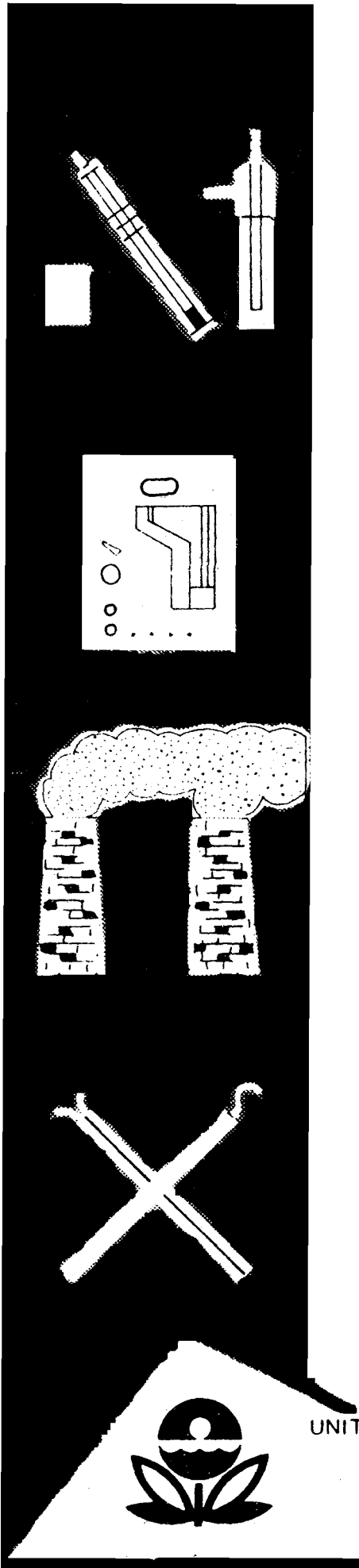


AIR POLLUTION EMISSION TEST

PACIFIC POWER & LIGHT COMPANY

CENTRALIA, WASHINGTON



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Emission Measurement Branch
Research Triangle Park, North Carolina

STATIONARY SOURCE TESTING OF
AN ELECTRIC POWER PLANT

at

The Pacific Power and Light Company
Centralia No. 1 Steam Plant
Centralia, Washington

by

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Midwest Research Institute

FINAL REPORT

October 21, 1977

EPA Contract No. 68-02-1403, Task No. 35
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For

Emission Measurements Branch
Field Testing Section
Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Attn: Mr. Dennis P. Holzschuh

PREFACE

The work reported herein was conducted by Midwest Research Institute (MRI) under Environmental Protection Agency (EPA) Contract No. 68-02-1403, Task No. 35.

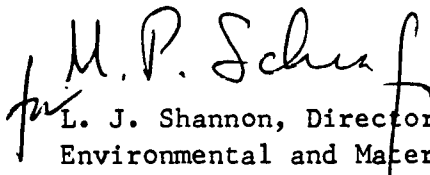
The project was under the technical supervision of Mr. Paul C. Constant, Jr., Head, Environmental Measurements Section of the Environmental and Materials Sciences Division. Mr. William Maxwell served as crew chief, and was assisted by Messrs. John LaShelle, Calvin Bolze, and Thurmon Oliver.

MIDWEST RESEARCH INSTITUTE



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SECTION 1

INTRODUCTION

This report presents the results of source testing done during the period July 11 to 15, 1977, by MRI on Boiler No. 1 of the Centralia Steam-Electric Plant, Centralia, Washington. This plant is jointly owned by Pacific Power and Light Company (47.5%), The Washington Water Power Company (15%), Seattle City Light (8%), Tacoma City Light (8%), Snohomish County Public Utility District (8%), Puget Sound Power and Light Company (7%), Gray's Harbor County Public Utility District (4%), and Portland General Electric Company (2.5%), and is operated by Pacific Power and Light Company. The boiler is a coal-fired steam generator providing steam for a 680-Mw electric turbine. The flue gases produced are passed through two cold electrostatic precipitators in series and vented to the atmosphere through a 470-ft stack.

