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Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

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Air

EPA

# Industrial Boilers

# Emission Test Report
# General Motors Corporation
# Lansing, Michigan

# INDUSTRIAL BOILERS

## Final Report

GENERAL MOTORS CORPORATION
FISHER BODY DIVISION
BOILER NO. 2
Lansing, Michigan

April 19-26, 1982

Technical Directives 23 and 24

by

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Prepared for

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MONSANTO RESEARCH CORPORATION
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# SECTION 1

# INTRODUCTION

Emissions from Boiler No. 2 at the General Motors Corporation, Fisher Body Division Plant in Lansing, Michigan, were tested April 19-26 by Monsanto Research Corporation (MRC). This work was performed for Emission Measurement Branch of the U.S. Environmental Protection Agency (EPA) under Contract 68-02-3547, Work Assignment No. 2.

The boiler tested is Boiler No. 2, a 81,720 Kg steam/hr (180,000 lb steam/hr) capacity, coal-fired boiler fed by a moving bed spreader stoker. It is equipped with a baghouse and cyclone-type mechanical dust collector pollution control equipment. Figure 1 is a schematic diagram of the installation showing the mechanical dust collector and baghouse sampling locations.

The purpose of the sampling program was to provide background information on well-controlled industrial boilers for the development of new source performance standards. Within this framework the objectives of the sampling at General Motors Corporation in Lansing, Michigan were: 1) to determine the effect of raising the temperature of the filter and probe on an EPA Method 5 train from 120°C (248°F) to 160°C (320°F) on the amounts of particulate emissions measured downstream of the cyclone; and 2) to determine the effect of varying boiler load conditions on particulate emissions. Method 5 testing with the filter and probe at 160 ± 14°C (320 ± 25°F) will be referred to as Method 5B testing.

Table 1 summarizes the monitoring performed at this plant. Phase I testing consisted of three simultaneous runs of Method 5B at the inlet and outlet of the mechanical collector at each of 3 different boiler loadings (2/3, 1/2, and 1/3 capacity), Method 9 visible emissions simultaneous with each run, and Andersen particle sizing corresponding to each run at the inlet and outlet.

During Phase II testing, an additional three runs were performed at the multicyclone outlet during Boiler No. 2 swing load conditions. Also, three Method 5B and three Andersen particle sizing runs were performed at the inlet to the baghouse collector located downstream of the dust collector as shown in Figure 1.

Grab samples of coal were taken during every run by sampling from the feed belt to the spreader stoker. The sulfur, ash, moisture, and Btu content of each sample were determined according to ASTM Methods.

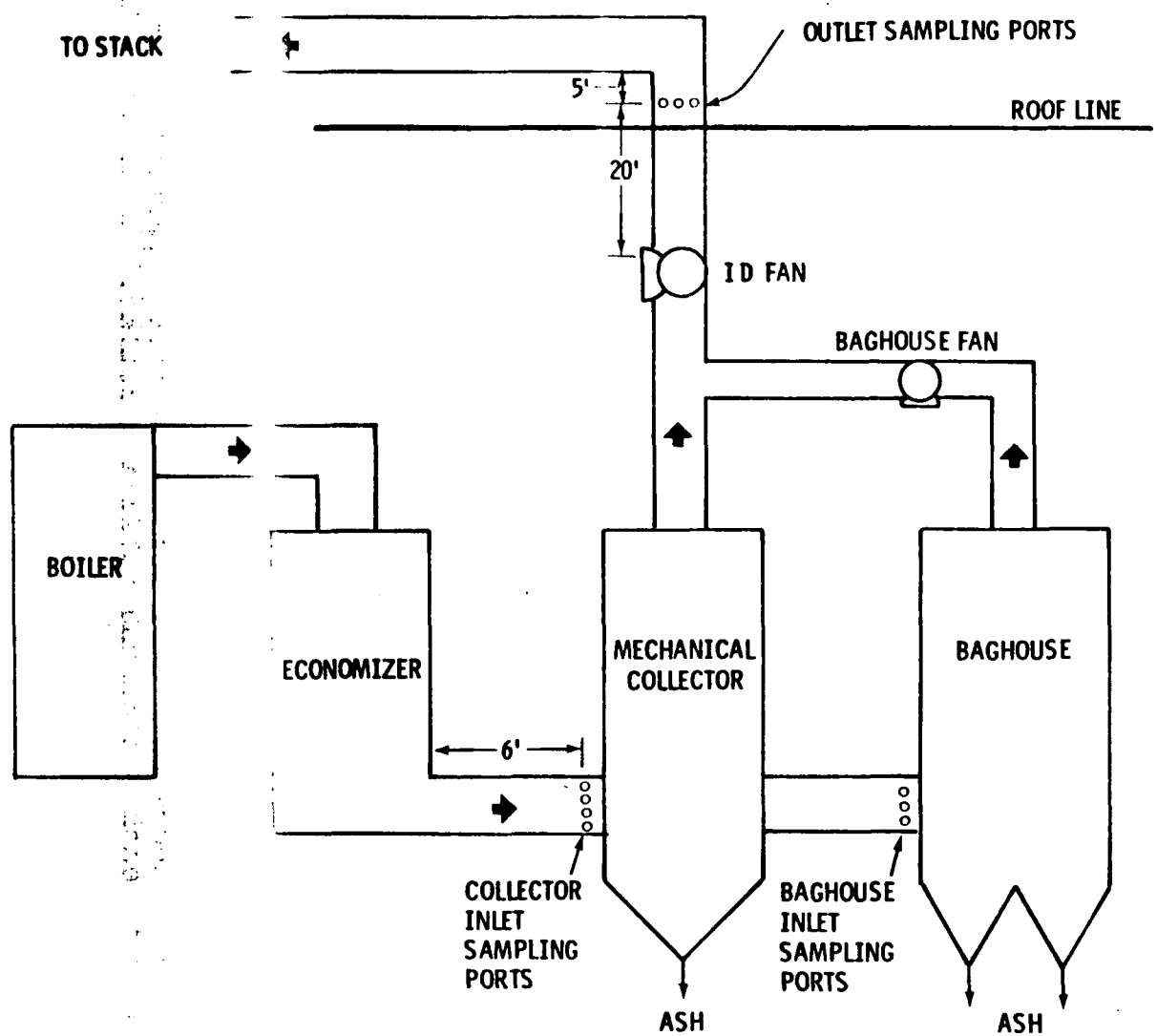



Figure 1. Schematic diagram of mechanical dust collector and baghouse sampling locations at GM Corporation, Fisher Body Division in Lansing, Michigan.

# TABLE 1. SOURCE SAMPLING AND ANALYSES AT GM CORPORATION, FISHER BODY DIVISION IN LANSING, MICHIGAN

| SAMPLING AND ANALYSIS REQUIREMENTS | Contract No.: 68-02-3547 | Assignment Number: 2 | Technical Directive: 23 & 24 |
|---|---|---|---|
| MRC Job No. 101.12211 | Company Name: General Motors Fisher Body Division | Company Location: Lansing, Michigan | |
| | Industry: Industrial Boiler #2 | Process: Coal-fired spreader stoker | Control Equipment: Multicyclone and Baghouse |

| Total no. of samples | Sample type | Sampling method | Sample collected by | Minimum sampling time | Minimum volume gas sampled ft[a] | Initial Analysis Type | Initial Analysis Method | Initial Analysis By | Final Analysis Type | Final Analysis Method | Final Analysis By |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Particulate, ORSAT[a] at inlet & outlet | 5B | MRC | 120 | 60 | Velocity, temp, $H_2O$, CO, $CO_2$, $O_2$ | 1-4 | MRC | Particulate | 5 | MRC |
| 3 | Particulate, ORSAT[a] at inlet & outlet | 5B | MRC | 120 | 60 | Velocity, temp, $H_2O$, CO, $CO_2$, $O_2$ | 1-4 | MRC | Particulate | 5 | MRC |
| 3 | Particulate, ORSAT[a] at inlet & outlet | 5B | MRC | 120 | 60 | Velocity, temp, $H_2O$, CO, $CO_2$, $O_2$ | 1-4 | MRC | Particulate | 5 | MRC |
| 9 | Coal | Grab | MRC | Simultaneous with above | | | | | S, Ash, moisture, | ASTM | Bowser-Morner Labs |
| 9 | Opacity | 9 | MRC | Simultaneous with above | | Visual Observation | | MRC | | | |
| 9 | Particle sizing at inlet & outlet | Andersen | MRC | After each run listed above | | | | | Particle sizing | Andersen | MRC |
| 3 | Particulate, ORSAT[b] at outlet | 5B | MRC | 120 | 60 | Velocity, temp, $H_2O$, CO, $CO_2$, $O_2$ | 1-4 | MRC | Particulate | 5 | MRC |
| 3 | Particulate, ORSAT[c] at inlet to baghouse | 5B | MRC | 120 | 60 | Velocity, temp, $H_2O$, CO, $CO_2$, $O_2$ | 1-4 | MRC | | 5 | MRC |
| 3 | Particulate sizing at inlet to baghouse | Andersen | MRC | After run listed above | | | | | Particle sizing | Andersen | MRC |

[a]Phase I testing at 2/3, 1/2, and 1/3 boiler loading.

[b]Phase II testing at swing load.

[c]Phase II testing at new location.

## SECTION 2

## SUMMARY OF RESULTS

### DESCRIPTION OF MONITORING

Table 1 summarizes the monitoring that was performed at the Lansing Plant. Phase I sampling consisted of 3 test runs of Method 5B at each of three boiler loading conditions at the mechanical dust collector exhaust performed simultaneously with Method 5B sampling at the mechanical collector inlet. Because of the 18-foot duct width at the multicyclone inlet sampling point, two Method 5B sampling trains were set up on opposite sides of the duct to simultaneously sample the entire width of the duct. The boiler was operating under steady state conditions (no soot blowing or ash loading) at 1/2 capacity during the first set of runs, at 2/3 capacity for the second set, and at 1/3 loading for the final set.

Phase II sampling consisted of three runs of Method 5B conducted at the mechanical collector outlet only, with the boiler operating at a variable or "swing load" capacity. As a part of the Phase II sampling, three runs of Method 5B were performed at the inlet to the baghouse collector simultaneously with the Phase I testing at the 2/3 capacity boiler loading condition.

Methods 1 through 4 were used during all Method 5B sampling runs, as in typical compliance sampling runs. Sample volumes of at least 0.91 dry standard $m^3$ (32 dry standard $ft^3$) were taken during these runs. A total of 21 particle size measurements were taken using an Andersen cascade impactor. Andersen samples were collected at all sampling points, at the 2/3, 1/2, and 1/3 boiler load conditions immediately before or after the Method 5B runs, at a point of average velocity as determined by the Method 5B data. In addition, plume opacity was measured by EPA Method 9 during all of the Phase I emission testing.

Feed coal samples were taken at the spreader-stoker inlet to the boiler. Samples were composited from individual samples collected before, during, and after each test run. The sulfur, ash, moisture, and Btu content of each aggregate sample were determined by ASTM methods.

## TEST RESULTS

Particulate emissions measured by Method 5B at the collector inlet, outlet, and baghouse inlet are summarized in Tables 2 and 3, in metric and English units, respectively. Tables 2 and 3 also show that the percent isokinetics for each sampling run ranged between 98.2 and 103.6, within the acceptable range of 90% to 110% for all except the first run, which was not isokinetic.

The amounts of particulates, water, and gas volumes reported for the multicyclone inlet runs represent the combined totals collected by the two inlet sampling trains. Velocity traverse data from both sampling trains have been combined for representative isokinetic duct sampling conditions over the entire width of the duct.

Emissions were calculated using the F-factor method described in 40 CFR 60.45 by the equation:

$$E = CF \frac{20.9}{20.9 - \%O_2},$$

where $E$ = emission rate, $lb/10^6$ Btu
$C$ = particulate concentration, lb/dscf
$F$ = constant for coal used, 9,820 $dscf/10^6$ Btu
$\%O_2$ = percent oxygen in stack

Tables showing all the calculations for emissions are shown in the latter part of Appendix B.

Emissions were not calculated from Run IT-1-1/2 because the sample probe was dipped into a dust pile while sampling which resulted in a non-representative sample.

Table 4 summarizes sampling duration, stack temperature, flow rate, static pressure, sample volume, and water content. Baghouse stack temperature data (runs FI-2/3) taken by the temperature sensor attached to the probe were incorrect due to the high negative pressure of the stack (-8 in. $H_2O$) which sucked in cooler outside air past the sensor. Baghouse stack temperature used in Table 4 are based on readings taken at the traverse points furthest from the sampling port.

Table 5 summarizes the integrated gas analysis results for the samples taken from the exhaust of the Method 5B train.

Table 6 summarizes the results of the Andersen Cascade impactor sampling. Figures for Andersen results are shown in Appendix A with the Andersen data sheets. Andersen sampling was performed at a point of average velocity as determined from the Method 5B data. With the exception of Run I-2-1/2, all runs were conducted under isokinetic conditions.

BLE 2. **PARTICULATE EMISSION DATA FOR GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN, APRIL 19-26, 1982 (METRIC UNITS)**

| Run number | te | Location | Boiler load | Average emissions: Actual g/dscm | Average emissions: kg/hr | Average emissions: ng/J | Corrected[a] to 12% $CO_2$, g/dscm | Percent isokinetic |
|---|---|---|---|---|---|---|---|---|
| IT-1-1/2 | 4 9-82 | Inlet | 1/2 | -[b] | -[b] | -[b] | -[b] | -[c] |
| O-1-1/2 | | Outlet | 1/2 | 0.1387 | 7.062 | 83.03 | 0.2685 | 103.7 |
| IT-2-1/2 | 4 :0-82 | Inlet | 1/2 | 2.9655 | 148.258 | 1,103 | 2.9169 | 100.0 |
| O-2-1/2 | | Outlet | 1/2 | 0.1103 | 5.548 | 47.41 | 0.1226 | 100.0 |
| IT-3-1/2 | 4 :0-82 | Inlet | 1/2 | 4.8727 | 196.242 | 1,812 | 4.6407 | 103.6 |
| O-3-1/2 | | Outlet | 1/2 | 0.1251 | 6.072 | 51.79 | 0.1486 | 103.6 |
| IT-1-2/3 | 4 :1-82 | Inlet | 2/3 | 5.8439 | 348.622 | 2,235 | 5.9784 | 103.0 |
| O-1-2/3 | | Outlet | 2/3 | 0.1463 | 8.905 | 59.41 | 0.1611 | 100.9 |
| FI-1-2/3 | | Baghouse inlet | 2/3 | 10.9487 | 147.062 | 4,186.4 | 11.2294 | 103.4 |
| IT-2-2/3 | 4-22-82 | Inlet | 2/3 | 4.0881 | 189.435 | 1,617 | 4.2685 | 98.2 |
| O-2-2/3 | | Outlet | 2/3 | 0.2049 | 11.105 | 91.85 | 0.2320 | 101.3 |
| FI-2-2/3 | | Baghouse inlet | 2/3 | 9.4426 | 124.099 | 3,735.0 | 9.8531 | 101.0 |
| IT-3-2/3 | 4-22-82 | Inlet | 2/3 | 6.6828 | 412.763 | 2,519.0 | 6.9420 | 99.2 |
| O-3-2/3 | | Outlet | 2/3 | 0.1647 | 8.989 | 81.22 | 0.2196 | 99.3 |
| FI-3-2/3 | | Baghouse in t | 2/3 | 9.7057 | 125.164 | 3,762.3 | 10.1277 | 99.6 |

(continued)

TABLE 2 (continued)

| Run number | Date | Location | Boiler load | Average emissions: Actual g/dscm | Average emissions: kg/hr | Average emissions: ng/J | Corrected to 12% $CO_2$,[a] g/dscm | Percent isokinetic |
|---|---|---|---|---|---|---|---|---|
| IT-1-1/3 | 4-24-82 | Inlet | 1/3 | 2.2267 | 83.724 | 980.6 | 2.8425 | 99.8 |
| O-1-1/3 | | Outlet | 1/3 | 0.1262 | 8.463 | 72.42 | 0.1941 | 100.4 |
| IT-2-1/3 | 4-24-82 | Inlet | 1/3 | 1.7338 | 60.551 | 763.5 | 2.2615 | 99.7 |
| O-2-1/3 | | Outlet | 1/3 | 0.1303 | 8.267 | 64.60 | 0.1907 | 98.5 |
| IT-3-1/3 | 4-24-82 | Inlet | 1/3 | 2.1755 | 71.041 | 1,050.0 | 2.7393 | 102.4 |
| O-3-1/3 | | Outlet | 1/3 | 0.1292 | 7.959 | 62.36 | 0.1723 | 101.8 |
| O-1-SL | 4-26-82 | Outlet | SL[d] | 0.2019 | 12.906 | 83.06 | 0.2330 | 100.2 |
| O-2-SL | 4-26-82 | Outlet | SL[d] | 0.2026 | 12.957 | 88.15 | 0.2431 | 98.7 |
| O-3-SL | 4-26-82 | Outlet | SL[d] | 0.1682 | 10.280 | 71.41 | 0.2103 | 98.5 |

[a]This is the concentration normalized to 12% $CO_2$. $C = C \times \frac{12}{\%CO_2}$; where C is the measured concentration in the stack, and percent $CO_2$ is the percent $CO_2$ measured in the stack.

