review of the data indicates that the results are representative of conditions. The mass of extractable organics per unit volume measured in the controlled emissions was significantly higher than the mass of extractable organics measured in the uncontrolled emissions. A possible explanation is that the scrubber water contributes to the extractable organics concentration of controlled emissions due to the concentration of extractable organics in the water mist carried over from the venturi. The scrubber water would include organic compounds that are water soluble or miscible that would concentrate in the scrubber water to a degree depending on gas phase concentration, water recycle, and make-up. Condensible hydrocarbons on the other hand would tend to condense on particulate and be physically removed by the venturi. The condensible hydrocarbons would then be removed with the venturi pond sludge or appear as an oily film on the pond water which would not be recycled. The results indicate that the venturi controls condensible hydrocarbons by an average of 82.0 percent during recycle operation and 76.8 percent during conventional operation.

## 2.4 COMPARISON OF TOC AND EXTRACTABLE ORGANICS EMISSION RESULTS

Two analytical procedures were used during this program to quantify the concentration of uncontrolled and controlled organic emissions generated during conventional and recycle operation. An instrumental technique was used to determine the concentration of TOC present in the 0.1N NaOH impinger solutions generated during EPA Method 5E testing. The same samples were also analyzed using a extraction/gravimetric technique to determine the concentration of extractable organics. The main objective of performing both analyses on the same samples was to provide data that could be used to assess the utility of both procedures in characterizing organic emissions from asphalt concrete plants.

### 2.4.1 Comparison of Uncontrolled TOC and Extractable Organics Emission Results

Table 2-9 presents a comparison of uncontrolled TOC and extractable organics emissions during conventional and recycle operation. The average uncontrolled TOC loadings during recycle operation (0.165 gr/DSCF) were 29.7 percent higher than during conventional operation (0.116 gr/DSCF). The average uncontrolled extractable organics loadings during recycle operation (0.0134 gr/DSCF) were 22.4 percent higher than during conventional operation (0.0104 gr/DSCF). During recycle operation, the average extractable organics loading was 8.1 percent of the TOC loading and 9.0 percent during conventional operation.

### 2.4.2 Comparison of Controlled TOC and Extractable Organics Emission Results

Table 2-10 presents a comparison of controlled TOC and extractable organics emissions during conventional and recycle operation. Average controlled TOC loadings during recycle operation (0.0416 gr/DSCF) were 12.5 percent lower than during conventional operation (0.0468 gr/DSCF). Average controlled extractable organics loadings during recycle operation (0.0190

TABLE 2-9. COMPARISON OF UNCONTROLLED TOC AND EXTRACTABLE ORGANICS EMISSIONS

| RUN NUMBER | C-1 | C-2 | C-3 | R-1 | R-2 | R-3 | AVERAGE | |
|---|---|---|---|---|---|---|---|---|
| PROCESS OPERATION | CONVENTIONAL | CONVENTIONAL | CONVENTIONAL | RECYCLE | RECYCLE | RECYCLE | CONVENTIONAL | RECYCLE |
| DATE | 11/12 | 11/13 | 11/14 | 11/11 | 11/11 | 11/12 | | |
| VOLUME GAS SAMPLES (DSCF) | 19.0 | 19.6 | 19.2 | 20.8 | 18.6 | 22.9 | 19.3 | 20.8 |
| STACK GAS FLOW RATE (DSCFM) | 11,700 | 11,700 | 12,500 | 14,800 | 12,300 | 14,000 | 12,000 | 13,700 |
| STACK TEMPERATURE (°F) | 298 | 289 | 304 | 296 | 314 | 317 | 297 | 309 |
| PERCENT MOISTURE BY VOLUME | 38.0 | 39.6 | 36.7 | 24.4 | 31.5 | 27.7 | 38.1 | 27.9 |
| PERCENT ISOKINETIC | 110 | 113 | 104 | 95 | 117 | 111 | 109 | 108 |
| PRODUCTION RATE (TONS/HR) | 244 | 235 | 213 | 229 | 250 | 236 | 231 | 238 |