Testing was done for particulate emissions after the control devices during periods of stable boiler operation. An EPA Reference Method 17 train was used, coupled with an EPA Reference Method 5 train. Coal samples were obtained from the feeders to the boiler. Visual opacity measurements were made of the emissions by EPA Reference Method 9. EPA personnel collected the boiler process data. The results of the tests are to be used in a review of the emission standards for coal-fired power plants

SECTION II

SUMMARY AND DISCUSSION OF RESULTS

Table Nos. 1 and 2 present a summary of the particulate results of the three tests. These data are presented as grains per dry standard cubic foot (GR/dscf) and pounds per hour (lb/hr) in Table 1 and as milligrams per normal cubic meter (mg/ncm) and kilograms per hour (kg/hr) in Table 2. Computer printouts of the field data and reductions are in Appendix A. Sample calculations are found in Appendix B. Copies of the raw field data sheets may be found in Appendix C.

The Method 17 results are believed to be correct and reflect the flue gas emissions from the plant. Although the train was leak checked from the probe tip back before and after each run (and passed), particulate matter was found in the probe rinse. (The probe was washed prior to the first run.) Based on consultations with EPA, this situation is not abnormal. Although the probe rinse showed increasing signs of corrosion as the test progressed, a result of the sulfur content of the coal burned, no sign of corrosion was observed in the probe (or in a subsequent washing) upon its return to MRI. The Method 5 filters show indications of being burned or having been wet although they were maintained at a temperature of approximately 300°F (149°C). The discoloration also resembles staining from the stainless steel filter support even though these had been washed and rinsed prior to testing.

The results of the visual opacity observations are presented in Table Nos. 3, 4, and 5. The emissions were observed to be 10% opacity for each run.

TABLE 1. SUMMARY OF MASS RESULTS - ENGLISH

| Date Run No. | July 13, 1977 | | July 14, 1977 | | July 14, 1977 | |
|---|---|------------------------------|---|------------------------------|---|------------------------------|
| | <u>gr/dscf</u> ¹ _{a/} | <u>(lb/hr)</u> _{a/} | <u>gr/dscf</u> ² _{a/} | <u>(lb/hr)</u> _{a/} | <u>gr/dscf</u> ³ _{a/} | <u>(lb/hr)</u> _{a/} |
| Method 17 Probe | 0.00122 | 16.8 | 0.00038 | 5.2 | 0.00060 | 8.0 |
| Filter | 0.00094 | 12.8 | 0.00149 | 20.1 | 0.00178 | 23.9 |
| Total Method 17 | 0.00216 | 29.6 | 0.00187 | 25.3 | 0.00238 | 31.9 |
| Average | 0.00214 | 28.9 | | | | |
| Method 5 Probe | 0.01142 | 156.4 | 0.00730 | 98.9 | 0.01371 | 184.2 |
| Filter | 0.00849 | 116.2 | 0.00625 | 84.6 | 0.00028 | 3.8 |
| ω Total Method 5 Front Half ^{b/} | 0.01991 | 272.6 | 0.01355 | 183.5 | 0.01399 | 188.0 |
| Average | 0.01582 | 214.7 | | | | |
| Method 5 Back Half ^{c/} | 0.03803 | 520.8 | 0.08622 | 1,167.7 | 0.07117 | 956.3 |
| Average | 0.06514 | 881.6 | | | | |
| Total | 0.06010 | 822.8 | 0.10164 | 1,376.5 | 0.08754 | 1,176.2 |
| Average | 0.08309 | 1,125.2 | | | | |

a/ gr/dscf = grains per dry standard cubic foot

 lb/hr = pounds per hour

b/ Excludes Method 17

c/ Includes ether/chloroform extraction and impinger rinse

TABLE 2. SUMMARY OF MASS RESULTS - METRIC

| Date Run No. | July 13, 1977 | | July 14, 1977 | | July 14, 1977 | |
|---|--|-----------------------|--|-----------------------|--|-----------------------|
| | ¹ mg/n _{cm} ^{a/} | (kg/hr) ^{a/} | ² mg/n _{cm} ^{a/} | (kg/hr) ^{a/} | ³ mg/n _{cm} ^{a/} | (kg/hr) ^{a/} |
| Method 17 Probe | 2.80 | 7.60 | 0.87 | 2.34 | 1.37 | 3.64 |
| Filter | 2.14 | 5.82 | 3.41 | 9.14 | 4.06 | 10.83 |
| Total Method 17 | 4.94 | 13.42 | 4.28 | 11.48 | 5.43 | 14.47 |
| Average | 4.88 | 13.12 | | | | |
| Method 5 Probe | 26.13 | 70.94 | 16.70 | 44.86 | 31.37 | 83.55 |
| Filter | 19.43 | 52.71 | 14.30 | 38.37 | 0.64 | 1.72 |
| 4 Total Method 5 Front Half ^{b/} | 45.56 | 123.65 | 31.00 | 83.23 | 32.01 | 85.27 |
| Average | 36.19 | 97.38 | | | | |
| Method 5 Back Half ^{c/} | 87.03 | 236.14 | 197.31 | 529.66 | 162.88 | 433.77 |
| Average | 149.07 | 399.86 | | | | |
| Total | 137.53 | 373.21 | 232.59 | 624.37 | 200.32 | 533.51 |
| Average | 190.15 | 510.36 | | | | |