[b]Emission rates not calculated due to nonrepresentative sample taken.

[c]Because of an error in temperature of meter, the first inlet run was not isokinetic.

[d]Swing load, variable load - approximately 2/3 capacity at time of sampling.

TABLE 3. EMISSION DATA FOR GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN, APRIL 19-26, 1982 (ENGLISH UNITS)

| Run number | Date | Location | Boiler load | Average emissions: Actual gr/dscf | Average emissions: lb/hr | Average emissions: lb/$10^6$ Btu | Corrected[a] to 12% $CO_2$, gr/dscf | Percent isokinetic |
|---|---|---|---|---|---|---|---|---|
| IT-1-1/2 | 4-19-82 | Inlet | 1/2 | -[b] | -[b] | -[b] | -[b] | -[c] |
| O-1-1/2 | | Outlet | 1/2 | 0.0606 | 15.570 | 0.19 | 0.1173 | 103.7 |
| IT-2-1/2 | 4-20-82 | Inlet | 1/2 | 1.2956 | 326.848 | 2.56 | 1.2744 | 100.0 |
| O-2-1/2 | | Outlet | 1/2 | 0.0482 | 12.231 | 0.11 | 0.0536 | 100.0 |
| IT-3-1/2 | 4-20-82 | Inlet | 1/2 | 2.1288 | 432.633 | 4.21 | 2.0274 | 103.6 |
| O-3-1/2 | | Outlet | 1/2 | 0.0546 | 13.386 | 0.12 | 0.0649 | 103.6 |
| IT-1-2/3 | 4-21-82 | Inlet | 2/3 | 2.5531 | 768.567 | 5.20 | 2.6119 | 103.0 |
| O-1-2/3 | | Outlet | 2/3 | 0.0639 | 19.632 | 0.14 | 0.0703 | 100.9 |
| FI-1-2/3 | | Baghouse inlet | 2/3 | 4.7834 | 324.210 | 9.73 | 4.9061 | 103.4 |
| IT-2-2/3 | 4-22-82 | Inlet | 2/3 | 1.7860 | 417.626 | 3.76 | 1.8637 | 98.2 |
| FI-2-2/3 | | Outlet | 2/3 | 0.0895 | 24.483 | 0.21 | 0.1013 | 101.3 |
| O-2-2/3 | | Baghouse inlet | 2/3 | 4.1254 | 273.587 | 8.68 | 4.3048 | 101.0 |
| IT-3-2/3 | 4-22-82 | Inlet | 2/3 | 2.9197 | 909.971 | 6.02 | 3.0467 | 99.2 |
| O-3-2/3 | | Outlet | 2/3 | 0.0720 | 19.818 | 0.19 | 0.0960 | 99.3 |
| FI-3-2/3 | | Baghouse inlet | 2/3 | 4.2403 | 275.935 | 8.74 | 4.4247 | 99.6 |

(continued)

TABLE 3 (continued)

| Run number | Date | Location | Boiler load | Average emissions: Actual gr/dscf | Average emissions: lb/hr | Average emissions: lb/$10^6$ Btu | Corrected to 12% $CO_2$,[a] gr/dscf | Percent isokinetic |
|---|---|---|---|---|---|---|---|---|
| IT-1-1/3 | 4-24-82 | Inlet | 1/3 | 0.9728 | 184.577 | 2.28 | 1.2418 | 99.8 |
| O-1-1/3 | | Outlet | 1/3 | 0.0551 | 18.657 | 0.17 | 0.0703 | 100.4 |
| IT-2-1/3 | 4-24-82 | Inlet | 1/3 | 0.7575 | 133.489 | 1.77 | 0.9880 | 99.7 |
| O-2-1/3 | | Outlet | 1/3 | 0.0569 | 18.226 | 0.15 | 0.0830 | 98.5 |
| IT-3-1/3 | 4-24-82 | Inlet | 1/3 | 0.9505 | 156.616 | 2.44 | 1.1968 | 102.4 |
| O-3-1/3 | | Outlet | 1/3 | 0.0565 | 17.546 | 0.14 | 0.0753 | 101.8 |
| O-1-SL | 4-26-82 | Outlet | SL[d] | 0.0882 | 28.453 | 0.19 | 0.1018 | 100.2 |
| O-2-SL | 4-26-82 | Outlet | SL[d] | 0.0885 | 28.565 | 0.20 | 0.1062 | 98.7 |
| O-3-SL | 4-26-82 | Outlet | SL[d] | 0.0735 | 22.663 | 0.17 | 0.0919 | 98.5 |

[a]This is the concentration normalized to 12% $CO_2$. $C = C \times \frac{12}{\%CO_2}$; where C is the measured concentration in the stack, and percent $CO_2$ is the percent $CO_2$ measured in the stack.

[b]Emission rates not calculated due to nonrepresentative sample taken.

[c]Because of an error in temperature of meter, the first inlet run was not performed under isokinetic conditions.

[d]Swing load, variable load - approximately 2/3 capacity at time of sampling.

TABLE 4. SUMMARY OF DURATION OF SAMPLING, STACK TEMPERATURE, STACK FLOW RATE, SAMPLE VOLUME, SAMPLE WATER CONTENT, AND STATIC PRESSURE AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN

| Run number | Location | Duration of sampling, min | Measured stack temperature, °C | Measured stack temperature, °F | Stack flow rate, dscm/min | Stack flow rate, dscf/min | Sample volume, dscm | Sample volume, dscf | Sample water content, % | Stack static pressures, cm $H_2O$ | Stack static pressures, in. $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IT-1-1/2 | Total inlet[a] | 132 | 140[b] | 283[b] | 698 | 24,648 | 1.22 | 43.06 | 7.76 | -2.54 | -1.00 |
| O-1-1/2 | Outlet | 126 | 144 | 291 | 849 | 29,978 | 0.95 | 33.42 | 6.26 | -0.38 | -0.15 |
| IT-2-1/2 | Total inlet | 144 | 138[b] | 280[b] | 834 | 29,437 | 1.95 | 68.77 | 6.10[b] | -2.54 | -1.00 |
| O-2-1/2 | Outlet | 126 | 142 | 287 | 848 | 29,959 | 0.93 | 32.50 | 7.22 | -0.38 | -0.15 |
| IT-3-1/2 | Total inlet | 144 | 139[b] | 282[b] | 672 | 23,714 | 1.62 | 57.36 | 8.81[b] | -2.54 | -1.00 |
| O-3-1/2 | Outlet | 126 | 141 | 286 | 810 | 28,589 | 1.49 | 52.60 | 7.00 | -0.38 | -0.15 |
| IT-1-2/3 | Total inlet | 144 | 150[b] | 301[b] | 988 | 34,879 | 2.39 | 84.47 | 7.94[b] | -5.08 | -2.00 |
| O-1-2/3 | Outlet | 126 | 153 | 308 | 1,015 | 35,833 | 1.40 | 49.29 | 7.37 | -0.38 | -0.15 |
| FI-1-2/3 | Baghouse inlet | 108 | 147[c] | 296[c] | 224 | 7,909 | 1.76 | 62.32 | 7.44 | -20.32 | -8.00 |
| IT-2-2/3 | Total inlet | 144 | 144[b] | 291[b] | 753 | 26,586 | 1.12 | 39.27 | 7.42[b] | -5.08 | -2.00 |
| O-2-2/3 | Outlet | 126 | 148 | 299 | 904 | 31,915 | 1.25 | 44.09 | 6.55 | -0.38 | -0.15 |
| FI-2-2/3 | Baghouse inlet | 108 | 147[c] | 296[c] | 219 | 7,738 | 1.69 | 59.57 | 7.51 | -20.32 | -8.00 |
| IT-3-2/3 | Total inlet | 144 | 147[b] | 297[b] | 1,031 | 36,413 | 2.01 | 71.02 | 7.83[b] | -5.08 | -2.00 |
| O-3-2/3 | Outlet | 126 | 153 | 298 | 910 | 32,139 | 1.62 | 57.04 | 7.20 | -0.38 | -0.15 |
| FI-3-2/3 | Baghouse inlet | 108 | 147[c] | 296[c] | 215 | 7,594 | 1.63 | 57.70 | 7.40 | -20.32 | -8.00 |

(continued)

TABLE 4 (continued)

| Run number | Location | Duration of sampling, min | Measured stack temperature °C | Measured stack temperature °F | Stack flow rate dscm/min | Stack flow rate dscf/min | Volume dscm | Volume dscf | Sample water content, % | Stack static pressures cm $H_2O$ | Stack static pressures in. $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IT-1-1/3 | Total inlet | 144 | 137[b] | 278[b] | 626 | 22,114 | 1.49 | 52.76 | 7.14[b] | -2.54 | -1.00 |
| O-1-1/3 | Outlet | 95 | 141 | 285 | 1,118 | 39,476 | 1.51 | 53.39 | 5.80 | -1.27 | -0.50 |
| IT-2-1/3 | Total inlet | 144 | 135[b] | 275[b] | 579 | 20,445 | 1.39 | 48.96 | 7.45[b] | -2.54 | -1.00 |
| O-2-1/3 | Outlet | 100 | 142 | 288 | 1,058 | 37,371 | 1.48 | 52.20 | 6.60 | -1.27 | -0.50 |
| IT-3-1/3 | Total inlet | 144 | 134[b] | 274[b] | 533 | 18,819 | 1.33 | 46.99 | 7.07[b] | -2.54 | -1.00 |
| O-3-1/3 | Outlet | 95 | 143 | 289 | 1,027 | 36,269 | 1.41 | 49.76 | 6.55 | -1.27 | -0.50 |
| O-1-SL | Outlet | 120 | 152 | 306 | 1,066 | 37,645 | 1.81 | 63.84 | 8.10 | -0.38 | -0.15 |
| O-2-SL | Outlet | 120 | 151 | 304 | 1,066 | 37,656 | 1.78 | 62.89 | 8.36 | -0.38 | -0.15 |
| O-3-SL | Outlet | 120 | 150 | 301 | 1,019 | 35,981 | 1.70 | 59.93 | 7.40 | -0.38 | -0.15 |

[a]Total inlet runs were conducted with two sampling trains at Inlet A and Inlet B.

[b]Average value for A and B sampling runs combined.

[c]Stack temperature for 3 baghouse runs as determined at the traverse point furtherest from the port opening of baghouse inlet. High negative pressure at this location prevented accurate readings at nearer points.

TABLE 5. SUMMARY OF INTEGRATED GAS ANALYSIS RESULTS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN, APRIL 19-26, 1982

| Run number | Location | Percent $CO_2$ | Percent CO | Percent $O_2$ | Percent $N_2$ | Dry molecular weight kg/kg mole (lb/lb mole) |
|---|---|---|---|---|---|---|
| IT-1-1/2 | Inlet | 10.6 | 0.2 | 7.8 | 81.4 | 30.0 |
| O-1-1/2 | Outlet | 6.2 | 1.3 | 11.7 | 80.8 | 29.5 |
| IT-2-1/2 | Inlet | 12.2 | 0.2 | 6.1 | 81.5 | 30.2 |
| O-2-1/2 | Outlet | 10.8 | 0.3 | 8.1 | 80.8 | 30.1 |
| IT-3-1/2 | Inlet | 12.6 | 0.4 | 6.1 | 80.9 | 30.3 |
| O-3-1/2 | Outlet | 10.1 | 0.9 | 7.6 | 81.4 | 29.9 |
| IT-1-2/3 | Inlet | 11.7 | 0.2 | 6.5 | 81.5 | 30.1 |
| O-1-2/3 | Outlet | 10.9 | 0.5 | 7.3 | 81.2 | 30.0 |
| FI-1-2/3 | Baghouse inlet | 11.7 | 0.2 | 6.5 | 81.5 | 30.1 |
| IT-2-2/3 | Inlet | 11.5 | 0.7 | 7.0 | 80.8 | 30.1 |
| O-2-2/3 | Outlet | 10.6 | 0.2 | 8.6 | 80.6 | 30.0 |
| FI-2-2/3 | Baghouse | 11.5 | 0.7 | 7.0 | 80.8 | 30.1 |
| IT-3-2/3 | Inlet | 11.5 | 1.5 | 6.3 | 81.0 | 30.2 |
| O-3-2/3 | Outlet | 9.0 | 0.9 | 9.7 | 80.4 | 30.0 |
| FI-3-2/3 | Baghouse inlet | 11.5 | 1.5 | 6.3 | 81.0 | 30.2 |
| IT-1-1/3 | Inlet | 9.4 | 0.7 | 8.3 | 81.6 | 29.8 |
| O-1-1/3 | Outlet | 7.8 | 1.0 | 10.3 | 80.8 | 29.6 |
| IT-2-1/3 | Inlet | 9.2 | 1.2 | 8.4 | 81.2 | 29.8 |
| O-2-1/3 | Outlet | 8.2 | 1.1 | 9.8 | 80.9 | 29.7 |
| IT-3-1/3 | Inlet | 9.4 | 0.2 | 8.3 | 81.6 | 29.8 |
| O-3-1/3 | Outlet | 7.8 | 0.7 | 10.3 | 80.8 | 29.6 |
| O-1-SL | Outlet | 9.2 | 0.4 | 8.4 | 81.2 | 29.8 |
| O-2-SL | Outlet | 9.2 | 0.9 | 8.4 | 81.2 | 29.8 |
| O-3-SL | Outlet | 8.2 | 0.9 | 9.8 | 80.9 | 29.7 |