| BACK HALF CATCH ORGANICS RESULTS (impinger solutions & rinses) | TOC* | EXT** ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG | TOC | EXT ORG. | TOC | EXT ORG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mg-mass | 299 | 4.0 | 65.0 | 14.1 | 70.0 | 21.1 | 72.0 | 25.1 | 63.0 | 9.30 | 576 | 20.8 | 145 | 13.1 | 237 | 18.4 |
| gr/DSCF | 0.242 | 0.0032 | 0.0512 | 0.0111 | 0.0562 | 0.0169 | 0.0534 | 0.0186 | 0.0523 | 0.0077 | 0.389 | 0.0140 | 0.116 | 0.0104 | 0.165 | 0.0134 |
| lbs/hr | 24.3 | 0.325 | 5.13 | 1.11 | 6.01 | 1.81 | 6.77 | 2.36 | 5.51 | 0.81 | 46.6 | 1.68 | 11.8 | 1.08 | 19.6 | 1.62 |
| lbs/ton production | 0.0995 | 0.0013 | 0.0218 | 0.0047 | 0.0282 | 0.0085 | 0.0296 | 0.0103 | 0.0220 | 0.0032 | 0.198 | 0.0071 | 0.0498 | 0.0048 | 0.0832 | 0.0069 |

* TOC - Total Organic Carbon

**EXT. ORG. - Extractable Organics

TABLE 2-10. COMPARISON OF CONTROLLED TOC AND EXTRACTABLE ORGANICS EMISSIONS

| RUN NUMBER | C-1 | C-2 | C-3 | R-1 | R-2 | R-3 | AVERAGE | |
|---|---|---|---|---|---|---|---|---|
| PROCESS OPERATION | CONVENTIONAL | CONVENTIONAL | CONVENTIONAL | RECYCLE | RECYCLE | RECYCLE | CONVENTIONAL | RECYCLE |
| DATE | 11/12 | 11/13 | 11/14 | 11/11 | 11/11 | 11/12 | | |
| VOLUME GAS SAMPLES (DSCF) | 48.2 | 46.2 | 48.5 | 57.1 | 59.3 | 60.1 | 47.6 | 58.8 |
| STACK GAS FLOW RATE (DSCFM) | 11,700* (11,400) | 11,900 (11,400) | 12,100 (11,800) | 14,000 | 13,300 (12,700) | 14,000 | 11,900 (11,500) | 13,800 (13,600) |
| STACK TEMPERATURE (°F) | 159 | 155 | 153 | 147 | 152 | 143 | 156 | 147 |
| PERCENT MOISTURE BY VOLUME | 32.0 (34.3) | 29.0 (32.3) | 27.5 (29.7) | 21.3 | 26.6 (30.6) | 20.7 | 29.5 (32.1) | 22.9 (24.2) |
| PERCENT ISOKINETIC | 102 (105) | 96 (100) | 99 (102) | 104 | 111 (116) | 107 | 99 (102) | 107 (109) |
| PRODUCTION RATE (TONS/HR) | 244 | 235 | 213 | 229 | 250 | 236 | 231 | 238 |

| BACK HALF CATCH ORGANICS RESULTS (impinger solutions & rinses) | TOC** | EXT*** ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. | TOC | EXT ORG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mg-mass | 128 | 71.0 | 150 | 39.3 | 155 | 60.7 | 238 | 44.7 | 162 | 110 | 72 | 63.0 | 144 | 57.0 | 157 | 72.6 |
| gr/DSCF | 0.0410 | 0.0227 | 0.0501 | 0.0131 | 0.0494 | 0.0193 | 0.0643 | 0.0121 | 0.0421 | 0.0286 | 0.0185 | 0.0162 | 0.0468 | 0.0184 | 0.0416 | 0.0190 |
| lbs/hr | 4.11 | 2.28 | 5.11 | 1.34 | 5.11 | 2.00 | 7.22 | 1.45 | 4.80 | 3.25 | 2.22 | 1.94 | 4.78 | 1.88 | 4.91 | 2.24 |
| lbs/ton production | 0.0168 | 0.0093 | 0.0217 | 0.0057 | 0.0240 | 0.0094 | 0.0337 | 0.0063 | 0.0192 | 0.0130 | 0.0094 | 0.0082 | 0.0208 | 0.0081 | 0.0208 | 0.0094 |

