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Anthracite Coal
Combustion
AP-42 Sect
Reference
Chap 4
Ref 4

AP42 Section 1.2
4/93

Reference 12

REPORT ON PARTICULATE EMISSIONS
BOILERS NOS. 1 & 3 AT PENNHURST CENTER
SPRING CITY, PENNSYLVANIA

PR
July 25th
Latest
To Rick
JANUARY 23 and 25, 1980



TRC PROJECT NO.1222-E80-00
EPA CONTRACT NO. 68-01-4145, Task 70

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1.0 INTRODUCTION

The particulate compliance status for sources at nine Commonwealth of Pennsylvania-owned facilities has been questioned with regard to applicable SIP air pollution regulations. Because the Pennsylvania Department of Environmental Resources cannot effect enforcement measures against the facilities, EPA Region III elected to initiate an investigatory action to determine the current particulate compliance status of the sources at those facilities and to document any violations of the applicable SIP regulations.

The measurement of the particulate emissions from the facility sources was contracted by EPA Region III to TRC Environmental Consultants, Inc. of Nethersfield, Connecticut. During the week of January 21, 1980, TRC tested at Pennhurst Center in Spring City, Pennsylvania, the first of nine facilities designated for testing. The effluent combustion gases from Boilers Nos. 1 and 2 were tested for particulate concentration in the chimney through which they discharge. Environmental Scientist Benjamin F. Brown and Associate Environmental Engineer Edward D. Astle from TRC conducted the testing.

Mr. Keith Owens, P.E., from the Pennsylvania State University Department of Architectural Engineering represented the Department of Public Welfare for the testing and served as liaison between TRC and Pennhurst Center.

Air Pollution Control Engineers Richard L. Ruhl and Thomas H. Jones, Jr., from the Region I - Norristown Office of the DER conducted visible emission observations during the particulate testing.

Utility Plant Operator Barry Gardner was responsible for recording the boiler operating data and the coal consumption weights during the testing.

This report presents the particulate test results for the Pennhurst source and all relevant testing information and data.

2.0 RESULTS AND CONCLUSION

The three test average particulate emission rate was 0.21 lb/MMBTU. The test results indicate that the combined particulate emission discharged from Pennhurst Center Boilers Nos. 1 and 3 do not exceed the particulate emission limit of 0.40 lb/MMBTU(1). The emission rate was determined by the F-Factor Method instead of the coal usage because the scales were considered to be inaccurate.

A summary of the testing results is presented in Table 2-1. Appendix A contains the computer summary of the particulate test results. The particulate test computer inputs are in Appendix B.

The methodology for the sampling and analysis which was used for the testing is detailed in Section 4.0.

TRC believes the results to be representative of normal operation for these boilers and recommends that EPA Region III consider this source to be in compliance with the aforementioned particulate limit.

An interpretation of the limit by the Pennsylvania DER appears in Appendix L.

(1) Section II, Chapter 123, Title 25 PA Code, Rules, Regulations, Environmental Resources.

TEST REPORT
SPRING CITY, PENNSYLVANIA

| TEST NO. | TEST DATE | TEST TIME | BOILER NO. 1 | BOILER NO. 3 | SOURCE TOTAL | MAX. SOURCE: (78-79 BASED ON TEST DATE) | EMISSION STANDARD: (4) (BSC) (4) (FSCF) | GR/HR: (4) (BSC) (4) (FSCF) | SOLID WASTE: (4) (BSC) (4) (FSCF) | ISO: (4) (BSC) (4) (FSCF) | KINETIC ENERGY: (4) (BSC) (4) (FSCF) | PARTICULATE EMISSIONS: | |
|----------|-------------|----------------------|--------------|---------------------|--------------|---|---|-----------------------------|-----------------------------------|---------------------------|--------------------------------------|------------------------|-------|
| | | | | | | | | | | | | | |
| 1-1 | 23 Jan 1980 | 1111 hrs to 1428 hrs | 14,100 | 13,700 | 27,800 | 32,284 ² | 44.8 | 17.92 | 0.40 | 0.30 | 12.22 | 0.05 | 26.62 |
| 1-3 | 25 Jan | 1009 hrs to 1158 hrs | 16,000 | 16,600 | 32,600 | 32,284 ² | 48.0 | 19.20 | 0.40 | 0.18 | 8.36 | 0.04 | 36.82 |
| 1-4 | 25 Jan | 1247 hrs to 1429 hrs | 16,400 | 15,700 | 32,100 | 32,284 ² | 50.0 | 20.0 | 0.40 | 0.16 | 7.80 | 0.03 | 38.45 |
| Average | | | 30,822 | 32,384 ² | 47.6 | 19.4 | 0.40 | 0.21 | 9.46 | 0.04 | | | |