TABLE 6. SUMMARY OF ANDERSEN PARTICLE SIZE RESULTS

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Inlet | I-1-1/2 | 0.018 | 0.65 | 91.1 | 0 | >12.9 | 94.86 | 5.14 |
| | | | | | 1 | 8.1-12.9 | 2.24 | 2.90 |
| | | | | | 2 | 5.5-8.1 | 0.79 | 2.11 |
| | | | | | 3 | 3.8-5.5 | 0.40 | 1.71 |
| | | | | | 4 | 2.4-3.8 | 0.66 | 1.05 |
| | | | | | 5 | 1.2-2.4 | 0.26 | 0.79 |
| | | | | | 6 | 0.74-1.2 | 0.26 | 0.53 |
| | | | | | 7 | 0.50-0.74 | 0.13 | 0.40 |
| | | | | | Final filter | 0.0-0.50 | 0.40 | 0.0 |
| Outlet | O-1-1/2 | 0.019 | 0.67 | 96.4 | 0 | >13.0 | 40.32 | 59.68 |
| | | | | | 1 | 8.2-13.0 | 4.03 | 55.65 |
| | | | | | 2 | 5.4-8.2 | 10.48 | 45.17 |
| | | | | | 3 | 3.9-5.4 | 15.32 | 29.85 |
| | | | | | 4 | 2.4-3.9 | 9.68 | 20.17 |
| | | | | | 5 | 1.2-2.4 | 8.07 | 12.10 |
| | | | | | 6 | 0.74-1.2 | 1.61 | 10.49 |
| | | | | | 7 | 0.50-0.74 | 2.42 | 8.07 |
| | | | | | Final filter | 0.0-0.50 | 8.07 | 0.0 |
| Inlet | I-2-1/2 | 0.026 | 0.91 | 122.3 | 0 | >11.4 | 92.98 | 7.02 |
| | | | | | 1 | 7.1-11.4 | 2.03 | 4.99 |
| | | | | | 2 | 4.8-7.1 | 0.92 | 4.07 |
| | | | | | 3 | 3.3-4.8 | 1.85 | 2.22 |
| | | | | | 4 | 2.2-3.3 | 0.55 | 1.67 |
| | | | | | 5 | 1.0-2.2 | 0.37 | 1.30 |
| | | | | | 6 | 0.64-1.0 | 0.37 | 0.93 |
| | | | | | 7 | 0.43-0.64 | 0.19 | 0.74 |

(continued)

TABLE 6 (continued)

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Outlet | O-2-1/2 | 0.019 | 0.68 | 100.4 | 0 | >13.0 | 56.58 | 43.42 |
| | | | | | 1 | 8.1-13.0 | 5.37 | 38.05 |
| | | | | | 2 | 5.5-8.1 | 6.34 | 31.71 |
| | | | | | 3 | 3.8-5.5 | 2.44 | 29.27 |
| | | | | | 4 | 2.4-3.8 | 9.27 | 20.00 |
| | | | | | 5 | 1.2-2.4 | 8.29 | 11.71 |
| | | | | | 6 | 0.74-1.2 | 0.49 | 11.22 |
| | | | | | 7 | 0.50-0.74 | 2.93 | 8.29 |
| | | | | | Final filter | 0.0-0.50 | 8.29 | 0.0 |
| Inlet | I-3-1/2 | 0.020 | 0.69 | 107.0 | 0 | >12.9 | 83.09 | 16.91 |
| | | | | | 1 | 8.1-12.9 | 4.86 | 12.05 |
| | | | | | 2 | 5.4-8.1 | 2.47 | 9.58 |
| | | | | | 3 | 3.7-5.4 | 1.60 | 7.98 |
| | | | | | 4 | 2.4-3.7 | 0.29 | 7.69 |
| | | | | | 5 | 1.2-2.4 | 2.83 | 4.86 |
| | | | | | 6 | 0.74-1.2 | 2.18 | 2.68 |
| | | | | | 7 | 0.50-074 | 2.03 | 0.65 |
| | | | | | Final filter | 0.0-0.50 | 0.65 | 0.0 |
| Outlet | O-3-1/2 | 0.019 | 0.67 | 101.1 | 0 | >13.1 | 14.47 | 85.53 |
| | | | | | 1 | 8.2-13.1 | 14.47 | 71.06 |
| | | | | | 2 | 5.5-8.2 | 15.79 | 55.27 |
| | | | | | 3 | 3.8-5.5 | 2.63 | 52.64 |
| | | | | | 4 | 2.4-3.8 | 7.90 | 44.74 |
| | | | | | 5 | 1.2-2.4 | 17.11 | 27.63 |
| | | | | | 6 | 0.75-1.2 | 10.52 | 17.11 |
| | | | | | 7 | 0.51-0.75 | 7.90 | 9.21 |
| | | | | | Final filter | 0.0-0.51 | 9.21 | 0.0 |

(continued)

TABLE 6 (continued)

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Inlet | I-1-2/3 | 0.020 | 0.72 | 102.1 | 0 | >12.4 | 90.41 | 9.59 |
| | | | | | 1 | 7.8-12.4 | 2.75 | 6.84 |
| | | | | | 2 | 5.2-7.8 | 3.80 | 3.04 |
| | | | | | 3 | 3.6-5.2 | 1.14 | 1.90 |
| | | | | | 4 | 2.3-3.6 | 0.28 | 1.62 |
| | | | | | 5 | 1.15-2.3 | 0.38 | 1.24 |
| | | | | | 6 | 0.72-1.15 | 0.29 | 0.95 |
| | | | | | 7 | 0.49-0.72 | 0.19 | 0.76 |
| | | | | | Final filter | 0.0-0.49 | 0.76 | 0.0 |
| Outlet | O-1-2/3 | 0.019 | 0.66 | 96.6 | 0 | >13.2 | 28.67 | 71.33 |
| | | | | | 1 | 8.2-13.2 | 10.04 | 61.29 |
| | | | | | 2 | 5.6-8.2 | 8.60 | 52.69 |
| | | | | | 3 | 3.8-5.6 | 19.35 | 33.34 |
| | | | | | 4 | 2.4-3.8 | 6.09 | 27.25 |
| | | | | | 5 | 1.2-2.4 | 12.19 | 15.06 |
| | | | | | 6 | 0.75-1.2 | 2.51 | 12.55 |
| | | | | | 7 | 0.51-0.75 | 2.51 | 10.04 |
| | | | | | Final filter | 0.0-0.51 | 10.04 | 0.0 |
| Inlet | I-2-2/3 | 0.023 | 0.80 | 105.9 | 0 | >12.0 | 80.04 | 19.96 |
| | | | | | 1 | 7.4-12.0 | 3.99 | 15.97 |
| | | | | | 2 | 5.0-7.4 | 6.37 | 9.60 |
| | | | | | 3 | 3.5-5.0 | 2.04 | 7.51 |
| | | | | | 4 | 2.2-3.5 | 2.28 | 5.23 |
| | | | | | 5 | 1.0-2.2 | 0.38 | 4.85 |
| | | | | | 6 | 0.67-1.0 | 0.67 | 4.18 |
| | | | | | 7 | 0.47-0.67 | 1.71 | 2.47 |
| | | | | | Final filter | 0.0-0.47 | 2.47 | 0.0 |

(continued)

TABLE 6 (continued)

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Outlet | O-2-2/3 | 0.019 | 0.66 | 100.3 | 0 | >13.2 | 26.34 | 73.66 |
| | | | | | 1 | 8.2-13.2 | 8.78 | 64.88 |
| | | | | | 2 | 5.6-8.2 | 10.25 | 54.63 |
| | | | | | 3 | 3.8-5.6 | 3.90 | 50.73 |
| | | | | | 4 | 2.4-3.8 | 13.17 | 37.56 |
| | | | | | 5 | 1.2-2.4 | 13.66 | 23.90 |
| | | | | | 6 | 0.75-1.2 | 5.85 | 18.05 |
| | | | | | 7 | 0.51-0.75 | 4.88 | 13.17 |
| | | | | | Final filter | 0.0-0.51 | 13.17 | 0.0 |
| Inlet | I-3-2/3 | 0.022 | 0.76 | 105.8 | 0 | >12.4 | 78.07 | 21.93 |
| | | | | | 1 | 7.7-12.4 | 5.06 | 16.87 |
| | | | | | 2 | 5.2-7.7 | 3.07 | 13.80 |
| | | | | | 3 | 3.6-5.2 | 3.99 | 9.81 |
| | | | | | 4 | 2.3-3.6 | 1.53 | 8.28 |
| | | | | | 5 | 1.1-2.3 | 2.45 | 5.83 |
| | | | | | 6 | 0.70-1.1 | 2.15 | 3.68 |
| | | | | | 7 | 0.48-0.70 | 0.92 | 2.76 |
| | | | | | Final filter | 0.0-0.48 | 2.76 | 0.0 |
| Outlet | O-3-2/3 | 0.019 | 0.66 | 99.7 | 0 | >13.2 | 17.07 | 82.93 |
| | | | | | 1 | 8.2-13.2 | 11.22 | 71.71 |
| | | | | | 2 | 5.6-8.2 | 7.80 | 63.91 |
| | | | | | 3 | 3.8-5.6 | 13.66 | 50.25 |
| | | | | | 4 | 2.4-3.8 | 10.24 | 40.01 |
| | | | | | 5 | 1.2-2.4 | 9.76 | 30.25 |
| | | | | | 6 | 0.75-1.2 | 7.81 | 22.44 |
| | | | | | 7 | 0.51-0.75 | 6.34 | 16.10 |
| | | | | | Final filter | 0.0-0.51 | 16.10 | 0.0 |

(continued)

TABLE 6 (continued)

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Inlet | I-1-1/3 | 0.021 | 0.75 | 102.4 | 0 | >12.5 | 86.24 | 13.76 |
| | | | | | 1 | 7.8-12.5 | 3.52 | 10.24 |
| | | | | | 2 | 5.2-7.8 | 2.52 | 7.72 |
| | | | | | 3 | 3.6-5.2 | 2.18 | 5.54 |
| | | | | | 4 | 2.3-3.6 | 0.84 | 4.70 |
| | | | | | 5 | 1.1-2.3 | 0.84 | 3.86 |
| | | | | | 6 | 0.70-1.1 | 1.17 | 2.69 |
| | | | | | 7 | 0.48-0.70 | 0.17 | 2.52 |
| | | | | | Final filter | 0.0-0.48 | 2.52 | 0.0 |
| Outlet | O-1-1/3 | 0.020 | 0.69 | 100.9 | 0 | >12.9 | 18.71 | 81.29 |
| | | | | | 1 | 8.1-12.9 | 10.32 | 70.97 |
| | | | | | 2 | 5.4-8.1 | 13.55 | 57.42 |
| | | | | | 3 | 3.7-5.4 | 10.97 | 46.45 |
| | | | | | 4 | 2.4-3.7 | 12.26 | 34.19 |
| | | | | | 5 | 1.2-2.4 | 7.74 | 26.45 |
| | | | | | 6 | 0.74-1.2 | 6.45 | 20.00 |
| | | | | | 7 | 0.50-0.74 | 7.10 | 12.90 |
| | | | | | Final filter | 0.0-0.50 | 12.90 | 0.0 |
| Inlet | I-2-1/3 | 0.020 | 0.69 | 102.8 | 0 | >12.7 | 87.67 | 12.33 |
| | | | | | 1 | 8.0-12.7 | 3.04 | 9.29 |
| | | | | | 2 | 5.4-8.0 | 2.53 | 6.76 |
| | | | | | 3 | 3.7-5.4 | 1.18 | 5.58 |
| | | | | | 4 | 2.4-3.7 | 1.52 | 4.06 |
| | | | | | 5 | 1.2-2.4 | 0.17 | 3.89 |
| | | | | | 6 | 0.73-1.2 | 1.01 | 2.88 |
| | | | | | 7 | 0.49-0.73 | 0.51 | 2.37 |
| | | | | | Final filter | 0.0-0.49 | 2.37 | 0.0 |

(continued)

TABLE 6 (continued)

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Outlet | O-2-1/3 | 0.020 | 0.69 | 100.5 | 0 | >12.9 | 23.72 | 76.28 |
| | | | | | 1 | 8.1-12.9 | 7.11 | 69.17 |
| | | | | | 2 | 5.4-8.1 | 9.48 | 59.69 |
| | | | | | 3 | 3.7-5.4 | 10.28 | 49.41 |
| | | | | | 4 | 2.4-3.7 | 17.00 | 32.41 |
| | | | | | 5 | 1.2-2.4 | 10.28 | 22.13 |
| | | | | | 6 | 0.74-1.2 | 6.72 | 15.41 |
| | | | | | 7 | 0.50-0.74 | 4.74 | 10.67 |
| | | | | | Final filter | 0.0-0.50 | 10.67 | 0.0 |
| Inlet | I-3-1/3 | 0.018 | 0.63 | 103.1 | 0 | >13.1 | 86.62 | 13.38 |
| | | | | | 1 | 8.2-13.1 | 4.25 | 9.13 |
| | | | | | 2 | 5.6-8.2 | 2.02 | 7.11 |
| | | | | | 3 | 3.8-5.6 | 1.39 | 5.72 |
| | | | | | 4 | 2.45-3.8 | 1.67 | 4.05 |
| | | | | | 5 | 1.25-2.45 | 1.53 | 2.52 |
| | | | | | 6 | 0.75-1.25 | 0.77 | 1.75 |
| | | | | | 7 | 0.52-0.75 | 0.84 | 0.91 |
| | | | | | Final filter | 0.0-0.52 | 0.91 | 0.0 |
| Outlet | O-3-1/3 | 0.021 | 0.73 | 107.1 | 0 | >12.6 | 20.24 | 79.76 |
| | | | | | 1 | 7.8-12.6 | 5.95 | 73.81 |
| | | | | | 2 | 5.3-7.8 | 4.76 | 69.05 |
| | | | | | 3 | 3.6-5.3 | 11.91 | 57.14 |
| | | | | | 4 | 2.3-3.6 | 10.71 | 46.43 |
| | | | | | 5 | 1.1-2.3 | 7.14 | 39.29 |
| | | | | | 6 | 0.71-1.1 | 12.50 | 26.79 |
| | | | | | 7 | 0.48-0.71 | 14.88 | 11.91 |
| | | | | | Final filter | 0.0-0.48 | 11.91 | 0.0 |

(continued)

TABLE 6 (continued)

| Location | Run | Flow rate acm/min | Flow rate acf/min | Percent isokinetic | Stage | Size range, µm | Percent in size range | Cumulative percent, <size range |
|---|---|---|---|---|---|---|---|---|
| Baghouse inlet | FI-1-2/3 | 0.019 | 0.68 | 102.4 | 0 | >12.8 | 74.14 | 25.86 |
| | | | | | 1 | 8.0-12.8 | 4.37 | 21.49 |
| | | | | | 2 | 5.4-8.0 | 3.90 | 17.59 |
| | | | | | 3 | 3.7-5.4 | 2.95 | 14.64 |
| | | | | | 4 | 2.4-3.7 | 3.66 | 10.98 |
| | | | | | 5 | 1.2-2.4 | 2.24 | 8.74 |
| | | | | | 6 | 0.73-1.2 | 3.78 | 4.96 |
| | | | | | 7 | 0.49-0.73 | 1.65 | 3.31 |
| | | | | | Final filter | 0.0-0.49 | 3.31 | 0.0 |
| Baghouse inlet | FI-2-2/3 | 0.020 | 0.69 | 104.0 | 0 | >12.9 | 86.36 | 13.64 |
| | | | | | 1 | 8.1-12.9 | 0.44 | 13.20 |
| | | | | | 2 | 5.4-8.1 | 5.90 | 7.30 |
| | | | | | 3 | 3.7-5.4 | 3.08 | 4.22 |
| | | | | | 4 | 2.4-3.7 | 0.44 | 3.78 |
| | | | | | 5 | 1.2-2.4 | 0.35 | 3.43 |
| | | | | | 6 | 0.74-1.2 | 0.97 | 2.46 |
| | | | | | 7 | 0.50-0.74 | 2.11 | 0.35 |
| | | | | | Final filter | 0.0-0.50 | 0.35 | 0.0 |
| Baghouse inlet | FI-3-2/3 | 0.019 | 0.68 | 101.8 | 0 | >13.0 | 75.00 | 25.00 |
| | | | | | 1 | 8.1-13.0 | 7.44 | 17.56 |
| | | | | | 2 | 5.5-8.1 | 3.37 | 14.19 |
| | | | | | 3 | 3.8-5.5 | 2.11 | 12.08 |
| | | | | | 4 | 2.4-3.8 | 4.50 | 7.58 |
| | | | | | 5 | 1.2-2.4 | 2.81 | 4.77 |
| | | | | | 6 | 0.74-1.2 | 0.56 | 4.21 |
| | | | | | 7 | 0.50-0.74 | 0.70 | 3.51 |
| | | | | | Final filter | 0.0-0.50 | 3.51 | 0.0 |

Tables 7a-7i summarize results of nine visible emissions observations taken according to EPA Method 9 during all of the Phase I emission testing.