^{a/} mg/n_{cm} = milligrams per normal cubic meter

 kg/hr = kilograms per hour

^{b/} Excludes Method 17

^{c/} Includes ether/chloroform extraction and impinger rinse

TABLE 3

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SUMMARY OF VISIBLE EMISSIONS

Run No. 1

Type of Plant: Steam-Electric Generation Date: July 13, 1977
 Type of Discharge: Stack Height of Point of Discharge: 470 ft
 Location of Discharge: Stack exit Height of Observation Point: Ground
 Distance from Observer to Discharge Point: 1,000 ft Duration: 3.75 hr
 Direction of Observer from Discharge Point: Northwest
 Descript. of Background: Clouds Wind Direction: W to E Color of Plume: Grey
 Descript. of Sky: Partly Cloudy Wind Velocity: 3-8mph Detached Plume: No

SUMMARY OF TIME AND AVERAGE OPACITY

| Set No. | Start | End | Sum | Avg. | Set No. | Start | End | Sum | Avg. |
|---------|-------|------|-----|------|---------|-------|------|-----|------|
| 1 | 1145 | 1150 | 240 | 10 | 21 | 1345 | 1350 | 240 | 10 |
| 2 | 1151 | 1156 | 240 | 10 | 22 | 1351 | 1356 | 240 | 10 |
| 3 | 1157 | 1202 | 240 | 10 | 23 | 1357 | 1402 | 240 | 10 |
| 4 | 1203 | 1208 | 240 | 10 | 24 | 1403 | 1408 | 240 | 10 |
| 5 | 1209 | 1214 | 240 | 10 | 25 | 1409 | 1414 | 240 | 10 |
| 6 | 1215 | 1220 | 240 | 10 | 26 | 1415 | 1420 | 240 | 10 |
| 7 | 1221 | 1226 | 240 | 10 | 27 | 1421 | 1426 | 240 | 10 |
| 8 | 1227 | 1232 | 240 | 10 | 28 | 1427 | 1432 | 240 | 10 |
| 9 | 1233 | 1238 | 240 | 10 | 29 | 1433 | 1438 | 240 | 10 |
| 10 | 1239 | 1244 | 240 | 10 | 30 | 1439 | 1444 | 240 | 10 |
| 11 | 1245 | 1250 | 240 | 10 | 31 | 1445 | 1450 | 240 | 10 |
| 12 | 1251 | 1256 | 240 | 10 | 32 | 1451 | 1456 | 240 | 10 |
| 13 | 1257 | 1302 | 240 | 10 | 33 | 1457 | 1502 | 240 | 10 |
| 14 | 1303 | 1308 | 240 | 10 | 34 | 1503 | 1508 | 240 | 10 |
| 15 | 1309 | 1314 | 240 | 10 | 35 | 1509 | 1514 | 240 | 10 |
| 16 | 1315 | 1320 | 240 | 10 | 36 | 1515 | 1520 | 240 | 10 |
| 17 | 1321 | 1326 | 240 | 10 | 37 | 1521 | 1526 | 240 | 10 |
| 18 | 1327 | 1332 | 240 | 10 | 38 | 1527 | 1530 | 120 | 10 |
| 19 | 1333 | 1338 | 240 | 10 | 39 | | | | |
| 20 | 1339 | 1344 | 240 | 10 | 40 | | | | |

Sketch showing how opacity varied with time:

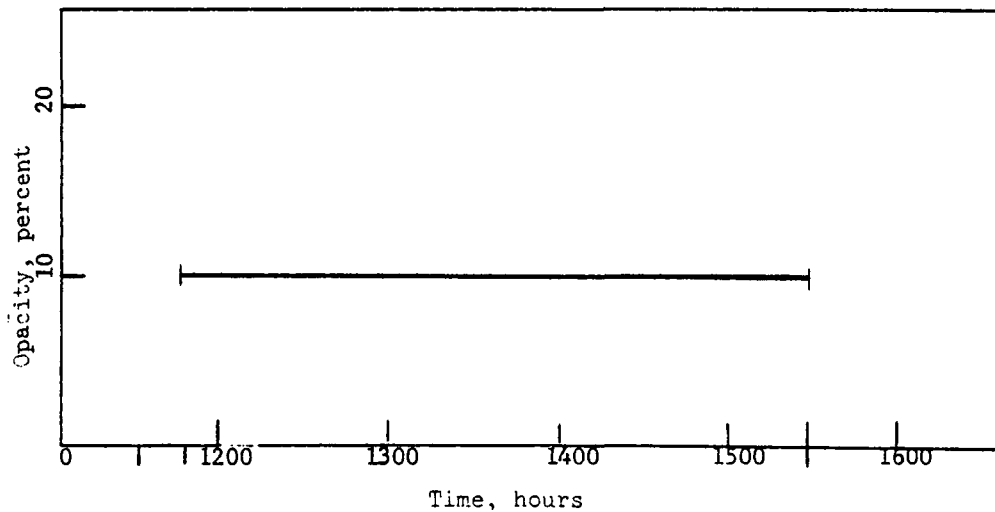


TABLE 4
MIDWEST RESEARCH INSTITUTE

SUMMARY OF VISIBLE EMISSIONS

Run No. 2

Type of Plant: Steam-Electric Generation Date: July 14, 1977
 Type of Discharge: Stack Height of Point of Discharge: 470 ft
 Location of Discharge: Stack Exit Height of Observation Point: Ground
 Distance from Observer to Discharge Point: 1,000 ft Duration: 3.75 hr
 Direction of Observer from Discharge Point: Northwest
 Descript. of Background: Clouds Wind Direction: W to E Color of Plume: Grey
 Descript. of Sky: Cloudy, Fog Wind Velocity: Calm Detached Plume: No

SUMMARY OF TIME AND AVERAGE OPACITY

| Set No. | Start | End | Sum | Avg. | Set No. | Start | End | Sum | Avg. |
|---------|-------|------|----------|------|---------|-------|------|-----|------|
| 1 | 0800 | 0805 | Not | | 21 | 0955 | 1000 | 240 | 10 |
| 2 | 0806 | 0811 | Readable | | 22 | 1001 | 1006 | 240 | 10 |
| 3 | 0812 | 0817 | Fog | | 23 | 1007 | 1012 | 240 | 10 |
| 4 | 0818 | 0823 | ↓ | | 24 | 1013 | 1018 | 240 | 10 |
| 5 | 0824 | 0829 | ↓ | | 25 | 1019 | 1024 | 240 | 10 |
| 6 | 0830 | 0835 | ↓ | | 26 | 1025 | 1030 | 240 | 10 |
| 7 | 0836 | 0841 | ↓ | | 27 | 1031 | 1036 | 240 | 10 |
| 8 | 0842 | 0847 | ↓ | | 28 | 1037 | 1042 | 240 | 10 |
| 9 | 0848 | 0848 | ↓ | | 29 | 1043 | 1048 | 240 | 10 |
| 10 | 0849 | 0854 | 240 | 10 | 30 | 1049 | 1054 | 240 | 10 |
| 11 | 0855 | 0900 | 240 | 10 | 31 | 1055 | 1100 | 240 | 10 |
| 12 | 0901 | 0906 | 240 | 10 | 32 | 1101 | 1106 | 240 | 10 |
| 13 | 0907 | 0912 | 240 | 10 | 33 | 1107 | 1112 | 240 | 10 |
| 14 | 0913 | 0918 | 240 | 10 | 34 | 1113 | 1118 | 240 | 10 |
| 15 | 0919 | 0924 | 240 | 10 | 35 | 1119 | 1124 | 240 | 10 |
| 16 | 0925 | 0940 | 240 | 10 | 36 | 1125 | 1130 | 240 | 10 |
| 17 | 0931 | 0936 | 240 | 10 | 37 | 1131 | 1136 | 240 | 10 |
| 18 | 0937 | 0942 | 240 | 10 | 38 | 1137 | 1142 | 240 | 10 |
| 19 | 0943 | 0948 | 240 | 10 | 39 | 1143 | 1145 | 120 | 10 |
| 20 | 0949 | 0954 | 240 | 10 | 40 | | | | |