*NOTE: Top number based on saturation volume for moisture content of gas: (bottom number) is moisture content calculated using impinger catch results indicating the presence of water mist.
** TOC - Total Organic Carbon
***EXT. ORG. - Extractable Organics

gr/DSCF) were slightly higher (3.2 percent) than during conventional operation (0.0184 gr/DSCF). The extractable organics loading was 45.7 percent of the TOC loading during recycle operation and 39.3 percent during conventional operation.

### 2.4.3 Discussion of TOC and Extractable Organics Emissions Results

Because of the limited quantity of available data, it is difficult to develop an accurate comparison between the TOC and extractable organics results. To formulate an opinion about the two procedures, one must first evaluate the analytical procedures. It is important that several factors be kept in mind. First, the TOC analysis results are indicative of the total mass of soluble carbon, as organic species, in the sample. The extractable organics analysis results are related to the mass of organic species having a boiling point greater than 300°F. Also, the TOC analysis procedure is a direct instrumental technique requiring a minimal amount of sample preparation (refer to Section 5.2). On the other hand, the extractable organics analysis procedure requires sample preparation (refer to Section 5.2) by means of extraction with chloroform and diethyl ether. The remaining extract is then evaporated to dryness at room temperature before weighing.

It is believed that the TOC analysis procedure is more suitable than the extractable organics procedure for characterizing organic emissions from asphalt concrete plants.

### 2.11.4 Recycled Asphalt Pavement and Asphalt Cement Smoke Point and Flash Point Results

Smoke point determination was performed on a single sample of recycled asphalt pavement (RAP) collected during the Campbell test program. The sample was analyzed by the Oklahoma Testing Laboratory and by Radian. The smoke point test results are presented in Table 2-24. The smoke point determined by Oklahoma Testing Laboratory was 340°F. The smoke point determined by Radian was 370°F.

Samples of the asphalt cement (AC) used during the Campbell test program were analyzed for smoke point and flash point. The AC smoke point and flash point analyses were performed by the Oklahoma Testing Laboratory. The smoke point and flash point data are presented in Table 2-24.

TABLE 2-24. SUMMARY OF RECYCLED ASPHALT PAVEMENT (RAP) SMOKE POINT RESULTS AND ASPHALT CEMENT (AC) SMOKE POINT AND FLASH POINT RESULTS

| Collection Date | Sample Description | Sample Type | Oklahoma Testing Smoke Point (°F) | Radian[a] Smoke Point (°F) | Flash Point (°F) |
|---|---|---|---|---|---|
| 11-12-83 | Recycled Asphalt Pavement | RAP | 340 | 370 | - |
| 11-08-83 | McGee Asphalt Cement | AC | 420 | - | 640 |
| 11-12-83 | Allied Chemical Asphalt Cement | AC | 345 | - | 550 |

[a]Flash point and smoke point analysis of the AC performed by Oklahoma Testing Laboratories only.

## 2.12 CONDENSIBLE HYDROCARBONS EMISSION RESULTS

The sample fraction which condensed on the walls of the chilled glassware is referred to as condensible hydrocarbons. A trichloroethane (TCE) rinse was used to recover the condensed hydrocarbons from the impingers. The TCE was evaporated to dryness at room temperature to determine the mass of condensible hydrocarbons. Condensible hydrocarbons results are presented in Table 2-25.

### 2.12.1 Conventional Operation Condensible Hydrocarbons Emission Results

Uncontrolled condensible hydrocarbons loadings were 0.173, 0.0457, and 0.114 gr/DSCF for Runs C-1, C-2, and C-3, respectively. The controlled condensible hydrocarbons loadings were 0.0558, 0.0140, and 0.0086 gr/DSCF for Runs C-1, C-2, and C-3, respectively.