(1) Paragraph (a) Section 11, Combustion Units, Chapter 125, Title 25 PA Code, Rules and Regulations, Environmental Resources, "No person shall cause, suffer, or permit the emission into the outdoor atmosphere of particulate matter, at any time, from any combustion unit in excess of:

- 1) The rate of 0.4 pounds per million Btu of heat input, when the heat input to the combustion unit in millions of Btu's per hour is greater than 2.5 but less than 50.
- 2) The rate determined by the formula: $A = 3.6B - 0.56$ where: A = Allowable emission in pounds per million Btu of heat input, and B = Heat input to the combustion unit in millions of Btu's per hour; when B is equal to or greater than 50 but less than 600.
- 3) The rate of 0.1 pounds per million Btu of heat input when the heat input to the combustion unit in millions of Btu's per hour is equal to or greater than 600."

(2) produced with two of facility's four boilers; all rated @ 25,875 lbs of steam/hr - continuous.

(3) Residue after evaporation of condensate catch after filtration through 0.22_f filter.

(4) Standard conditions: 68°F, 29.92 inches hg.

OPERATION DESCRIPTION

Pennhurst Center has four Keeler water-tube Boilers Nos. 1, 2, 3, and 4, which produce steam for hot-water heating, space heating, cooling, and food preparation. During peak load demand periods, two of the four boilers operate with the other two on standby. During the 1978-79 heating season, two of the four boilers produced a maximum continuous load which averaged 32,384 lbs. of steam/hr. All four boilers are rated at 34,500 lbs. of steam/hr. maximum with a heat input of 49 MMBTR/hr. and 28,875 lbs. of steam/hr. continuous with a heat input of 37 MMBTU/hr. They all burn Buckwheat No. 3 anthracite coal which is fed into Boilers Nos. 1 and 3 on Coxe traveling grate stokers.

The effluent combustion gases from all four boilers flow into a common flueing and exhaust to the atmosphere through a 165' chimney.