Coal analysis data is summarized in Table 8.

TABLE 7a. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 1-1/2

Date: 4-19-82 Type of Plant: Automobile

Type of Discharge: Stack Location of Discharge: Boiler #2 Stack

Height of Point of Discharge: 150 ft Description of Sky: Cloudy

Wind Direction: W Wind Velocity: 5-10 mph

Color of Plume: Brown to black Detached Plume: No

Observer Name: Vasu B. Kulkarni Duration of Observation: 174 min total[a]

Distance From Observer to Discharge Point: 200 ft

Direction of Observer From Discharge Point: SE

Height of Observation Point: Ground level

Description of Background: Blue sky, changing to dark gray cloudy sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| 1 | 14:10 | 14:15 | 140 | 5.8 |
| 2 | 14:16 | 14:21 | 110 | 4.6 |
| 3 | 14:32 | 14:27 | 210 | 8.8 |
| 4 | 14:28 | 14:33 | 160 | 6.7 |
| 5 | 14:34 | 14:39 | 120 | 5.0 |
| 6 | 14:40 | 14:45 | 135 | 5.6 |
| Test began | | | | |
| 7 | 14:46 | 14:51 | 175[b] | 7.3[b] |
| 8 | 14:52 | 14:57 | 125[b] | 6.3[b] |
| 9 | 14:58 | 15:03 | 120[b] | 10.0[b] |
| 10 | 15:04 | 15:09 | 105[b] | 9.5[b] |
| 11 | 15:10 | 15:15 | 30[c] | 7.5[c] |
| 12 | 15:15 | 15:21 | 210[b] | 9.5[b] |
| 13 | 15:22 | 15:27 | 180[b] | 11.3[b] |
| 14 | 15:28 | 15:33 | 400[b] | 16.7[b] |
| 15 | 15:34 | 15:39 | 160[b] | 12.3[b] |
| 16 | 15:40 | 15:45 | 220[b] | 13.8[b] |
| 17 | 15:46 | 15:51 | 310 | 12.9 |
| 18 | 15:52 | 15:57 | 225 | 9.4 |
| 19 | 15:58 | 16:03 | 275 | 11.5 |
| 20 | 16:04 | 16:09 | 280 | 11.7 |
| 21 | 16:10 | 16:15 | 95[b] | 10.6[b] |
| 22 | 16:16 | 16:21 | 45[c] | 5.6[c] |
| 23 | 16:22 | 16:27 | 205 | 8.5 |
| 24 | 16:28 | 16:33 | 210 | 8.8 |
| 25 | 16:34 | 16:39 | 190 | 7.9 |
| 26 | 16:40 | 16:45 | 155[b] | 9.7[b] |
| 27 | 16:46 | 16:51 | 230 | 9.6 |
| 28 | 16:52 | 16:57 | 285 | 11.9 |
| 29 | 16:58 | 17:03 | 250[d] | 10.4[d] |
| Test ended[e] | | | | |
| Average, all sets | | | | 9.3 |

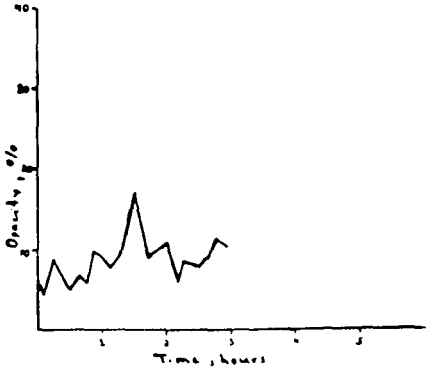


TABLE 7b. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 2-1/2

Date: 4-20-82 | Type of Plant: Automobile

Type of Discharge: Stack | Location of Discharge: Boiler #2 Stack

Height of Point of Discharge: 150 ft | Description of Sky: Overcast to clearing

Wind Direction: W | Wind Velocity: 10 mph

Color of Plume: Black | Detached Plume: No

Observer Name: Vasu B. Kulkarni | Duration of Observation: 174 min total[a]

Distance From Observer to Discharge Point: 250 ft

Direction of Observer From Discharge Point: S

Height of Observation Point: Ground level

Description of Background: Dark gray clouds, changing to blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| 1 | 9:30 | 9:35 | 130 | 5.4 |
| Test began | | | | |
| 2 | 9:36 | 9:41 | 140[b] | 5.8[b] |
| 3 | 9:42 | 9:47 | 90[b] | 5.0[b] |
| 4 | 9:48 | 9:53 | 60[b] | 5.0[b] |
| 5 | 9:54 | 9:59 | 120[b] | 5.0[b] |
| 6 | 10:00 | 10:05 | 55[b] | 5.0[b] |
| 7 | 10:06 | 10:11 | 185 | 7.7 |
| 8 | 10:12 | 10:17 | 135[b] | 5.6[b] |
| 9 | 10:18 | 10:23 | 50[b] | 5.6[b] |
| 10 | 10:24 | 10:29 | 160[b] | 8.0[b] |
| 11 | 10:30 | 10:36 | 715[b] | 29.8[b] |
| 12 | 10:36 | 10:41 | 55[b] | 13.8[b] |
| 13 | 10:42 | 10:47 | 75[b] | 6.3[b] |
| 14 | 10:48 | 10:53 | 200 | 8.3 |
| 15 | 10:54 | 10:59 | 160 | 6.7 |
| 16 | 11:00 | 11:05 | 200[b] | 8.3[b] |
| 17 | 11:06 | 11:11 | 230[b] | 10.5[b] |
| 18 | 11:12 | 11:17 | 190[b] | 7.9[b] |
| 19 | 11:18 | 11:23 | 180[b] | 8.2[b] |
| 20 | 11:24 | 11:29 | 45[b] | 5.0[b] |
| 21 | 11:30 | 11:35 | 80[b] | 7.3[b] |
| 22 | 11:36 | 11:41 | 235 | 9.8 |
| 23 | 11:42 | 11:47 | [b,c] | [b,c] |
| 24 | 11:48 | 11:53 | 385[c] | 16.0[c] |
| Test ended | | | | |
| 25 | 11:54 | 11:59 | 55[b] | 13.8[b] |
| 26 | 12:00 | 12:05 | 150[b] | 7.9[b] |
| 27 | 12:06 | 12:11 | 200[b] | 10.0[b] |
| 28 | 12:12 | 12:17 | 195[b] | 9.3[b] |
| 29 | 12:18 | 12:23 | 80 | 10.0 |
| Average, all sets except 23 | | | | 8.8 |

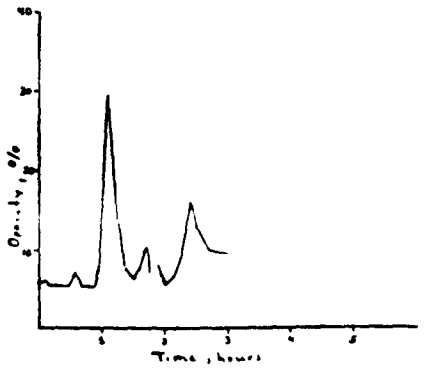


TABLE 7c. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 3-1/2

Date: 4-20-82 Type of Plant: Automobile

Type of Discharge: Stack Location of Discharge: Boiler #2 Stack

Height of Point of Discharge: 150 ft Description of Sky: Partly Cloudy

Wind Direction: W Wind Velocity: 10-15 mph

Color of Plume: Black to brown Detached Plume: No

Observer Name: Vasu B. Kulkarni Duration of Observation: 168 min total[a]

Distance From Observer to Discharge Point: 350 ft

Direction of Observer From Discharge Point: N changing to SE

Height of Observation Point: Ground level

Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| Test began | | | | |
| 1 | 14:40 | 14:45 | 85[b] | 5.0[b] |
| 2 | 14:46 | 14:51 | 50[b] | 5.0[b] |
| 3 | 14:52 | 14:57 | 95[b] | 6.8[b] |
| 4 | 14:58 | 15:03 | 75[b] | 6.3[b] |
| 5 | 15:04 | 15:09 | -[b] | -[b] |
| 6 | 15:10 | 15:15 | 110[b] | 5.0[b] |
| 7 | 15:16 | 15:21 | 80[b] | 5.0[b] |
| 8 | 15:22 | 15:27 | 30[b] | 5.0[b] |
| 9 | 15:28 | 15:33 | 75[b] | 7.5[b] |
| 10 | 15:34 | 15:39 | 140[b] | 7.0[b] |
| 11 | 15:40 | 15:45 | -[c] | -[c] |
| 12 | 15:46 | 15:51 | 40[c] | 5.0[c] |
| 13 | 15:52 | 15:57 | 100[b] | 5.3[b] |
| 14 | 15:58 | 16:03 | 45[b] | 5.0[b] |
| 15 | 16:04 | 16:09 | 165[b] | 6.9[b] |
| 16 | 16:10 | 16:15 | 215[b] | 10.2[b] |
| 17 | 16:16 | 16:21 | 275 | 11.5 |
| 18 | 16:22 | 16:27 | 280 | 11.7 |
| 19 | 16:28 | 16:33 | 170[b] | 9.4[b] |
| 20 | 16:34 | 16:39 | 255[b] | 12.8[b] |
| 21 | 16:40 | 16:45 | 175[b] | 11.7[b] |
| 22 | 16:46 | 16:51 | 170[c] | 10.6[c] |
| 23 | 16:52 | 16:57 | 145[c] | 12.1[c] |
| Test ended | | | | |
| 24 | 15:58 | 17:03 | 250[b] | 10.9[b] |
| 25 | 17:04 | 17:09 | 150[b] | 7.5[b] |
| 26 | 17:10 | 17:15 | 145[b] | 8.1[b] |
| 27 | 17:16 | 17:21 | 200 | 8.3 |
| 28 | 17:22 | 17:27 | 70 | 5.8 |
| Average, all sets except 5 and 11 | | | | 7.9 |

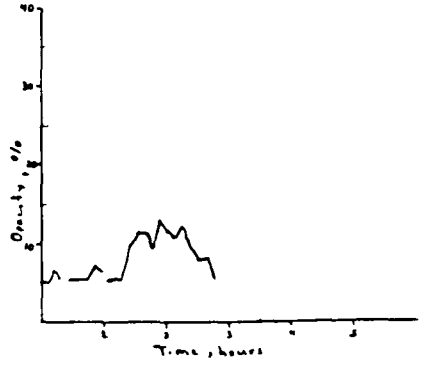


TABLE 7d. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 1-2/3

Date: 4-21-82
Type of Plant: Automobile
Type of Discharge: Stack
Location of Discharge: Boiler #2 Stack
Height of Point of Discharge: 150 ft
Description of Sky: Clear
Wind Direction: W
Wind Velocity: 10-15 mph
Color of Plume: Brown to black
Detached Plume: No
Observer Name: Vasu B. Kulkarni
Duration of Observation: 246 min total[a]
Distance From Observer to Discharge Point: 250 ft
Direction of Observer From Discharge Point: S
Height of Observation Point: Ground level
Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| 1 | 10:25 | 10:30 | 480 | 20.0 |
| 2 | 10:31 | 10:36 | 495 | 20.7 |
| 3 | 10:37 | 10:42 | 460 | 19.2 |
| 4 | 10:43 | 10:48 | 375 | 15.6 |
| Test began | | | | |
| 5 | 10:49 | 10:54 | 430 | 17.9 |
| 6 | 10:55 | 11:00 | 355[c] | 14.8[c] |
| 7 | 11:01 | 11:06 | -[c] | -[c] |
| 8 | 11:07 | 11:12 | -[c] | -[c] |
| 9 | 11:13 | 11:18 | -[c] | -[c] |
| 10 | 11:19 | 11:24 | 430 | 21.5 |
| 11 | 11:25 | 11:30 | 480[c] | 22.9[c] |
| 12 | 11:31 | 11:36 | 275[c] | 17.2[c] |
| 13 | 11:37 | 11:42 | 435 | 18.1 |
| 14 | 11:43 | 11:48 | 440 | 18.3 |
| 15 | 11:49 | 11:54 | 435 | 18.1 |
| 16 | 11:55 | 12:00 | 345[f] | 17.3[f] |
| 17 | 12 01 | 12:06 | -[f] | -[f] |
| 18 | 12 07 | 12:12 | -[f] | -[f] |
| 19 | 12 13 | 12:18 | 270[f] | 16.9[f] |
| 20 | 12 19 | 12:24 | 465 | 19.4 |
| 21 | 12.25 | 12:30 | 490 | 20.4 |
| 22 | 12:31 | 12:36 | 120[g] | 24.0[g] |
| 23 | 12 37 | 12:42 | -[g] | -[g] |
| 24 | 12:43 | 12:48 | -[g] | -[g] |
| 25 | 12:49 | 12:54 | 345[g] | 21.6[g] |
| 26 | 12:55 | 13:00 | 535 | 22.3 |
| 27 | 13:01 | 13:06 | 570 | 23.8 |
| 28 | 13:07 | 13:12 | 545 | 22.7 |
| 29 | 13:13 | 13:18 | 170[c] | 21.3[c] |
| 30 | 13:19 | 13:24 | -[c] | -[c] |
| 31 | 13:25 | 13:30 | 95[c] | 23.8[c] |
| 32 | 13 31 | 13:36 | 535 | 22.3 |
| 33 | 13 37 | 13:42 | 610 | 25.4 |
| 34 | 13:43 | 13:48 | 595 | 24.8 |
| 35 | 13 49 | 13:54 | 575 | 24.0 |
| 36 | 13 55 | 14:00 | 505 | 21.0 |
| 37 | 14:01 | 14:06 | 575 | 24.8 |
| Test ended | | | | |
| 38 | 14:07 | 14:12 | 545 | 22.7 |
| 39 | 14:13 | 14:18 | 485 | 20.2 |
| 40 | 14:19 | 14:24 | 405 | 16.9 |
| 41 | 14:25 | 14:30 | 340 | 17.0 |
| Average, all sets except 7, 8, 9, 17, 18, 23, 24, & 30 | | | | 20.5 |

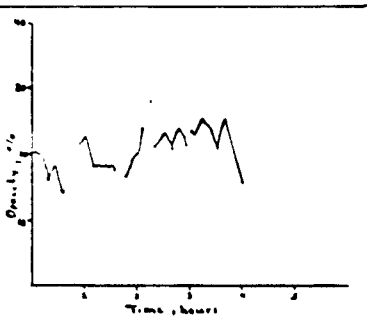


TABLE 7e. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 2-2/3

Date: 4-22-82 Type of Plant: Automobile

Type of Discharge: Stack Location of Discharge: Boiler #2 Stack

Height of Point of Discharge: 150 ft Description of Sky: Clear

Wind Direction: W Wind Velocity: 5-10 mph

Color of Plume: Brown to black Detached Plume: No

Observer Name: Vasu B. Kulkarni Duration of Observation: 162 min total[a]