### 2.12.2 Recycle Operation Condensible Hydrocarbons Emission Results

Uncontrolled condensible hydrocarbons loadings were 0.136, 0.133, and 0.0619 gr/DSCF for Runs R-1, R-2, and R-3, respectively. The controlled condensible hydrocarbons loadings were 0.0114, 0.0311, and 0.0173 gr/DSCF for Runs R-1, R-2, and R-3, respectively.

### 2.12.3 Discussion of Condensible Hydrocarbons Emission Results

The uncontrolled condensible hydrocarbons loadings varied from 0.0457 to 0.173 gr/DSCF during conventional operation and from 0.0619 to 0.136 gr/DSCF during recycle operation. The controlled condensible hydrocarbons loadings varied from 0.0086 to 0.0558 gr/DSCF during conventional operation and from 0.0114 to 0.0311 gr/DSCF during recycle operation. With the limited data available, it is difficult to develop any correlations between process operation and degree of variability of the controlled and uncontrolled condensible hydrocarbon emissions during conventional and recycle operation.

TABLE 2-25. SUMMARY OF CONDENSIBLE HYDROCARBONS EMISSIONS

| Date | Run Description | Corrected TCE Rinse Wt (mg)[a] | gr/DSCF | lbs/hr | lbs/ton |
|---|---|---|---|---|---|
| | CONTROLLED EMISSIONS | | | | |
| Recycle Operation | | | | | |
| 11-11-83 | Run R-1 | 42.1 | 0.0114 | 1.36 | 0.0060 |
| 11-11-83 | Run R-2 | 120 | 0.0311 | 3.54 | 0.0142 |
| 11-12-83 | Run R-3 | 67.3 | 0.0173 | 2.07 | 0.0088 |
| | Average | 76.3 | 0.0199 | 2.32 | 0.0097 |
| Conventional Operation | | | | | |
| 11-12-83 | Run C-1 | 174 | 0.0558 | 5.59 | 0.0229 |
| 11-13-83 | Run C-2 | 41.8 | 0.0140 | 1.43 | 0.0061 |
| 11-14-83 | Run C-3 | 27.0 | 0.0086 | 0.89 | 0.0042 |
| | Average | 81.0 | 0.0261 | 2.64 | 0.0111 |
| | UNCONTROLLED EMISSIONS | | | | |
| Recycle Operation | | | | | |
| 11-11-83 | Run R-1 | 183 | 0.136 | 17.2 | 0.0750 |
| 11-11-83 | Run R-2 | 160 | 0.133 | 14.0 | 0.0559 |
| 11-12-83 | Run R-3 | 91.9 | 0.0619 | 7.42 | 0.0315 |
| | Average | 145 | 0.110 | 12.9 | 0.0541 |
| Conventional Operation | | | | | |
| 11-12-83 | Run C-1 | 213 | 0.173 | 17.3 | 0.0710 |
| 11-13-83 | Run C-2 | 58.2 | 0.0457 | 4.58 | 0.0195 |
| 11-14-83 | Run C-3 | 142 | 0.114 | 12.2 | 0.0571 |
| | Average | 138 | 0.111 | 11.4 | 0.0492 |

[a]Corrected for trichloroethane blank residue

The average uncontrolled condensible hydrocarbons loading during recycle operation (0.110 gr/DSCF) approximated the average uncontrolled condensible hydrocarbons loading during conventional operation (0.111 gr/DSCF). The average controlled condensible hydrocarbons loading during recycle operation (0.0199 gr/DSCF) was approximately 24 percent less than the conventional operation condensible hydrocarbons loading (0.0261 gr/DSCF). The average removal efficiency of the venturi scrubber was 82.0 percent during recycle operation and 76.8 percent during conventional operation.