TESTING LOCATION, METHODOLOGY AND ANALYSES

4.1 Location

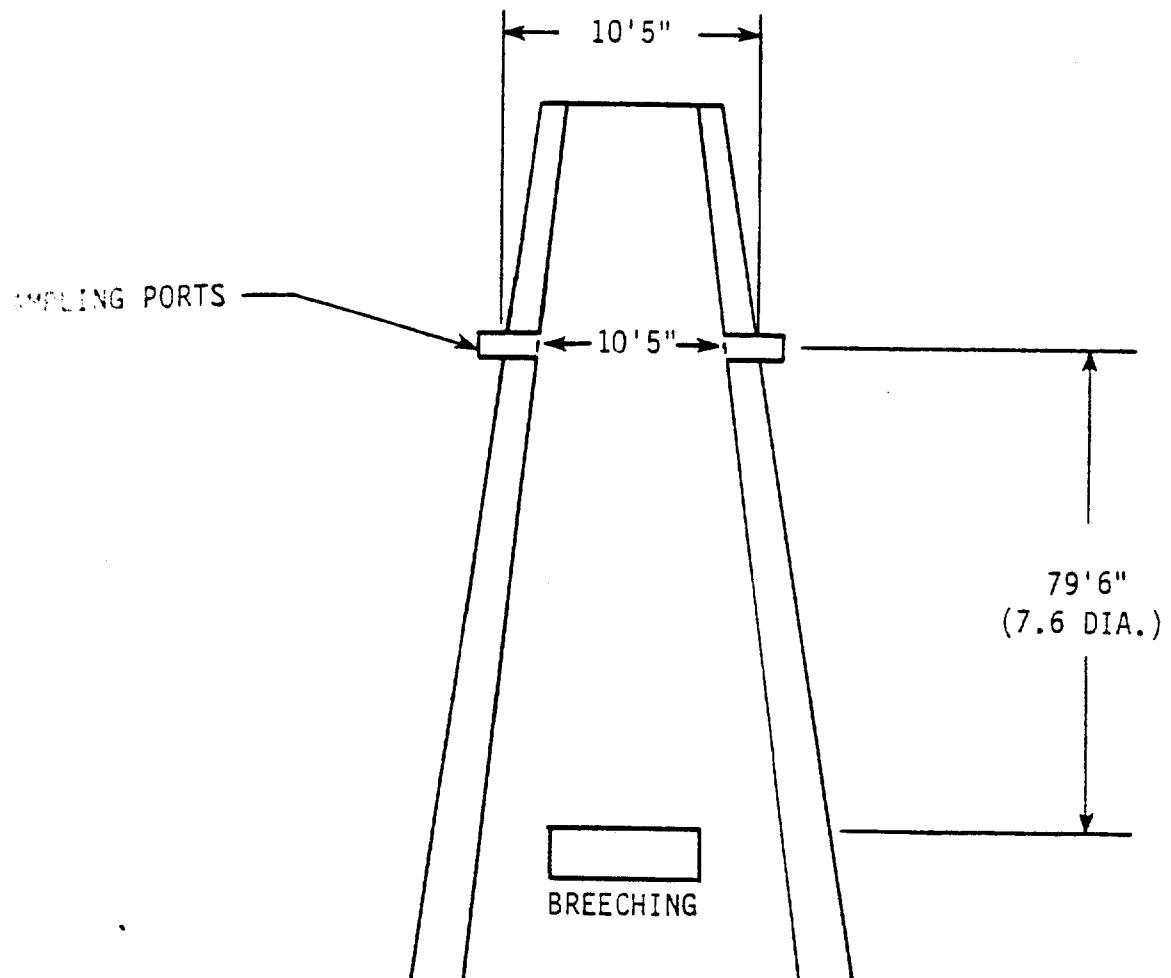
Figure 4-1 illustrates the location of the sampling ports which were installed for the testing. The table at the bottom of the figure presents the traverse point intervals from the inside wall of the stack to the sampling point.

4.2 Testing Methodology and Analyses

4.2.1 Particulate

The following procedures were followed to assure the quality of the samples and data collected:

1. Complete sampling train calibrations were performed before testing commenced. The inside diameter of each nozzle was measured to the nearest 0.0001 inch with a micrometer. The probe pitot tubes were calibrated against a reference standard pitot tube in a 20" ID wind tunnel capable of velocities ranging from 0 to 100 fps. The dry gas meters, with their respective orifices attached, were calibrated against a wet test meter (1 cubic foot per revolution) while pressure differentials across the orifices were recorded for the corresponding gas volumes drawn through the dry gas meters. The chromelalumel thermocouples and indicators were calibrated electronically. The calibration data is contained in Appendix C.
2. Acetone blanks were analyzed prior to the field use and only acetone with low blank values (< 0.001 percent) was used.
3. All filters were permanently numbered. The filter numbers and tare weights were recorded in a bound notebook kept in the custody of the chemistry laboratory supervisor.
4. Each filter was placed in a filter holder and sealed to prevent any contamination. The sealed filter holder was clearly labeled with the filter number. The sealed filter holders were placed in a fiberglass transport case. The fiberglass transport case was in the custody of the field team leader for the duration of the field program. When a filter was used in the field, its filter number was recorded on the field data sheet. At the conclusion of the sample run, the filter holder was sealed and returned to the fiberglass, foam-lined transport case. The case also contained clean, numbered, glass probe-wash sample bottles and plastic silica gel bottles. When they were used, their bottle numbers were recorded on the field data sheets. The bottles were sealed and returned to the fiberglass case.