Distance From Observer to Discharge Point: 200 ft

Direction of Observer From Discharge Point: NE, SE, S

Height of Observation Point: 50 ft

Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| 1 | 9:00 | 9:05 | 495 | 20.6 |
| 2 | 9:06 | 9:11 | 510 | 21.3 |
| Test began | | | | |
| 3 | 9:12 | 9:17 | 625 | 26.0 |
| 4 | 9:18 | 9:23 | 620 | 25.8 |
| 5 | 9:24 | 9:29 | 625 | 26.0 |
| 6 | 9:30 | 9:35 | 605 | 25.2 |
| 7 | 9:36 | 9:41 | 750 | 31.3 |
| 8 | 9:42 | 9:47 | 600 | 25.0 |
| 9 | 9:48 | 9:53 | 585 | 24.4 |
| 10 | 9:54 | 9:59 | 710 | 29.6 |
| 11 | 10:00 | 10:05 | 115[c] | 28.8[c] |
| 12 | 10:06 | 10:11 | 885 | 36.9 |
| 13 | 10:12 | 10:17 | 885 | 36.9 |
| 14 | 10:18 | 10:23 | 950 | 39.6 |
| 15 | 10:24 | 10:29 | 845 | 35.2 |
| 16 | 10:30 | 10:35 | 795 | 33.1 |
| 17 | 10:36 | 10:41 | 860 | 35.8 |
| 18 | 10:42 | 10:47 | 755[h] | 31.5[h] |
| 19 | 10:48 | 10:53 | 490[h] | 32.7[h] |
| 20 | 10:54 | 10:59 | 440[h] | 22.0[h] |
| 21 | 11:00 | 11:05 | 445[c] | 22.3[c] |
| 22 | 11:06 | 11:11 | 185[c] | 23.1[c] |
| 23 | 11:12 | 11:17 | 305[h] | 17.9[h] |
| 24 | 11:18 | 11:23 | 410 | 17.1 |
| 25 | 11:24 | 11:29 | 385 | 16.0 |
| Test ended | | | | |
| 26 | 11:30 | 11:35 | 420 | 17.5 |
| 27 | 11:36 | 11:41 | 370 | 23.1 |
| Average, all sets | | | | 26.8 |

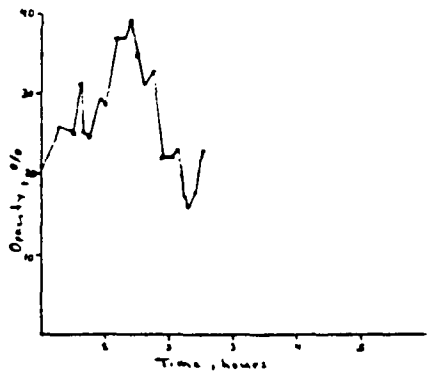


TABLE 7f. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 3-2/3

Date: 4-22-82
Type of Plant: Automobile
Type of Discharge: Stack
Location of Discharge: Boiler #2 Stack
Height of Point of Discharge: 150 ft
Description of Sky: Clear
Wind Direction: NW
Wind Velocity: 10 mph
Color of Plume: Brown to black
Detached Plume: No
Observer Name: Vasu B. Kulkarni
Duration of Observation: 174 min total[a]
Distance From Observer to Discharge Point: 200 ft
Direction of Observer From Discharge Point: S
Height of Observation Point: 50 ft
Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| 1 | 13:55 | 14:00 | 440 | 18.3 |
| 2 | 14:01 | 14:06 | 530 | 22.1 |
| Test began | | | | |
| 3 | 14:07 | 14:12 | 460 | 19.2 |
| 4 | 14:13 | 14:18 | 460 | 19.2 |
| 5 | 14:19 | 14:24 | 490[h] | 20.4[h] |
| 6 | 14:25 | 14:30 | 465[h] | 25.8[h] |
| 7 | 14:31 | 14:36 | 460 | 19.2 |
| 8 | 14:37 | 14:42 | 445 | 18.5 |
| 9 | 14:43 | 14:48 | 405[h] | 16.9[h] |
| 10 | 14:49 | 14:54 | 210[h] | 16.2[h] |
| 11 | 14:55 | 15:00 | 80[c] | 20.0[c] |
| 12 | 15:01 | 15:06 | 415 | 17.3 |
| 13 | 15:07 | 15:12 | 410 | 17.1 |
| 14 | 15:13 | 15:18 | 325[h] | 13.5[h] |
| 15 | 15:19 | 15:24 | 395[h] | 20.8[h] |
| 16 | 15:25 | 15:30 | 405[h] | 21.3[h] |
| 17 | 15:31 | 15:36 | 500 | 20.8 |
| 18 | 15:37 | 15:42 | 420 | 17.5 |
| 19 | 15:43 | 15:48 | 500 | 20.8 |
| 20 | 15:49 | 15:54 | 585[h] | 24.4[h] |
| 21 | 15:55 | 16:00 | 405[c] | 20.2[c] |
| 22 | 16:01 | 16:06 | 100[c] | 12.5[c] |
| 23 | 16:07 | 16:12 | 430 | 17.9 |
| 24 | 16:13 | 16:18 | 430 | 17.9 |
| 25 | 16:19 | 16:24 | 330 | 13.8 |
| 26 | 16:25 | 16:30 | 420 | 17.5 |
| 27 | 16:31 | 16:36 | 335 | 14.0 |
| Test ended | | | | |
| 28 | 16:37 | 16:40 | 210[h] | 13.1[h] |
| 29 | 16:43 | 16:46 | 135 | 16.9 |
| Average, all sets | | | | 18.4 |

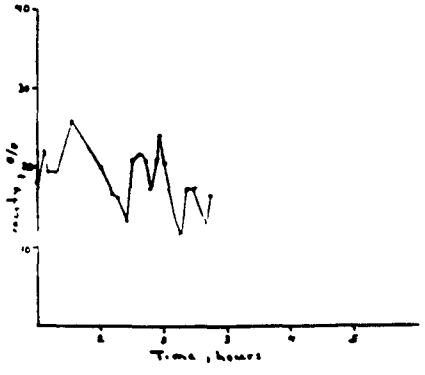


TABLE 7g. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 1-1/3

Date: 4-24-82 Type of Plant: Automobile

Type of Discharge: Stack Location of Discharge: Boiler #2 Stack

Height of Point of Discharge: 150 ft Description of Sky: Clear

Wind Direction: SW Wind Velocity: 5-10 mph

Color of Plume: Dark brown to black Detached Plume: No

Observer Name: Vasu B. Kulkarni Duration of Observation: 126 min total[a]

Distance From Observer to Discharge Point: 200 ft

Direction of Observer From Discharge Point: S

Height of Observation Point: 50 ft

Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| Test began | | | | |
| 1 | 8:15 | 8:20 | 475 | 19.8 |
| 2 | 8:21 | 8:26 | 535 | 22.3 |
| 3 | 8:27 | 8:32 | 570 | 23.8 |
| 4 | 8:33 | 8:38 | 610 | 25.4 |
| 5 | 8:39 | 8:44 | 600 | 25.0 |
| 6 | 8:45 | 8:50 | 605 | 25.2 |
| 7 | 8:51 | 8:56 | 385 | 16.0 |
| 8 | 8:57 | 9:02 | 370 | 15.4 |
| 9 | 9:03 | 9:08 | 410 | 17.1 |
| 10 | 9:09 | 9:14 | 360 | 15.0 |
| 11 | 9:15 | 9:20 | 235[c] | 19.6[c] |
| 12 | 9:21 | 9:26 | 520 | 21.7 |
| 13 | 9:27 | 9:32 | 360 | 15.0 |
| 14 | 9:33 | 9:38 | 345 | 14.4 |
| 15 | 9:39 | 9:44 | 330 | 13.8 |
| 16 | 9:45 | 9:50 | 265 | 11.0 |
| 17 | 9:51 | 9:56 | 335 | 14.0 |
| Test ended | | | | |
| 18 | 9:57 | 10:02 | 325 | 13.5 |
| 19 | 10:03 | 10:08 | 360 | 15.0 |
| 20 | 10:09 | 10:14 | 270 | 11.3 |
| 21 | 10:15 | 10:20 | 135 | 11.3 |
| Average, all sets | | | | 17.4 |

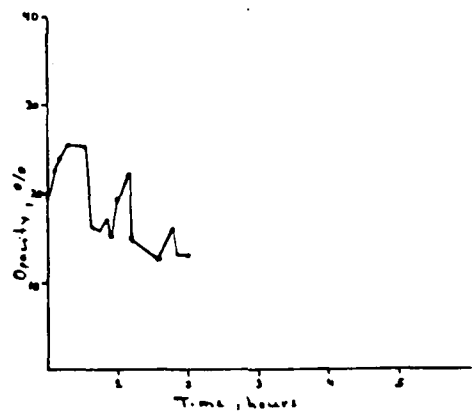


TABLE 7h. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 2-1/3

Date: 4-14-82 Type of Plant: Automobile

Type of Discharge: Stack Location of Discharge: Boiler #2 Stack

Height of Point of Discharge: 150 ft Description of Sky: Clear

Wind Direction: W Wind Velocity: 5-10 mph

Color of Plume: Brown to black Detached Plume: No

Observer Name: Vasu B. Kulkarni Duration of Observation: 126 min total[a]

Distance From Observer to Discharge Point: 300 ft

Direction of Observer From Discharge Point: S

Height of Observation Point: 50 ft

Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| Test began | | | | |
| 1 | 11:50 | 11:55 | 345 | 14.4 |
| 2 | 11:56 | 12:01 | 310 | 12.9 |
| 3 | 12:02 | 12:07 | 365 | 15.2 |
| 4 | 12:08 | 12:13 | 415 | 17.3 |
| 5 | 12:14 | 12:19 | 390 | 16.3 |
| 6 | 12:20 | 12:25 | 430 | 17.9 |
| 7 | 12:26 | 12:31 | 310 | 12.9 |
| 8 | 12:32 | 12:37 | 295 | 12.3 |
| 9 | 12:38 | 12:43 | 280 | 11.7 |
| 10 | 12:44 | 12:49 | 250 | 10.4 |
| 11 | 12:50 | 12:55 | 180[c] | 11.3[c] |
| 12 | 12:56 | 13:01 | 230 | 9.6 |
| [illegible] | 13:02 | 13:07 | 220 | 9.2 |
| 14 | 13:08 | 13:13 | 180 | 7.5 |
| 15 | 13:14 | 13:19 | 255 | 10.6 |
| 16 | 13:20 | 13:25 | 255 | 10.6 |
| 17 | 13:26 | 13:31 | 245 | 10.2 |
| 18 | 13:32 | 13:37 | 200 | 8.3 |
| Test ended | | | | |
| 19 | 13:38 | 13:43 | 205 | 8.5 |
| 20 | 13:44 | 13:49 | 175 | 7.3 |
| 21 | 13:50 | 13:55 | 70 | 8.8 |
| Average, all sets | | | | 11.6 |

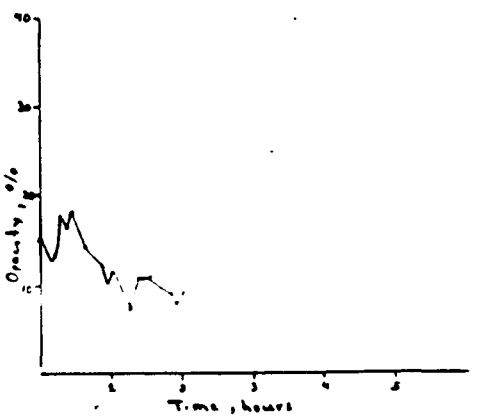


TABLE 7i. SUMMARY OF METHOD 9 VISIBLE EMISSION OBSERVATIONS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN - RUN NO. 3-1/3

Date: 4-24-82
Type of Plant: Automobile
Type of Discharge: Stack
Location of Discharge: Boiler #2 Stack
Height of Point of Discharge: 150 ft
Description of Sky: Clear
Wind Direction: W
Wind Velocity: 5 mph
Color of Plume: Dark brown to black
Detached Plume: No
Observer Name: Vasu B. Kulkarni
Duration of Observation: 120 min total[a]
Distance From Observer to Discharge Point: 250 ft
Direction of Observer From Discharge Point: N
Height of Observation Point: Ground level
Description of Background: Blue sky

| Summary of average opacity | | | | |
|---|---|---|---|---|
| Set number | Time | | Opacity | |
| | Start | End | Sum | Average |
| 1 | 15:30 | 15:35 | 250 | 10.4 |
| Test began | | | | |
| 2 | 15:36 | 15:41 | 150 | 6.3 |
| 3 | 15:42 | 15:47 | 180 | 7.5 |
| 4 | 15:48 | 15:53 | 160 | 6.7 |
| 5 | 15:54 | 15:59 | 205 | 8.6 |
| 6 | 16:00 | 16:05 | 345 | 14.4 |
| 7 | 16:06 | 16:11 | 420 | 17.5 |
| 8 | 16:12 | 16:17 | 490 | 20.4 |
| 9 | 16:18 | 16:23 | 560 | 23.3 |
| 10 | 16:24 | 16:29 | 540 | 22.5 |
| 11 | [illegible] | [illegible] | 520 | 21.7 |
| 12 | 16:36 | 16:41 | 545 | 22.7 |
| 13 | 16:42 | 16:47 | 460 | 19.2 |
| 14 | 16:48 | 16:53 | 335 | 14.0 |
| 15 | 16:54 | 16:59 | 255 | 10.6 |
| 16 | 17:00 | 17:05 | 260 | 10.8 |
| 17 | 17:06 | 17:11 | 240 | 10.0 |
| Test ended | | | | |
| 18 | 17:12 | 17:17 | 255 | 10.6 |
| 19 | 17:18 | 17:23 | 260 | 10.8 |
| 20 | 17:24 | 17:29 | 255 | 10.6 |
| Average, all sets | | | | 11.6 |

[a]Total observation time includes periods when no opacity readings could be obtained because of transient conditions.

[b]Observations were interrupted by poor visibility due to weather conditions and cloudy skies.

[c]Observations were interrupted by the move to a different observation point.

[d]Observations were suspended because of dark clouds and poor light for observation.

[e]Method 5B run was completed at 1801. Poor weather conditions prevented plume opacity observations during final hour of run.

[f]Observations were interrupted 15 min because of process changes.

[g]Observations were interrupted 19 min to obtain ice.

[h]Observations were interrupted because of interference from other stack plumes.

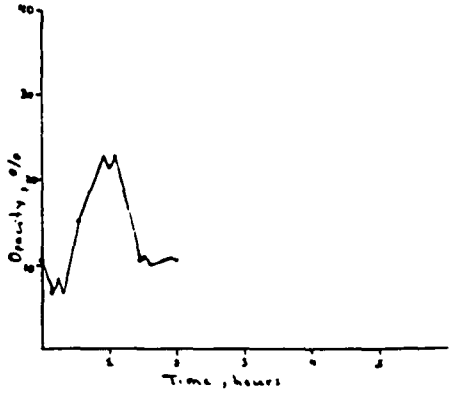


TABLE 8. SUMMARY OF COAL ANALYSIS AT GENERAL MOTORS CORPORATION, FISHER BODY DIVISION, BOILER NO. 2 IN LANSING, MICHIGAN APRIL 19-26, 1982

| Run number | Total moisture, percent | Heating value, Joule/gram, Dry | Heating value, Joule/gram, As received | Heating value, Btu/lb, Dry | Heating value, Btu/lb, As received | Ash, percent, Dry | Ash, percent, As received | Sulfur, percent, Dry | Sulfur, percent, As received |
|---|---|---|---|---|---|---|---|---|---|
| 1-1/2 | 11.47 | 30,638 | 27,123 | 13,187 | 11,674 | 8.65 | 7.66 | 1.05 | 0.92 |
| 2-1/2 | 18.81 | 35,389 | 28,730 | 15,232 | 12,366 | 7.69 | 6.24 | 0.90 | 0.73 |
| 3-1/2 | 13.01 | 27,952 | 24,316 | 12,031 | 10,466 | 8.06 | 7.01 | 0.98 | 0.86 |
| 1-2/3 | 13.25 | 31,123 | 27,000 | 13,396 | 11,621 | 7.73 | 6.71 | 0.86 | 0.75 |
| -2/3 | 12.48 | 32,439 | 28,391 | 13,962 | 12,220 | 7.54 | 6.60 | 1.02 | 0.89 |
| -2/3 | 4.33 | 31,730 | 30,354 | 13,657 | 13,065 | 6.02 | 5.76 | 0.81 | 0.77 |
| -1/3 | 10.20 | 29,120 | 26,150 | 12,534 | 11,255 | 9.80 | 8.80 | 1.14 | 1.03 |
| -1/3 | 11.75 | 29,390 | 25,938 | 12,650 | 11,164 | 8.85 | 7.81 | 1.04 | 0.92 |
| -1/3 | 11.63 | 30,391 | 26,858 | 13,081 | 11,560 | 10.45 | 9.24 | 0.95 | 0.84 |
| -1-SL | 15.33 | 29,539 | 25,010 | 12,714 | 10,765 | 9.32 | 7.89 | 1.29 | 1.09 |
| -2-SL | 15.08 | 30,315 | 25,472 | 13,048 | 11,080 | 8.99 | 7.63 | 1.22 | 1.03 |
| -3-SL | 14.30 | 29,490 | 25,273 | 12,693 | 10,878 | 11.28 | 9.67 | 1.72 | 1.48 |

# SECTION 3

## PROCESS DESCRIPTION
## (Provided by Radian Corporation)

This section presents a generalized description and discussion of the boiler and side stream separator process. This description includes a process flow diagram, equipment design data, design operating parameters, actual operating parameters and emission control performance data. The boiler and side stream separator are discussed individually in the following two subsections.