Sketch showing how opacity varied with time:

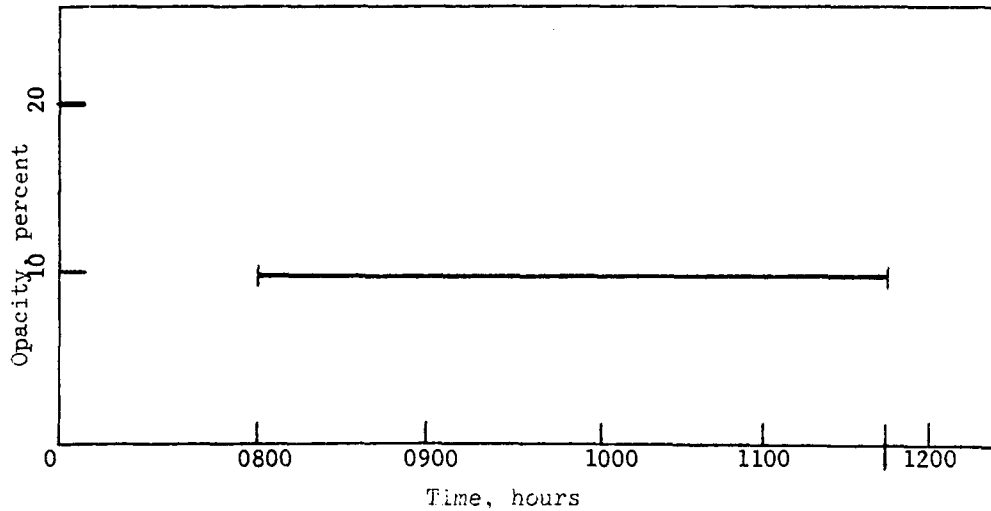


TABLE 5
MIDWEST RESEARCH INSTITUTE

SUMMARY OF VISIBLE EMISSIONS

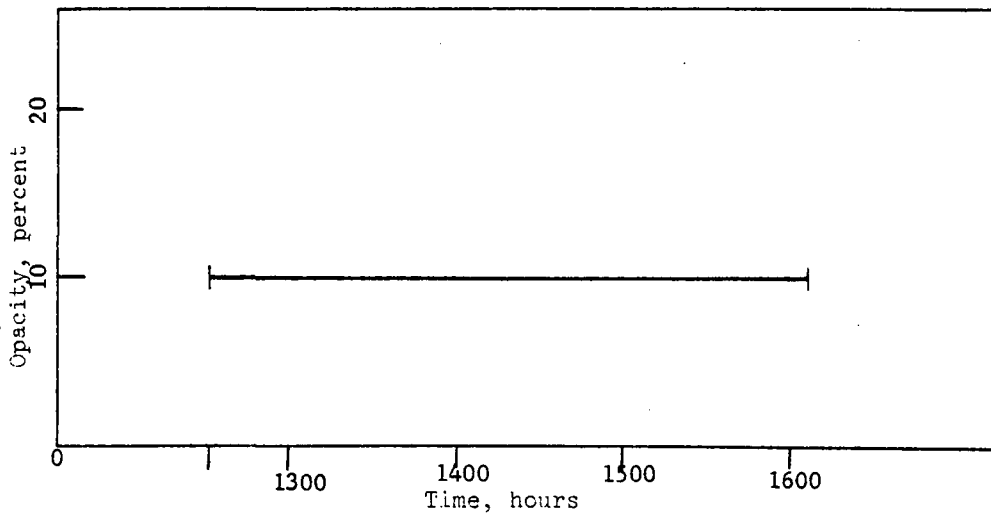
Run No. 3

Type of Plant: Steam-Electric Generation Date: July 14, 1977
 Type of Discharge: Stack Height of Point of Discharge: 470 ft
 Location of Discharge: Stack Exit Height of Observation Point: Ground
 Distance from Observer to Discharge Point: 1,000 ft Duration: 3.58 hr
 Direction of Observer from Discharge Point: Northwest
 Descript. of Background: Clouds Wind Direction: W to E Color of Plume: Grey
 Descript. of Sky: Partly Cloudy Wind Velocity: Calm - Detached Plume: No
10 mph