## 2.13 COMPARISON OF TOC ANALYTICAL METHODS

Two analytical methods were used to determine the TOC concentrations of the 0.1N NaOH impinger solutions. The original method (the values reported in the original report) consisted of acidifying the sample below pH 2 with $H_2SO_4$ and purging with nitrogen to remove inorganic carbon. This method was specified in the test plan for the T.J. Campbell emission test. The second method was the EPA Method 5E protocol (see Appendix Section J.1).

To determine if the two methodologies yielded different results, the original samples were reanalyzed using both methods. Table 2-26 presents a comparison of the original analysis (acidification) and the reanalysis using both methods (EPA Method 5E and acidification).

Results of the sample reanalysis indicate that EPA Method 5E protocol yields lower results than the acidification and purge technique. A possible explanation for the lower values obtained by EPA Method 5E is that the absence of inorganic carbon is verified and if present the results are corrected accordingly. With the acidification and purge method, this step is not performed and if there is incomplete inorganic carbon removal, a high bias would occur.

TABLE 2-26. SUMMARY OF T.J. CAMPBELL TOTAL ORGANIC CARBON (TOC) EMISSION RESULTS COMPARING TWO ANALYTICAL METHODS

| Run ID | Original Campbell TOC Emissions: Method 1[a] | | | Campbell TOC Reanalysis: Method 1[a] | | | Campbell TOC Reanalysis: Method 2[b] | | |
|---|---|---|---|---|---|---|---|---|---|
| | gr/DSCF | lbs/hr | lbs/ton | gr/DSCF | lbs/hr | lbs/ton | gr/DSCF | lbs/hr | lbs/ton |
| **UNCONTROLLED EMISSIONS** | | | | | | | | | |
| Recycle Run 1 | 0.448 | 56.8 | 0.248 | 0.685 | 86.8 | 0.379 | 0.0534 | 6.77 | 0.0296 |
| Run 2 | 0.655 | 68.9 | 0.276 | 1.16 | 122 | 0.490 | 0.0523 | 5.51 | 0.0220 |
| Run 3 | 0.504 | 60.5 | 0.256 | 0.963 | 115 | 0.489 | 0.389 | 46.6 | 0.198 |
| Average | 0.536 | 62.1 | 0.260 | 0.936 | 108 | 0.453 | 0.165 | 19.6 | 0.0832 |
| Conventional Run 1 | 0.205 | 20.6 | 0.0843 | 0.958 | 96.0 | 0.394 | 0.242 | 24.3 | 0.0995 |
| Run 2 | 0.434 | 43.6 | 0.186 | 0.684 | 68.5 | 0.291 | 0.0512 | 5.13 | 0.0218 |
| Run 3 | 0.297 | 31.9 | 0.150 | 0.602 | 64.4 | 0.302 | 0.0562 | 6.01 | 0.0282 |
| Average | 0.312 | 32.0 | 0.140 | 0.748 | 76.3 | 0.329 | 0.116 | 11.8 | 0.0498 |
| **CONTROLLED EMISSIONS** | | | | | | | | | |
| Recycle Run 1 | 0.0592 | 7.10 | 0.0310 | 0.290 | 34.8 | 0.152 | 0.0643 | 7.72 | 0.0337 |
| Run 2 | 0.0975 | 11.1 | 0.0444 | 0.159 | 18.1 | 0.0724 | 0.0421 | 4.80 | 0.0192 |
| Run 3 | 0.159 | 19.0 | 0.0808 | 0.190 | 22.8 | 0.0964 | 0.0185 | 2.22 | 0.0094 |
| Average | 0.105 | 12.4 | 0.0521 | 0.213 | 25.2 | 0.107 | 0.0416 | 4.91 | 0.0208 |
| Conventional Run 1 | 0.0532 | 5.32 | 0.0218 | 0.188 | 18.9 | 0.0773 | 0.0410 | 4.11 | 0.0168 |
| Run 2 | 0.139 | 14.2 | 0.0604 | 0.154 | 15.7 | 0.0669 | 0.0501 | 5.11 | 0.0217 |
| Run 3 | 0.129 | 13.4 | 0.0627 | 0.233 | 24.1 | 0.113 | 0.0494 | 5.11 | 0.0240 |
| Average | 0.107 | 11.0 | 0.0483 | 0.192 | 19.6 | 0.0857 | 0.0468 | 4.78 | 0.0208 |

[a]Acidificationa nd purge analysis
[b]EPA Method 5E protocol analysis

## 5.2 ANALYTICAL METHODOLOGY

The previous section described sampling procedures. This section describes the analytical procedures and points out where samples for analysis were retrieved from the various sample streams.