(NOT TO SCALE)

| TRaverse Points | |
|-----------------|--------------------|
| Point No. | *Distance (Inches) |
| 1 | 5.5 |
| 2 | 18.3 |
| 3 | 37.0 |
| 4 | 88.0 |
| 5 | 106.8 |
| 6 - | 119.5 |

*FROM THE INSIDE WALL

FIGURE 4-1: SAMPLING PORT LOCATIONS - PENNHURST CENTER, SPRING CITY, PENNSYLVANIA

5. Back at TRC, the filters were removed from their sealed holders and placed in sealed petri dishes. The sealed petri dishes containing the filters, the sealed glass bottles containing the probe wash, and front-end glassware washes, the impinger catch containers, and the silica gel bottles were submitted to the lab supervisor.
6. All lab weighings and calculations were recorded in bound notebooks which are in the custody of the lab supervisor. The lab results were checked by the lab supervisor and submitted to the program manager on the lab reporting form (see Appendix D).

Particulate sampling was accomplished by using the EPA collection train, Method #5, described in the August 18, 1977 edition of the Federal Register: It is shown schematically in Figure 4-2 and consists of a nozzle, probe, filter, four impingers, vacuum pump, dry gas meter, and an orifice flow meter.

The nozzle (1) was attached to a stainless steel glasslined probe (2) that was wrapped with nichrome heating wire and jacketed. Controlling the temperature at $\sim 250^{\circ}\text{F}$ prevented condensation of the sampled gas. Following the probe, the gas stream impacted on a 4-1/2" Reeve Angel Type 934AH filter mounted to a fritted-glass disk in a Pyrex glass holder (3). A heated box enclosed the whole filter assembly to maintain filter temperatures at $250^{\circ}\text{F} \pm 25^{\circ}\text{F}$ to prevent condensation of water and SO_3 . An ice bath containing four impingers (5) was attached to the end of the filter holder (6). All condensable material in the sample stream was collected here. The first two impingers contained distilled water, the third was dry and the fourth contained silica gel to remove any remaining moisture. Leaving the fourth impinger, the sample stream flowed through flexible tubing (6), a vacuum gauge (7), needle valve (8), a leakless vacuum pump (9), in parallel with a bypass valve (10), and a dry gas meter (11). A calibrated orifice and inclined manometer (12) completed the sampling train. The stack velocity pressure was measured using a pitot tube and inclined manometer (13).