SUMMARY OF TIME AND AVERAGE OPACITY

| Set No. | Start | End | Sum | Avg. | Set No. | Start | End | Sum | Avg. |
|---------|-------|------|-----|------|---------|-------|------|-----|------|
| 1 | 1230 | 1235 | 240 | 10 | 21 | 1430 | 1435 | 240 | 10 |
| 2 | 1236 | 1241 | 240 | 10 | 22 | 1436 | 1441 | 240 | 10 |
| 3 | 1242 | 1247 | 240 | 10 | 23 | 1442 | 1447 | 240 | 10 |
| 4 | 1248 | 1253 | 240 | 10 | 24 | 1448 | 1453 | 240 | 10 |
| 5 | 1254 | 1259 | 240 | 10 | 25 | 1454 | 1459 | 240 | 10 |
| 6 | 1300 | 1305 | 240 | 10 | 26 | 1500 | 1505 | 240 | 10 |
| 7 | 1306 | 1311 | 240 | 10 | 27 | 1506 | 1511 | 240 | 10 |
| 8 | 1312 | 1317 | 240 | 10 | 28 | 1512 | 1517 | 240 | 10 |
| 9 | 1318 | 1323 | 240 | 10 | 29 | 1518 | 1523 | 240 | 10 |
| 10 | 1324 | 1329 | 240 | 10 | 30 | 1524 | 1529 | 240 | 10 |
| 11 | 1330 | 1335 | 240 | 10 | 31 | 1530 | 1535 | 240 | 10 |
| 12 | 1336 | 1341 | 240 | 10 | 32 | 1536 | 1541 | 240 | 10 |
| 13 | 1342 | 1347 | 240 | 10 | 33 | 1542 | 1547 | 240 | 10 |
| 14 | 1348 | 1353 | 240 | 10 | 34 | 1548 | 1553 | 240 | 10 |
| 15 | 1354 | 1359 | 240 | 10 | 35 | 1554 | 1559 | 240 | 10 |
| 16 | 1400 | 1405 | 240 | 10 | 36 | 1600 | 1605 | 240 | 10 |
| 17 | 1406 | 1411 | 240 | 10 | 37 | | | | |
| 18 | 1412 | 1417 | 240 | 10 | 38 | | | | |
| 19 | 1418 | 1423 | 240 | 10 | 39 | | | | |
| 20 | 1424 | 1429 | 240 | 10 | 40 | | | | |

Sketch showing how opacity varied with time:



SECTION III

PROCESS DESCRIPTION AND OPERATION

This section to be furnished by EPA.

SECTION IV

LOCATION OF SAMPLE POINTS

Figure 1 presents a schematic of the sampling site, which was located in accordance with Federal Register guidelines. Table 6 presents the sampling point location for the stack.

Figure 2 presents an approximate plant site layout showing the location of the opacity observer.

The coal samples were obtained from the available entry doors in the boiler coal feeders.