The majority of analyses for this project were performed at Radian's Austin laboratories. Samples for analysis resulted from the following:

- particulate, TOC/extractable organics/condensible hydrocarbons sampling train for controlled and uncontrolled air emissions;
- particulate, TOC/extractable organics/condensible hydrocarbons, and trace metals sampling train for controlled and uncontrolled air emissions;
- polynuclear aromatic hydrocarbons sampling train for controlled and uncontrolled air emissions;
- scrubber water to and from the venturi; and
- virgin aggregate and recycled asphalt pavement.

Figures 5-7 through 5-10 present analytical schemes for the three sampling trains, scrubber waters, and process samples. These figures indicate where samples were retrieved from the various systems and the analyses performed. The following analyses were performed:

- gravimetric analysis of solvent rinses,
- gravimetric analysis of ether chloroform extract of impingers,
- total organic carbon,

- major organics and benzo(a)pyrene,
- trace metals,
- total solids,
- pH and temperature, and
- moisture.

Analysis of Extractable Organics--The extractable organics sample consisted of the material obtained by extracting the 0.1N NaOH impinger solutions with a mixture of chloroform and diethyl ether. The extractable organics content of the NaOH impinger samples was determined using the following procedure. First, a 400 ml sample aliquot was adjusted to pH 7 using HCl to improve extraction efficiency. The sample was then extracted with three portions of a 3:1 mixture of chloroform and diethyl ether for a total of 200 mls. The solvent was then filtered. The filtrate was evaporated to dryness at room temperature (70-75°) and weighed to a constant weight following desiccation.

Analysis of Condensible Hydrocarbons--The condensible hydrocarbon sample consisted of the material that condensed on the walls of the chilled glassware. The condensed hydrocarbon content was determined using the following gravimetric procedure. The impingers and associated glassware were rinsed with trichloroethane (TCE). The volume of each rinse was determined gravimetrically, the entire sample was transferred to a tared beaker, and evaporated at room temperature. When dry, the beakers were desiccated 24 hours and weighed to a constant weight to determine the mass of condensed hydrocarbon. Each sample weight was corrected for the residue contributed by the solvent.

Total Organic Carbon (TOC) Analysis--The TOC content of the EPA Method 5E sodium hydroxide impinger solutions and scrubber water filtrate samples

was determined instrumentally using the procedure specified in EPA Method 5E. A Beckman Model 915B Total Carbon Analyzer was used to determine the total carbon content and total inorganic carbon content of the sample. The concentration of carbon present in the sample was determined by comparing the sample results with the results of standards prepared using potassium hydrogen phthalate. The total organic carbon content was determined by subtracting the total inorganic carbon content from the total carbon content.

Gravimetric Analysis of Solvent Rinses--The sampling train for particulate and TOC/extractable organics and the train which combined trace metals with particulate and TOC/extractable organics produced several solvent rinses requiring gravimetric analysis. The solvent rinses included:

- acetone probe rinse, and
- trichloroethane probe rinse.

The rinse samples were placed in glass bottles and transported to Radian's Austin laboratories for analysis. The volume of solvent in each sample was determined gravimetrically and then the entire sample was evaporated at room temperature. The sample could not be dried at elevated temperatures because of the potential loss of hydrocarbons. When dry, the beakers were desiccated for 24 hours and then weighed to a constant weight. A constant weight is defined as two weighings that agree within 0.5 mg or 1 percent of the residue mass.