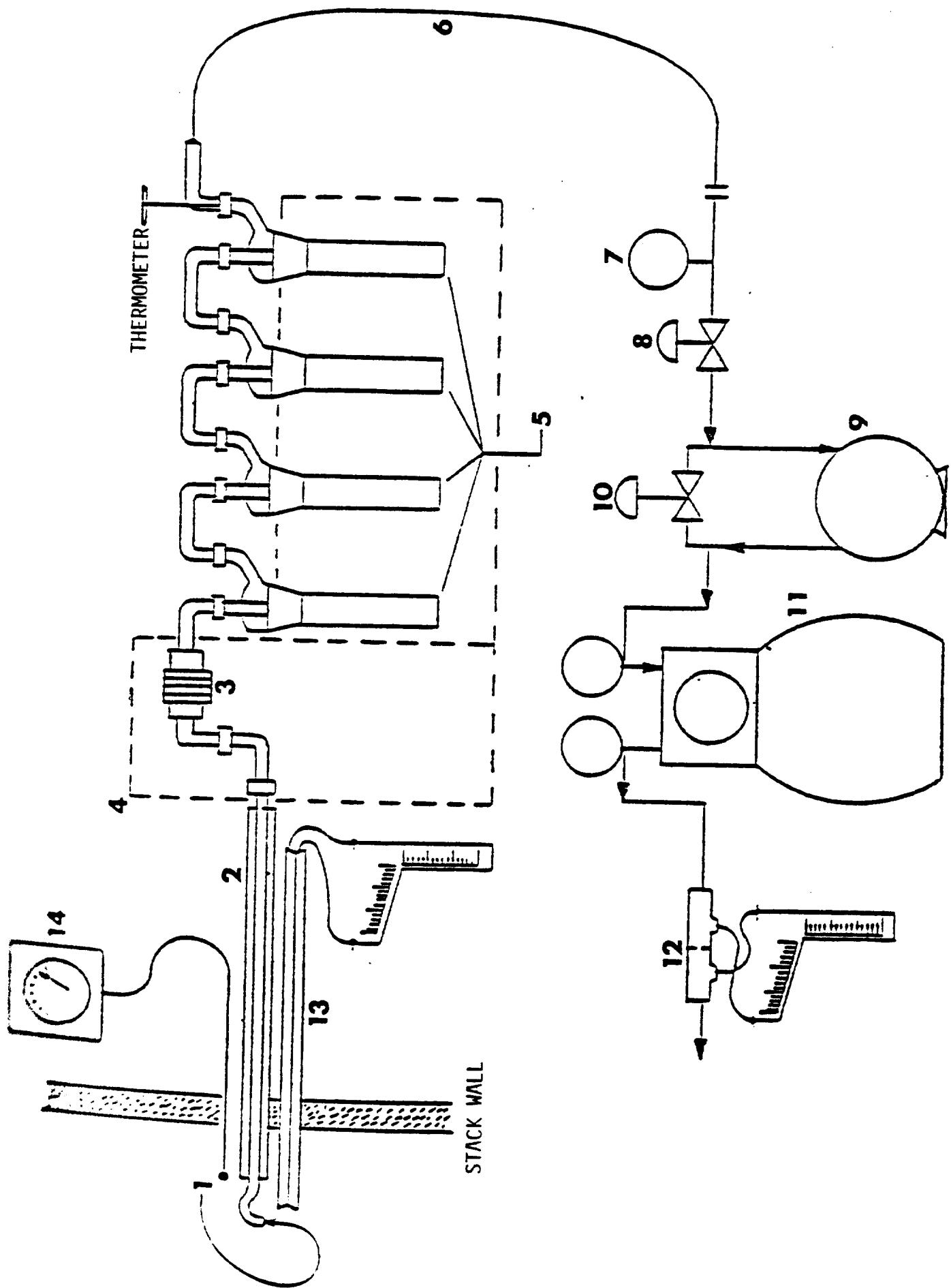


FIGURE 4-2: MODIFIED EPA PARTICULATE SAMPLING TRAIN
AUGUST 18, 1977, FEDERAL REGISTER

and stack temperature was monitored by a thermocouple attached to the pitot and connected to a potentiometer (14).

A nomograph was used to quickly determine the orifice pressure drop required for the measured pitot velocity pressures and stack temperatures in order to maintain isokinetic sampling conditions. The sampling flow was adjusted by means of the bypass valve.

Test data recorded included test time, sampling duration at each traverse point, pitot pressure, stack temperature, meter volume, meter inlet-outlet temperature and orifice pressure drop. The field data sheets are included in Appendix E.

At the end of each test, four sample containers were used as follows to transport the samples back to TRC:

Container #1 - to transport the filter.

Container #2 - to transport the acetone wash of probe and front half of filter holder.

Container #3 - to transport the catch from the first and second impingers.

Container #4 - to transport the silica gel from the fourth impinger.

At TRC's laboratory, the sample analyses were performed in the following manner:

Container #1 - The filter, and any loose particulate matter from the sample container was transferred to a tared glass weighing dish, desiccated and dried to a constant weight. Results were reported to the nearest 0.1 mg.

Container #2 - The acetone washings were transferred to a tared beaker and evaporated to dryness at ambient temperature and pressure. They were desiccated and dried to a constant weight. Results were reported to the nearest 0.1 mg.

Container #3 - The impinger condensate was filtered through a tared, 0.22 μm membrane filter. The filter was transferred to a tared glass weighing dish and desiccated to a constant weight. The results were reported to the nearest 0.1 mg. This was called insoluble particulate and its weight was added to the front end catch to obtain the total particulate catch.

An aliquot of the impinger condensate was evaporated in a tared glass weighing dish and desiccated to a constant weight. The results were reported to the nearest 0.1 mg. This value was designated as soluble particulate.

Container #4 - Silica gel was weighed to the nearest 0.5 g. the weight of the moisture entrapped in the silica gel, along with the volume of moisture which was condensed in the impingers, was used to calculate the moisture content of the flue gas.