The process data collected during all emission testing periods are tabulated in Appendix C. Also present in Appendix C is a discussion of any process upsets or abnormalities that occurred during testing. Some general comments on the process operation are also included.

### BOILER SYSTEM DESCRIPTION

The Fisher Body plant in Lansing, Michigan is an auto body assembly plant operated by General Motors Corporation. Steam from the plants power house is required for both heating and assembly line operations at the Fisher Body and adjoining Oldsmobile assembly plants. Steam is supplied from five coal fired spreader stoker boilers. Three boilers are rated at 45,400 kg/hr (100,000 lb/hr) of steam (Boilers 7, 8, 11) while the remaining two (Boilers 1, 2) are rated at 81,720 kg/hr (180,000 lb/hr) of steam. Particulate emissions testing was conducted on Boiler 2, exclusively.

Figure 2 presents a process flow diagram for Boiler 2, which is a Riley Stoker Company Spreader Stoker with a rated heat output capacity of 81,720 kg/hr (180,000 lb/hr) of saturated steam at 1.2 MPa (175 psig). The side stream separator is also shown. Table 9 presents design and operating data for the boiler and its associated equipment. Side stream separator design and operating data are presented in the following subsection.

Coal is fed onto a traveling grate by four identical spreader feeder mechanisms. Boiler bottom ash is discarded continuously into the ash pit at the front end of the boiler and removed from the ash pit three times a day via a pneumatic ash removal system. This system was not used during the performance of any emission tests. Exhaust gases from the furnace exit the boiler and pass through the boiler outlet hopper. The larger, partially burned

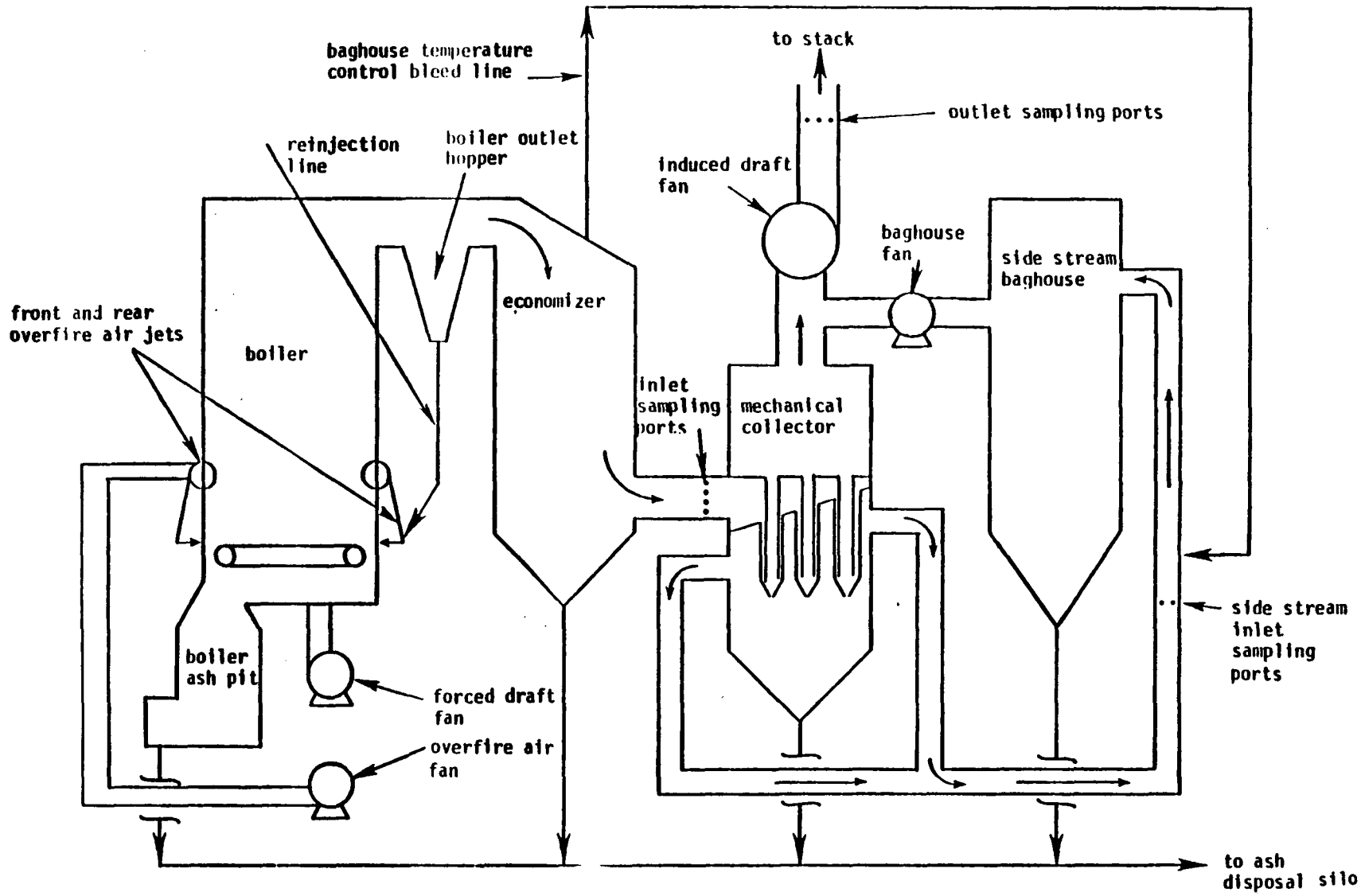



Figure 2. Boiler sidestream separator process flow diagram.

TABLE 9. BOILER DESIGN AND OPERATING DATA

| | |
|---|---|
| Year installed | 1976 |
| Manufacturer | Riley Stoker Company |
| Stoker type | Spreader Stoker |
| Grate type | Traveling grate front ash discharge |
| Rated capacity | 180,000 lb/hr steam |
| Boiler efficiency | 80.0% |
| Soot blowing system | None |
| Furnace draft leaving boiler | -1.0 inch $H_2O$ |
| Bottom ash discharge system | Pnuematic |
| Economizer data | |
| Number of gas passes | 3 vertical passes |
| Gas temperature entering | 590°F |
| Gas temperature leaving | 400°F |
| Draft loss | 1.3 inch $H_2O$ |
| Overfire air system data | |
| Number/diameter (front) | 14/1½" jets |
| Number/diameter (rear) | 28/1½" jets |
| Fly reinjection system data | |
| Ash trap location | Boiler outlet hopper |
| Reinjection port location | Through rear overfire jets |
| Coal specifications | |
| Sulfur | 0.77% |
| Ash | 5.22% |
| Btu/lb | 13,200 |
| Excess air data | |
| Actual | 55% |
| Manufacturers suggested | 30% |

coal particles that settle out in this hopper are removed and reinjected back into the furnace continuously through the rear overfire air jets. It should be noted there is no soot blowing system on Boiler 2.

As shown in Figure 2, Boiler 2 has an economizer which preheats incoming boiler feedwater from 104°C to 154°C at 1.7 MPa (220°F to 310°F at 250 psig). This increases the boilers thermal efficiency and results in a system draft loss of 3.3 cm (1.3 inch) wg. when the boiler operates at rated capacity. The economizer also acts as a particulate matter trap. Particulate matter settles out in the economizer hopper which is evacuated three times a day via the pneumatic ash removal system. All testing was performed downstream of the economizer and, therefore, its particulate matter removal capability is not addressed in this test report. At the boiler rated capacity, the flue gas temperature drop across the economizer is 88°C (190°F).

Boiler 2 has four fans operating on a continuous basis. Overfire air is supplied by a 75 HP fan which pressurizes two headers: one for the front and one for the rear overfire air jets. Combustion air is supplied by a 150 HP forced draft fan while system pressure drops are overcome by an 800 HP induced draft fan. The original design of the boiler system specified the installation of a scrubber. However, after the ID fan was installed GM opted to purchase low sulfur coal rather than scrub to reduce $SO_2$ emissions. Because the fan is designed to overcome the boiler system and scrubber pressure drops, it is now considered by GM to be oversized. This oversized fan results in a sensitive system that at times is difficult to control and stabilize. A slight fan control adjustment can subsequently result in a large system pressure change.

The fourth fan mentioned earlier is discussed in the following subsection.

SIDE STREAM SEPARATOR SYSTEM DESCRIPTION

A flow diagram of the side stream separator system was presented earlier in Figure 2. Design and operating data are presented in Table 10. The mechanical collector described in Table 10 was installed with the boiler in 1976. In 1980, the two module baghouse was added to the system to filter a slip stream from the mechanical collector hopper. The mechanical collector and baghouse collectively form the side stream separator system.

The baghouse is designed to filter about 20 percent of the total system flow when the boiler is operating at rated capacity. Under these conditions, the operating air-to-cloth ratio is 1.8 $m^3/min/m^2$ (6.0 $CFM/ft^2$) and the pressure drop across either of the two modules is 10.1 cm (4 inch) wg. The total filter area available is 304 $m^2$ (3267 $ft^2$) of teflon bag fabric supported on mild steel

TABLE 10. SIDE STREAM SEPARATOR DESIGN AND OPERATING DATA

| | |
|---|---|
| **Mechanical collector** | |
| Year installed | 1976 |
| Manufacturer | Western precipitation |
| Model | 9 VIOT |
| Collector efficiency | 96.8% |
| Tube diameter | 9 inches |
| Gas flow in[a] | 98,000 ACFM |
| Pressure drop | 2.9 inch w.g. |
| Ash discharge system | Pneumatic |
| **Baghouse** | |
| Year installed | 1980 |
| Manufacturer | Western precipitation |
| Collector efficiency[b] | 99.8% |
| Cleaning system | Pulse jet |
| Air/cloth | 6.0 CFM/$ft^2$ |
| Pressure drop | 4 inch $H_2O$ |
| Gas flow[a] (% of total flow) | 19,600 ACFM (20%) |
| Bag material | Teflon |
| Number of modules | 2 |
| Operating temperature range | 350-400°F |
| Temperature control system | Economizer gas mix[c] |
| Ash discharge system | Pneumatic |

[a]Flow at rated capacity.

[b]At rated capacity with an inlet loading of 5 lb/$10^6$ Btu.

[c]Less than 1% of hot economizer inlet gas flow mixed with baghouse inlet gas flow to increase inlet temperature when required.

cages. Bag filter cleaning is accomplished by operation of the pulse jet cleaning system. This system is operated on a continuous basis by programmed timers which pulse the bags by rows. Each row is individually controlled by an integral solenoid/diaphragm valve. Pulse duration is manually programmed into the system and depends on the inlet loading to the baghouse and subsequent pressure drop.

As previously mentioned, the baghouse fan pulls about 20 percent of the total flue gas flow from the mechanical collector hopper into the baghouse. Because this fan is a constant speed unit, the percentage flow to the baghouse increases with decreasing overall flue gas flowrate from the boiler. Therefore, as the boiler load decreases, percent flow to the baghouse increases.

As shown in Figure 2, baghouse temperature is regulated by an automatic valve which mixes hot economizer inlet gas with the baghouse inlet gas. This mixing value maintains baghouse temperature above the acid dew point and below the manufacturer's recommended maximum bag fabric temperature. The operating range is between 177°C to 204°C (350°F to 400°F). No more than 1 percent of the economizer inlet flowrate is required for baghouse temperature maintenance.

Prior to the start of testing the baghouse and mechanical collector were inspected for damage and wear. None was found. It should be noted that the bags in module two are a few months newer than those in module one. An overfilled hopper burned the old teflon bags in module two and necessitated their replacement. The effect of this age difference on the process parameters monitored is discussed in Appendix C.

## SECTION 4

## LOCATION OF SAMPLING POINTS

### INLET

Four, 7.6 cm (3 in.) I.D. sampling ports are located on each side of a 5.3 m (17.5 foot) by 1.4 m (4.6 foot) rectangular duct. The sampling ports are 0.3 m (1 foot) downstream of the mechanical collector (0.1 duct diameter) and 1.8 m (6 feet) upstream of the economizer (0.9 duct diameters) as shown in Figure 3.

A maximum 48-point traverse was conducted at this location, with 12 points being sampled at each port as shown in Figure 4. Due to the limited working space behind the ports (see Figure 3 end view) a 6-foot probe was used on one side of the duct and an 10-foot probe was used on the opposite side of the duct. Heated, flexible hoses were used from the probe to the oven box. Thus, two Method 5B trains were operating simultaneously at the inlet to sample all the points, except traverse point number 5 in Figure 3 which was not sampled.

### OUTLET

Three, 1.6 cm (4 in.) I.D. sampling ports are located on a 1.9 m (6.2 foot) by 2.1 m (6.8 foot) rectangular duct. The sampling ports are 1.7 m (5.5 feet) upstream of the 90 degree bend leading to the stack (0.9 duct diameters) and 6.1 m (20 feet) downstream of the cyclone collector (3.3 duct diameters), see Figure 5. This arrangement meets all criteria for an acceptable measurement specified under EPA Methods 1-5. A 42-point traverse was conducted at this location, with 14 points being sampled at each port as shown in Figure 6.

### COAL FEED SYSTEM

Low sulfur, preweighed coal is fed continuously to the boiler from a coveyer-hopper and the spreader stoker. The coal was sampled at the Boiler No. 2 coal feed from the conveyer belt, before during and after each run. These samples were combined for each run and stored in a plastic container. Photographs of the coal scale along with inlet and outlet ports to Boiler No. 2 are shown in Figure 7.