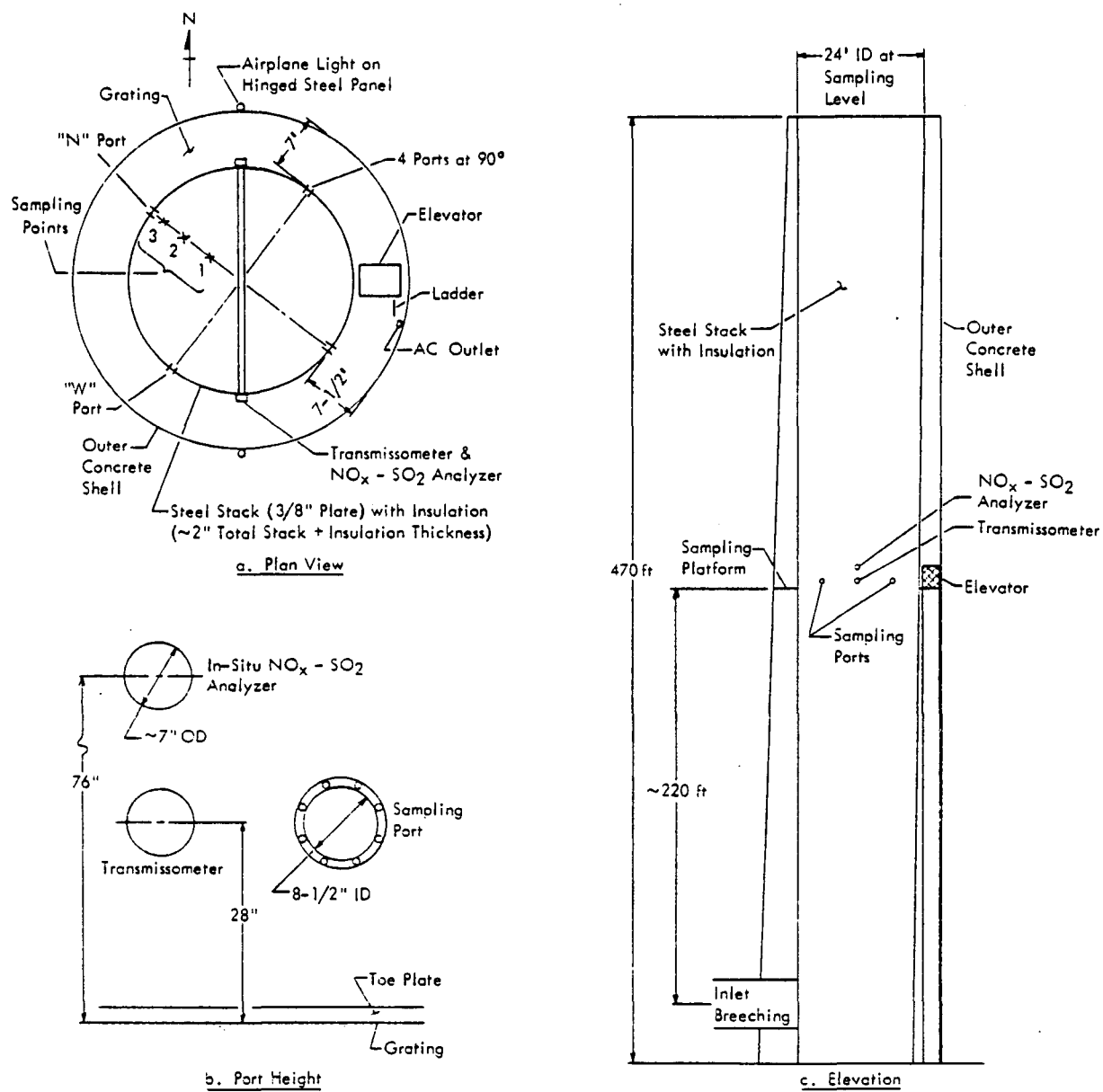
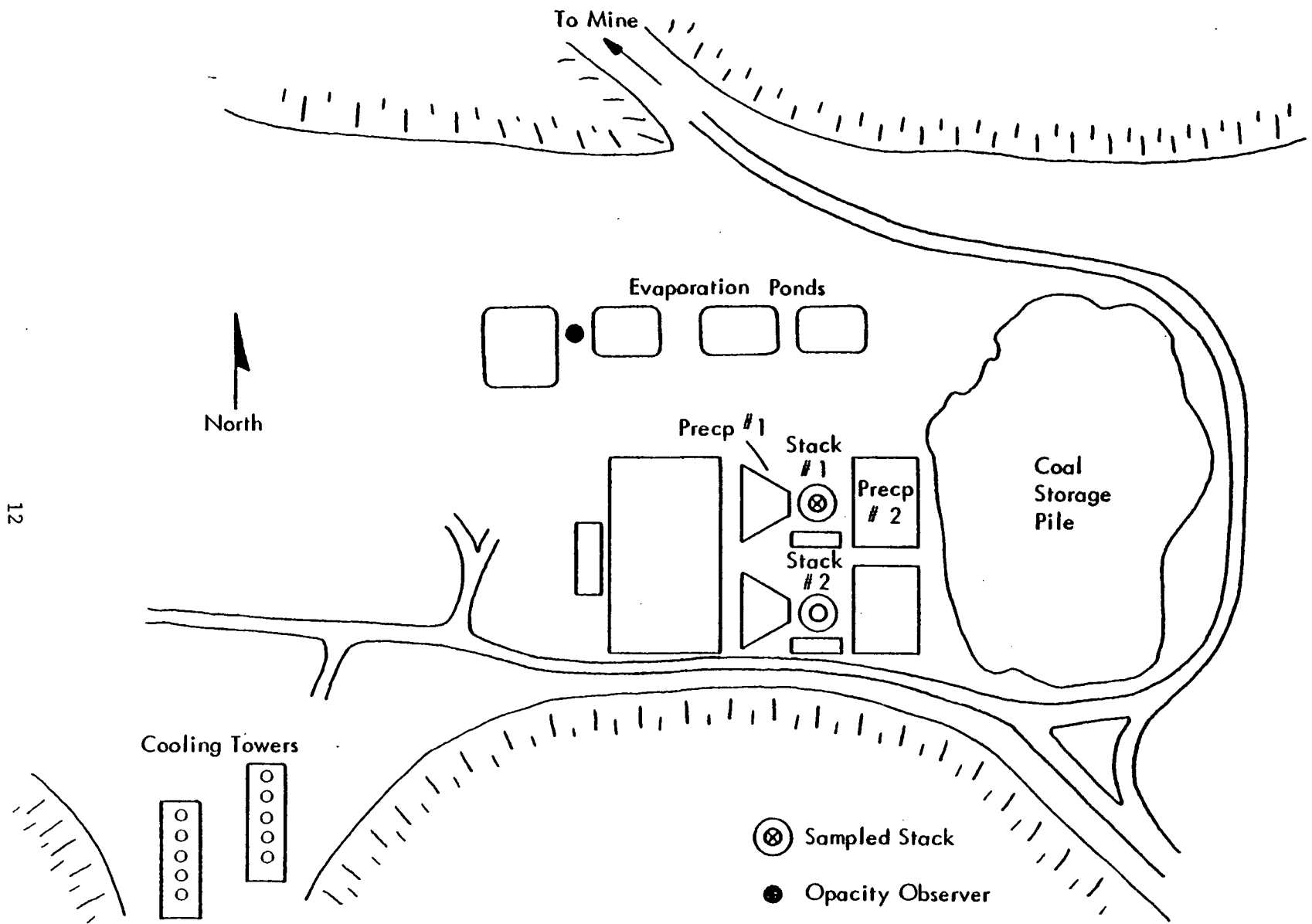