The residue in the solvent probe rinses collected during the trace metals runs was dissolved in HCl, $HNO_3$, and $H_2O_2$ and was analyzed by Inductively Coupled Argon Plasma Emissions Spectroscopy (ICAPES).

Smoke Point Determination of Recycled Asphalt Pavement--The smoke point of the RAP samples was determined using a test procedure developed by the Oklahoma Testing Laboratory. Based on this method, a sample of RAP is first dried to a constant weight in an oven set at 140°F. 500 grams of the dried

sample is then placed in a stainless steel bowl and heated at a rate of 25 to 30°F per minute while stirring the RAP with a stainless steel spatula. When the sample temperature is approximately 250°F, the heating rate is decreased so that the sample temperature rise is 5° to 10°F per minute until the smoke point is reached. The smoke point is recorded as the temperature at which the RAP starts to smoke.

Smoke Point and Flash Point Determination of Asphalt Cement--The smoke point and flash point of the asphalt cement used during testing was determined by the ASTM D92-Cleveland Open Cup procedure.[1] Based on this method, the test cup is filled to a specified level with the asphalt sample. The temperature of the sample is increased rapidly at first and then at a slow constant rate as the smoke point is approached. As soon as the smoke is detected, the temperature of the sample is noted. To determine the flash point, the temperature is increased and at specified intervals, a small test flame is passed across the cup. The lowest temperature at which application of the test flame causes the vapors above the surface of the liquid to ignite is taken as the flash point.

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[1]Annual Book of ASTM Standards, "Standard Test Method for Flash and Fire Points by Cleveland Open Cup," Part 23, Petroleum Products and Lubricants (I), D92-72, pages 27-32.

TABLE 6-2. SUMMARY OF TOTAL ORGANIC CARBON AUDIT SAMPLE MEASUREMENTS

| Sample No. | Date of Analysis | (A) Actual Values | (R) Radian Analysis Values (mg/L) | Percent Error R-A/A x 100 |
|---|---|---|---|---|
| EPA Prepared Sample Results (9/9/83) | | | | |
| EPA 1 | 10-28-83 | 4.1 | 4.5 | 9.76 |
| EPA 2 | thru | 61.2 | 70 | 14.4 |
| EPA 3 | 11-02-83 | 61.2 | 69 | 12.7 |
| EPA 5 | | 4.1 | 3 | -26.8 |
| Radian Prepared Sample Results | | | | |
| Set 1 - Submitted 11-30-83 | | | | |
| Radian #1 | | 80 | 85 | 6.25 |
| Radian #2 | | 40 | 45 | 12.5 |
| Radian #3 | | 80 | 81 | 1.2 |
| Radian #4 | | 4 | 4 | 0 |
| Radian #5 | | 4 | 3 | -25.0 |
| Radian #6 | | 40 | 41 | 2.5 |
| Set 2 - Submitted 12-12-83 | | | | |
| Radian #1[a] | | 80[a] | 85 | 6.25 |
| Radian #2 | | 20[b] | 21 | 5.0 |
| Radian #3 | | 20[a] | 19 | -5.0 |
| Radian #4 | | 80[b] | 84 | 5.0 |
| Radian #5 | | 80[a] | 77 | -3.75 |
| Radian #6 | | 20[a] | 21 | 5.0 |

[a]Sample in 0.1 in. NaOH matrix
[b]Sample in distilled water

| Sample Number | Date of Analysis | (A) Actual Value | (R) Radian Analysis Method 1[a] | Percent Error R-A/Ax100 | (R) Radian Analysis Method 2[b] | Percent Error R-A/Ax100 |
|---|---|---|---|---|---|---|
| Radian 1 | Submitted 8-09-84 | 593 | 562 | -5.2 | 604 | 1.8 |
| Radian 2 | | 119 | 108 | -9.2 | 167 | 40.3 |
| Radian 3 | | 59.3 | 40.9 | -31.0 | 128 | 116 |

[a]EPA Method 5E Protocol
[b]Acidification