The lab data was transferred to coding forms and keypunched along with the field data. The field data sheet also served as a coding form. The keypunched cards were run through our inhouse Univac 90/30 computer which is programmed to perform the U.S. EPA Reference Method Calculations.

The program calculated the emission rates in lb/hr, grain loading in grains per standard cubic foot, lb/MMBTU and the volume flow in the duct stack. The emission rates in lb/MMBTU are calculated by the F-Factor stoichiometric method. The Federal Registers of October 6, 1976 (for the F-factor method) and August 18, 1977 are the references for the formulas used in performing the required calculations. An example emissions calculation is shown in Appendix F.

4.2.2 Flue Gases

Grab samples were taken and measured for CO_2 , O_2 and N_2 (by difference) during each test. An Orsat and/or portable Teledyne Analyzer, Model #320P-4, were used for the sampling and measurements. The average results are in Appendix G.

4.2.3 Coal

During the test series coal samples were composited from each boiler in a drum. A representative 10-pound sample of that drum composite was obtained for analysis. Five pounds of that sample were sent to an outside laboratory and analyzed by ASTM methods for the following constituents:

- moisture
- ash
- heating value
- sulfur
- carbon
- hydrogen
- nitrogen
- oxygen

The coal analysis is reported in Appendix H.

5.0 DISCUSSION

This first series of tests, in the series of nine, served not only to measure the source emissions at Pennhurst Center but to "shakedown" the program techniques and procedures. Certain circumstances and occurrences which developed during this series necessitated occasional variations, both temporary and permanent from the original scope. The following discussion will explain the nature of and the reason for those variations.

Test Number 1-2 was never completed. During that test, the filter particulate accumulation reduced the sampling train flow to a subisokinetic rate. Due to the imminent sunset and the hazard that the test crew would have faced descending from the testing platform in darkness, the test was cancelled.

In Test Number 1-1 the required 30.0 DSCF samples volume was not reached. A sample volume at 26.62 DSCF was drawn for Test Number 1-1. This occurred because a nozzle of less than optimum ID (0.379") was chosen, based upon preliminary velocity data taken from the previous day. Unfortunately, velocity averages on the test day were significantly lower than those measured on the preceding day. When the observed test volumes of the initial traverse points were extrapolated for the planned test duration, it became apparent that the required volume would be inadequate. Each point on the first traverse was resampled for another five minutes. The points on the second traverse were sampled for ten minutes each to increase the sample volume. Tests Numbers 1-3 and 1-4 were performed with a nozzle with an ID of (0.503"). This allowed the required volume to be sampled in a reasonable amount of time.

Another slight variation in the test procedure was the sampling of the gases by grab methods only, instead of the planned integrated sampling

system. The pump which served the integrated system failed and could not be repaired in the field. Sufficient grab samples were taken and analyzed with a Fyrite (for CO_2 and O_2) and a portable Teledyne Analyzer, Model #320P-4 (for O_2) to provide accurate combustion gas data similar to what would have been obtained from a composite sample.

Originally, four test ports were to have been used for testing. This was based upon the difficulty anticipated in moving the sampling unit with a probe long enough to accomodate a full ID traverse. However, once on location, the crew discovered that a sampling unit with a probe of sufficient length was not such an unmanageable system. This discovery allowed the scaffolding plans for the remaining eight locations to be modified so that only three, instead of the five sites, would require the four-port configuration.

The stack ID at the testing location was measured as 10'5". This was 6" larger than the 9'11" calculated from the engineering blueprints. The ports were located 79'6" (7.6 diameters) above (downstream) the breeching.

TRC feels that these occurrences, circumstances, and variations did not affect the integrity of the emissions data.

Concurrent with the emissions tests, personnel from the DER monitored the visibility from the stack. The visible emissions observations records are in Appendix I.

The boilers were monitored for steam load and for coal usage during the sampling period. The Boiler Field Data sheets are contained in Appendix J.

A sample calculation for the Heat Input using the F-Factor is shown in Appendix K.