Figure 1. Sampling site--Centralia steam-electric plant.

TABLE 6. SAMPLE POINT LOCATION

| <u>Radius point</u> | <u>Fraction of duct ID (%)</u> | <u>Distance from inside wall</u> |
|---------------------|--------------------------------|----------------------------------|
| 3 | 4.4 | 1 ft 5/8 in. |
| 2 | 14.7 | 3 ft 6-3/8 in. |
| 1 | 29.5 | 7 ft 1 in. |



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Figure 2. General plant lay-out.

SECTION V

SAMPLING AND ANALYTICAL PROCEDURES

PARTICULATE

Particulate samples were taken with Research Appliance Company (RAC) Model 2243 "Stacksampler" equipment, modified by MRI. An EPA-provided Method 17 in-stack filter holder was attached to a standard probe. The s-shaped pitot was extended to allow for the in-stack filter length. A stainless steel liner was used due to the expected buffeting of the probe by the gas stream due to the added mass of the in-stack filter. As no openings were present in the outer concrete shell opposite the stack ports, the sample box could not be directly attached to the probe. A flexible teflon-lined hose was used for this purpose.

Sample times of 2 hr were used for each test, 10 min/point. Console readings were taken every 5 min. The Method 5 filter compartment was heated to approximately 300° F (149° C) for the duration of each test.

Flue gas samples were obtained at each point, integrated over the length of the run, and analyzed using Orsat apparatus.

COAL

Coal samples were taken from each of the operating feeders during the period of a run. There are eight feeders associated with Boiler No. 1, but only seven were in operation during this period.

The method of sampling was to open a port just prior to the feeder belt and collect the ejected coal in a small shovel (3 in. x 4 in. x 12 in.). This was accomplished in less than 3 sec. The sample was immediately placed in a plastic bag and tied to prevent moisture loss. Equipment was moved to the next feeder which was sampled 5 min later and its sample placed in the same bag. The combined samples from a completed circuit of feeders is a sweep and this sample was then sealed and labeled indicating run and sweep number.

The next sweep was done in the reverse order of feeders. This routine was continued until the run was over. Each sweep sample represents 35 min of operation.

During the course of sampling it was noticed that a wide variation of coal size existed between the various feeders. Personnel familiar with coal sampling at this plant said that this was normal and consistent and that apparently, some segregation occurs in the overhead transport system. Some feeders had coal particles as large as 3-in. cubes, whereas some had no particles larger than 1/4-in. cubes.

At the end of a test run, the bags from the various sweeps were combined, and quartered down to a sample size of approximately 8 lb (3.6 kg).

Analysis of the coal samples was done by EPA.