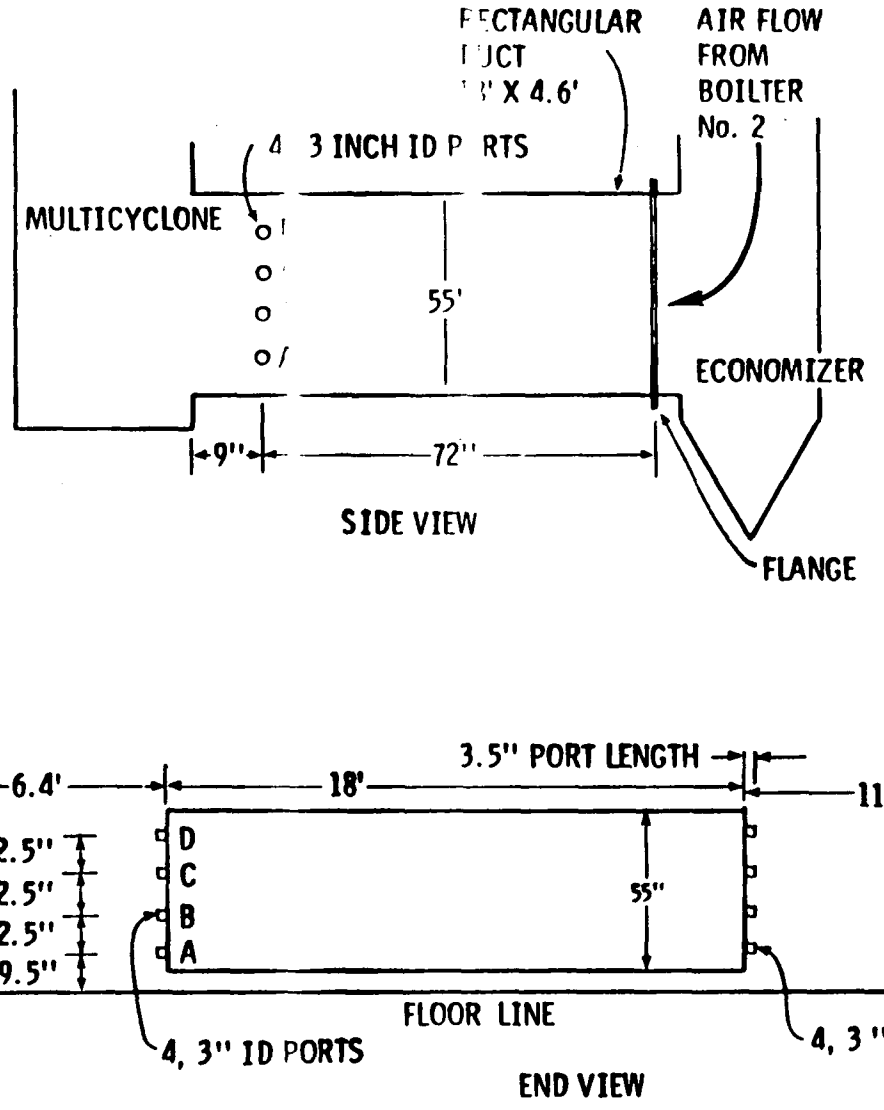
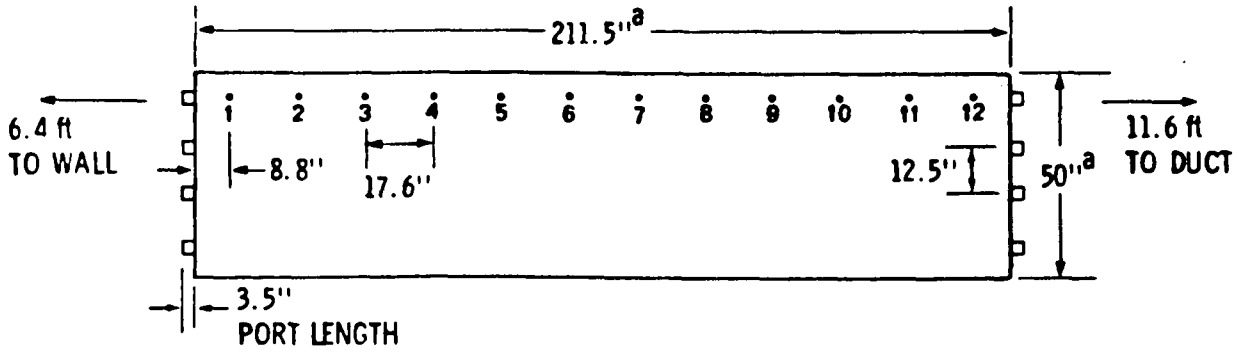


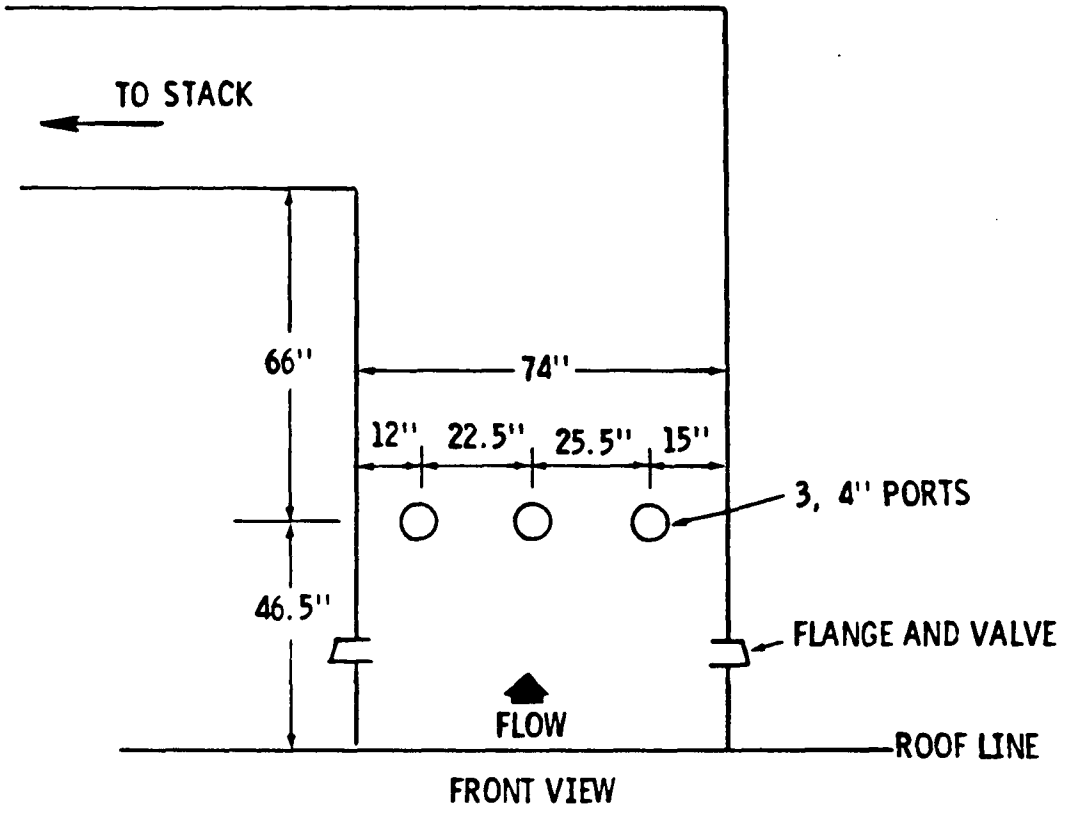

Figure 3. Inlet sampling ports to mechanical collector for Boiler #2 at GM Corporation, Fisher Body Division in Lansing, Michigan.




[a]INSIDE DIMENSION, EXCLUDING INSULATION

| Traverse point number | Inside of wall to traverse point, inch | Distance of port, inch | Traverse point location from outside of port, inch |
|---|---|---|---|
| 1 | 8.82 | 3.5 | 12.32 |
| 2 | 26.45 | 3.5 | 29.95 |
| 3 | 44.08 | 3.5 | 47.58 |
| 4 | 61.71 | 3.5 | 65.21 |
| 5 | 79.34 | 3.5 | 135.73 |
| 6 | 96.97 | 3.5 | 118.10 |
| 7 | 114.60 | 3.5 | 100.47 |
| 8 | 132.23 | 3.5 | 82.84 |
| 9 | 149.86 | 3.5 | 65.21 |
| 10 | 167.49 | 3.5 | 47.58 |
| 11 | 185.12 | 3.5 | 29.95 |
| 12 | 202.75 | 3.5 | 12.32 |

Figure 4. Traverse point location at inlet to mechanical collector for Boiler #2 at GM Corporation, Fisher Body Division in Lansing, Michigan.



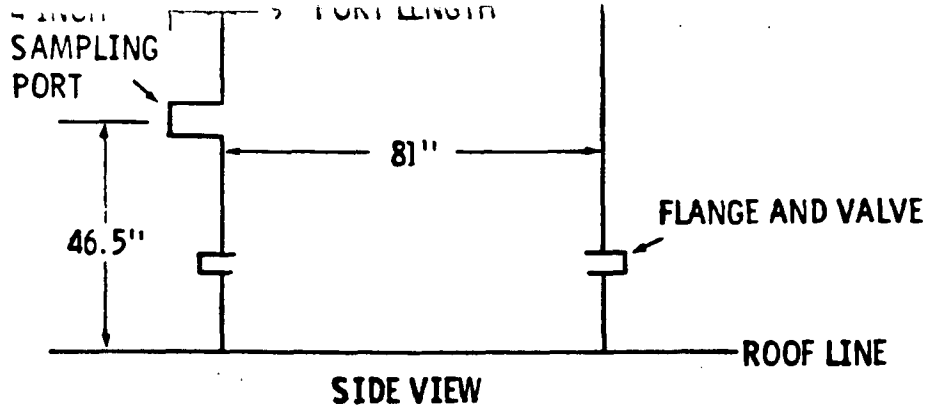
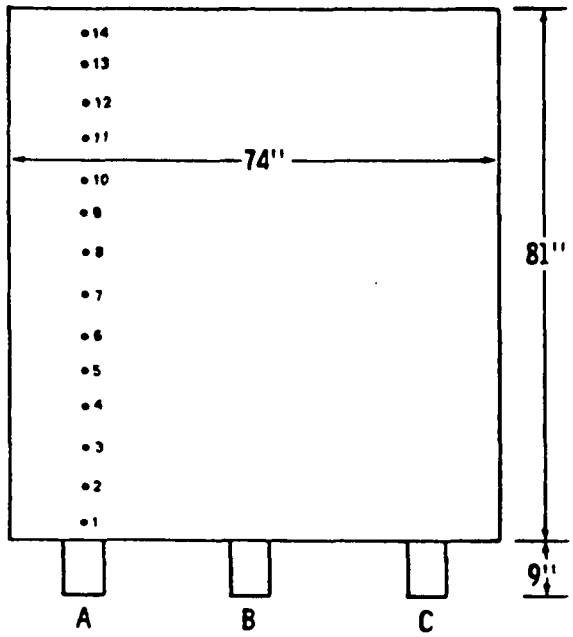
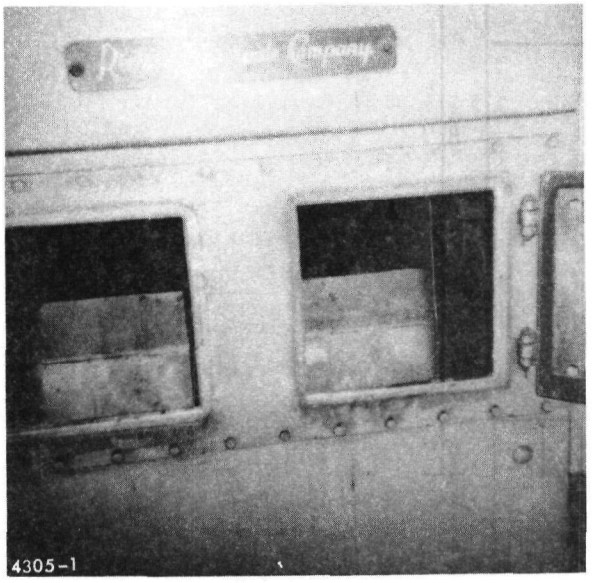




Figure 5. Port location on outlet of mechanical collector for Boiler #2 at GM Corporation, Fisher Body Division in Lansing, Michigan.

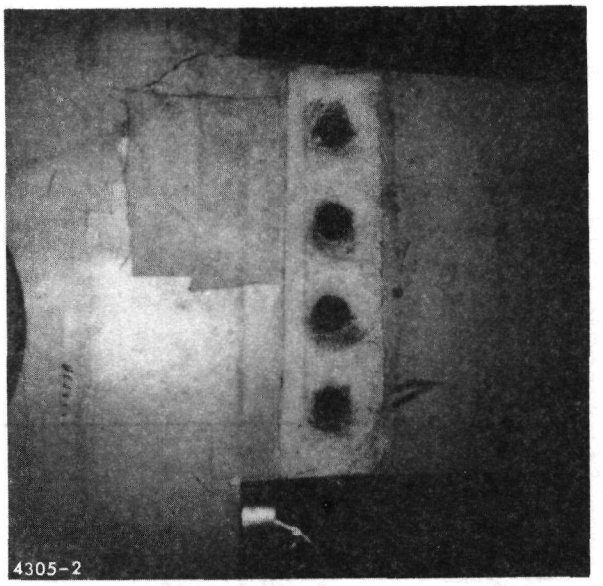



| Traverse point number | Inside of wall to traverse point, inch | Distance of port, inch | Traverse point location from outside of port, inch |
|---|---|---|---|
| 1 | 2.89 | 9.0 | 11.89 |
| 2 | 8.68 | 9.0 | 17.68 |
| 3 | 14.46 | 9.0 | 23.46 |
| 4 | 20.25 | 9.0 | 29.25 |
| 5 | 26.04 | 9.0 | 35.04 |
| 6 | 31.82 | 9.0 | 40.82 |
| 7 | 37.61 | 9.0 | 46.61 |
| 8 | 43.39 | 9.0 | 52.39 |
| 9 | 49.18 | 9.0 | 58.19 |
| 10 | 54.96 | 9.0 | 63.96 |
| 11 | 60.76 | 9.0 | 69.76 |
| 12 | 66.54 | 9.0 | 75.54 |
| 13 | 72.32 | 9.0 | 81.32 |
| 14 | 78.11 | 9.0 | 87.11 |

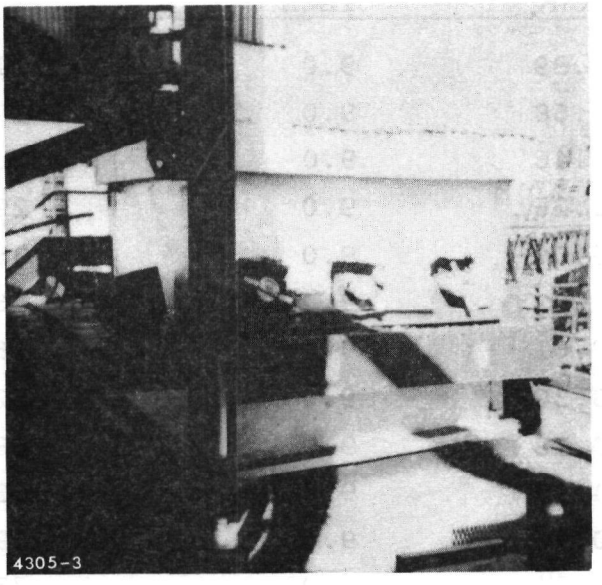
Figure 6. Traverse point locations for outlet of mechanical collector on Boiler #2 at GM Corporation, Fisher Body Division in Lansing, Michigan.




Coal Scale




Inlet Dust Collector
Boiler No. 1




Outlet I.D. Fan
Boiler No. 2

Figure 7. Photographs of coal scale, inlet and outlet ports for Boiler No. 2, General Motors Corporation, Fisher Body Division, in Lansing, Michigan.

BAGHOUSE

A third sampling point was located at the inlet of the baghouse collector as shown in Figure 1. This duct was sampled at the point near the inlet to the baghouse. The baghouse exhaust duct emptied into the top of the dust collector at a point before the roof level outlet sampling ports for the cyclone/dust collector.

Two, 1.6 cm (4 in.) I.D. sampling ports are located on a 0.73 m (2.40 ft) diameter duct. The sampling ports are 1.5 m (4.9 ft) upstream of the change in direction of flow (2.0 duct diameters) and 1.5 m (4.9 ft) downstream of the duct 90° elbow (2.0 duct diameters) as shown in Figure 8. A 36-point traverse was conducted at this location, with 16 points being sampled at each port as shown in Figure 9.

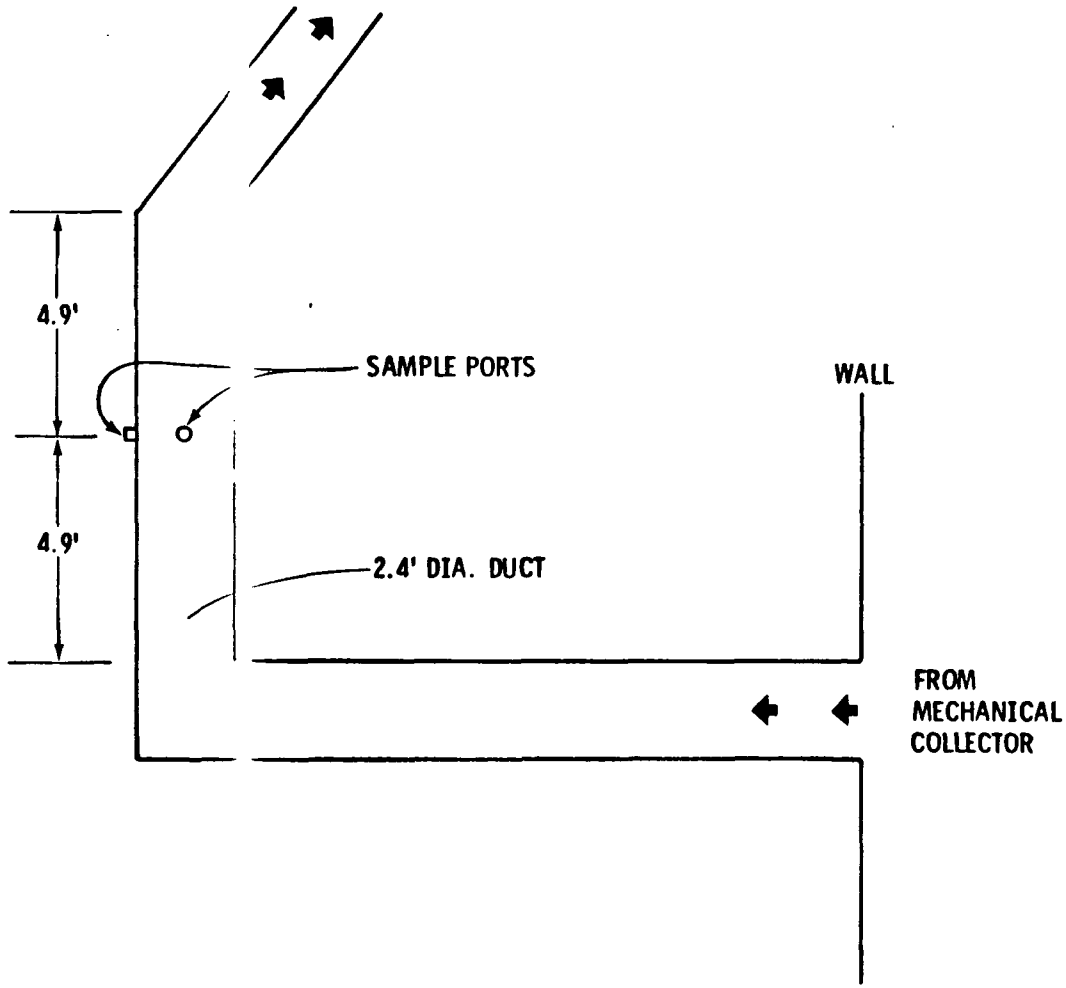
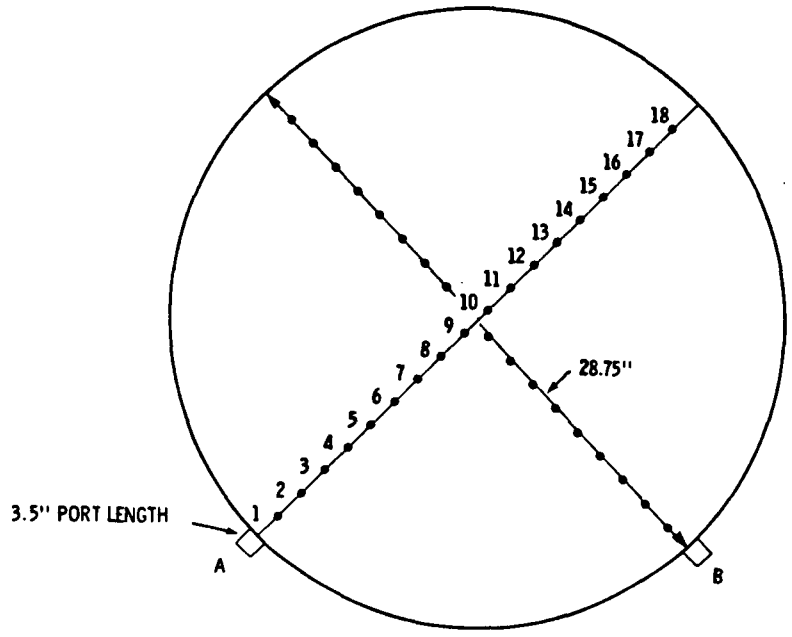



Figure 8. Sample port location at inlet to baghouse for Boiler #2 at GM Corporation, Fisher Body Division in Lansing, Michigan.




| Traverse point number | Inside of wall to traverse point, inch | Distance of port, inch | Traverse point location from outside of port, inch |
|---|---|---|---|
| 1 | 0.40 | 3.5 | 3.9 |
| 2 | 1.27 | 3.5 | 4.8 |
| 3 | 2.16 | 3.5 | 5.7 |
| 4 | 3.13 | 3.5 | 6.6 |
| 5 | 4.20 | 3.5 | 7.7 |
| 6 | 5.41 | 3.5 | 8.9 |
| 7 | 6.76 | 3.5 | 10.3 |
| 8 | 8.51 | 3.5 | 12.0 |
| 9 | 11.0 | 3.5 | 14.5 |
| 10 | 17.8 | 3.5 | 21.3 |
| 11 | 20.2 | 3.5 | 23.7 |
| 12 | 22.0 | 3.5 | 25.5 |
| 13 | 23.4 | 3.5 | 26.9 |
| 14 | 24.6 | 3.5 | 28.1 |
| 15 | 25.6 | 3.5 | 29.1 |
| 16 | 26.6 | 3.5 | 30.1 |
| 17 | 27.5 | 3.5 | 31.0 |
| 18 | 28.4 | 3.5 | 31.9 |

Figure 9. Traverse point location at inlet to baghouse for Boiler [illegible] Corporation, Fisher Body Division in Lansing, Michigan.

# SECTION 5

## SAMPLING AND ANALYSIS PROCEDURE

### SUMMARY

The sampling and analysis methods used at the Lansing site are shown in Table 1. Three simultaneous runs of Method 5B at the inlet and outlet of the multicyclone to Boiler No. 2 were conducted at each of three different boiler loadings (2/3, 1/2, and 1/3 of boiler capacity). Three runs at the "swing load" variable boiler loading were conducted at the multicyclone outlet only. The three baghouse inlet runs were conducted simultaneously with the inlet and outlet runs at the 2/3 boiler capacity load.

The flue gas velocity, temperature, flow rate, oxygen content, and carbon dioxide content were measured by EPA Methods 1-4 during all the Method 5B stack sampling runs. Integrated gas samples were taken from the exhaust of the Method 5B train.

Particulate analysis followed standard Method 5 gravimetric procedures. All Method 5B filters and acetone probe washes were dried and weighed to a constant weight.

During each stack sampling run representative grab samples of the coal being burned were taken from the feed line to the spreader stoker. The sulfur, ash, moisture, and heat content of the samples were analyzed by ASTM Methods D3176 and D2015-66(72).

### STACK SAMPLING

A typical Method 5 stack test system was used for sampling, except that oven and filter temperatures were maintained at 160 ± 14°C (320 ± 25°F). Heated glass-lined or stainless steel probes and Reeve Angel Type 934 AH filters were used for the Method 5B testing. The filter temperatures were monitored using thermocouples installed in the oven. Figure 10 is a schematic diagram of the Method 5B test probe system.

Method 5B sample volumes of at least 32 cubic feet were taken. The probes, nozzles, and filter holders were rinsed with acetone. When Method 5B was used, Methods 1 through 4 also were used, as in compliance monitoring.

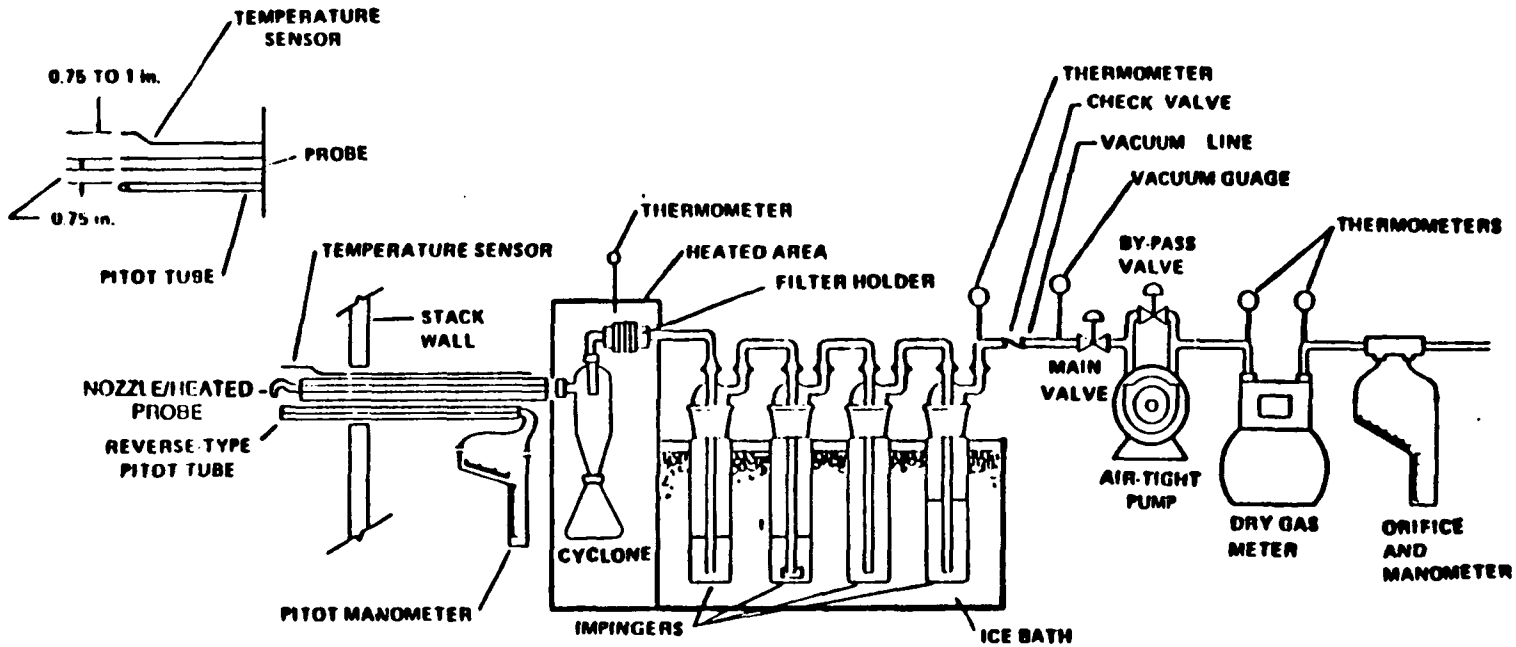



Figure 10. Particulate sampling train - EPA Method 5B.

During several of the runs at both inlet and outlet locations, zero velocity points were found. To maintain isokinetic sampling, no sampling time was spent at the zero velocity points and twice the sampling time was spent at the next sample point. This method has minimal effect on particulates collected and was approved by the EPA representative on site during sampling. Obtaining an average duct velocity is extremely difficult due to the zero velocity points. Velocity calculations and volumetric flow rates shown in Table 4 and Appendix B computer data sheets should be reviewed with these restrictions in mind.

Due to space restrictions outside of the inlet duct, it was impossible to reach the number 5 traverse point of each traverse. The sampling time was made up by sampling at point number 4 for twice as long.

As described in the field log (Appendix A-1) dust build-up occurred in the inlet duct at the 1/3 boiler load condition. At this location, the lower sample port was not used and sampling time was increased from 3 min/point to 4 min/point. Some deposition and re-entrainment of particulates was assumed to occur onto and from the dust pile. However, the effect on particulate sampling was assumed minimal as the deposition and re-entrainment effects most likely would balance out. This dust build-up reduced the duct area by approximately 10% (and thus increased velocity also). However, once again this has no effect on emission calculations which are based on mass of particulate collected and volume of sample collected not stack velocity or area.

During sampling runs O-2-1/3 and O-3-1/3, the bottles containing acetone wash for each run were not labelled properly and were mixed. Each bottle was labelled with appropriate run number after the team leader evaluated the situation.

Plume opacity was observed according to EPA Method 9 during each of these sampling runs. In addition, Andersen particle sizing was done at the inlet and outlet to the mechanical collector immediately before or after each sampling run.

At the baghouse inlet, three Method 5B runs were performed simultaneously with the three mechanical collector inlet/outlet runs at the 2/3 boiler load capacity. Andersen particle sizing was performed at the baghouse inlet in addition to that at the mechanical collector inlet and outlet.

Three additional Method 5B runs were performed at the outlet of the mechanical collector for Boiler No. 2 at swing load conditions. Actual percent capacity of the boiler (at swing load) was based on steam demand. Neither plume opacity, (Method 9), or Andersen particle sizing, was performed during these three runs.

## STACK SAMPLE ANALYSES

Gravimetric particulate analyses according to standard Method 5 procedures were conducted on all Method 5B samples. The Method 5B filters and acetone proble washes were dried and weighed to a constant weight. The weighing was repeated until the weight of the particulates was within 0.9 mg of the weight on the previous weighing.

Blank filters and residue from the evaporation of clean acetone blanks were analyzed along with the stack samples for quality control.

## COAL SAMPLING AND ANALYSES

Coal samples, corresponding to the coal burned during each stack sampling run, were taken from the conveyer belt feed line to the spreader stoker three times during each sampling run. The three samples were combined for one aggregate coal sample per run and analyzed for sulfur, ash, moisture, and Btu content by standard ASTM D3176 and D2015-66 bomb calorimetry methods.

## SAMPLE HANDLING

Filters were transferred into closed clean containers. Deposits of the inside of the sampling equipment were removed with acetone and distilled water. The acetone rinse was bottled. This occurred in the boiler room or on tables located near the stack. The coal samples were sealed in plastic containers until ready for analysis. Access to the samples was limited by storing them in a locked truck, except when being handled by authorized individuals. The samples were shipped in the truck to the MRC Dayton Laboratory for analysis. Records of the chain of custody of the samples have been maintained.

## DATA REDUCTION

MRC's computer and programmable calculators were used to reduce the analytical and field data to determine results. The "F" value used to determine ng/Joule (lb/$10^6$ Btu) emissions was taken from the boiler emission regulations in 40CFR 60.45(f)(4)(ii).

Appendix A contains copies of all raw field data sheets and coding sheets for data processing.

Appendix B contains complete computer printouts of the results of the sampling and emission calculations. For computer coding purposes, letters Y, Z, and X were used for 1/2, 2/3, and 1/3 boiler loading conditions, respectively, for run identification. For example, IA-2-Y implies inlet side A, Run 2, 1/2 boiler load capacity; or IT-3-X implies inlet total, Run 3, 1/3 boiler load capacity.

Appendix C (supplied by Radian Corporation) contains boiler monitoring data during the testing.

Apprendix D contains the analytical report and a summary of the results of the quality control and assurance procedures.

Appendix E identifies the people performing the sampling, analysis, and data reduction.

QUALITY ASSURANCE

The quality assurance and control program included all applicable procedures specified in the Federal Register for EPA Methods 1-5 and the procedures specified in the EPA Guidelines for the Developement of Quality Assurance Programs for these methods.

Standard ASTM procedures were used for the coal analysis. Bowser-Morner Testing Laboratories, Inc., the coal analysis sub-contractor, participates in EPA's new quality assurance program for coal sulfur, ash, and moisture content. This program involves the analysis of samples provided by EPA.

The accuracy of the data used in computerized data processing was checked by comparing the printout of the data used to calculate results with the raw field data used to code the computer input.