APPENDICES

Pennhurst

Test No. 1-1

Velocity = 7.8 f/s
Volume = 26,200 DSCF/m
Gr./DSCF = 0.055
lbs./hr. = 11.90 lbs./hr

41.9 MBtu/hr

Test No 1-3

Velocity = 8.2 f/s * 1 ft. = 3 m, 1 ft. = 0.3 m
Volume = 26,900 DSCF/m what is min. per point
Gr./DSCF = 0.036
lbs./hr. = 8.30

44.8 MBtu/hr

Test No. 1-4

Velocity = 8.75 f/s
Volume = 26,800
Gr./DSCF = 0.032
lbs./hr. = 7.90

APPENDIX A

COMPUTER SUMMARY OF THE PARTICULATE TEST RESULTS
OF JANUARY 23, 1980 AND JANUARY 25, 1980

TEST DATA -- EPA METHOD #5 -- TEST NO 1-1
 TRC PROJECT 1022-E80

PENNHLRST

LESS 1 AND 3

STACK

JANUARY 23 1980 11:11 TC 14:29

| | |
|--|--------------|
| TOTAL SAMPLING TIME, MINUTES | 120. |
| AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP .5 | 2.115 C.M.H. |
| AVERAGE OR IF ICE PRESSURE DROP, IN H2O | 0.128. |
| AVERAGE METER TEMPERATURE, DEG F | 42.8 41.4 |
| AVERAGE Duct STATIC PRESSURE, IN H2O | 0.05 |
| AVERAGE Duct TEMPERATURE | 312. |
| TOTAL SAMPLE VOLUME, DACT | 25.94 |
| INITIAL SAMPLE VOLUME, DSCF | 25.62 26.66 |
| MOISTURE CONTENT OF Duct GAS, PERCENT | 2.11 2.11 |
| DUCT VOLUMETRIC FLOW, ACFM | 46545. |
| DUCT VOLUMETRIC FLOW, DSCFM | 26641. |
| AVERAGE Duct VELOCITY, FPM | 476. |
| EXCESS AIR, PERCENT | 257.6 |
| AVERAGE Duct GAS DENSITY, LBS/ACF | 1.052 |
| ISOKINETIC FACTOR, PERCENT | 90.6 |
| F FACTOR, DSCF/FM BTU | 9963.320 |

EMISSION DATA

| GR/ | GR/ |
|-----|------|
| ACF | DSCF |

| | | |
|-----------------------|-------|-------|
| PARTICULATE PROBE | 0.012 | 0.018 |
| PARTICULATE FILTER | 0.023 | 0.035 |
| TOTAL EXY PARTICULATE | 0.034 | 0.052 |

| | | |
|-----------------|-------|-------|
| ExY Particulate | 0.001 | 0.001 |
|-----------------|-------|-------|

| | | |
|-----------------|-------|-------|
| ExY PARTICULATE | 0.035 | 0.054 |
|-----------------|-------|-------|

| LBS/ | LBS/ |
|------|------|
| HR | MMTU |

| | | |
|-----------------------|--------|-------|
| PARTICULATE PROBE | 3.997 | 0.097 |
| PARTICULATE FILTER | 7.961 | 0.192 |
| TOTAL EXY PARTICULATE | 11.958 | 0.289 |

| | | |
|-----------------|-------|-------|
| ExY Particulate | 0.265 | 0.006 |
|-----------------|-------|-------|

| | | |
|-----------------|--------|-------|
| ExY PARTICULATE | 12.023 | 0.295 |
|-----------------|--------|-------|

TEST DATA -- EPA METHOD HE -- TEST NO 1-3
 TRC PROJECT 1222-EBC

PENNSYLVANIA

STACK

JANUARY 25 1980 10:09 TO 11:59

TOTAL SAMPLING TIME, MINUTES

04.0

3.121 0.18

AVERAGE SQUARE ROOT VELOCITY HEAD, IN H2O EXP 5

3.655

AVERAGE ORIFICE PRESSURE DROP, IN H2O

35.4

AVERAGE METER TEMPERATURE, DEG F

3.34

AVERAGE DUCT STATIC PRESSURE, IN H2O

338.

AVERAGE DUCT TEMPERATURE

35.36 35.05

TOTAL SAMPLE VOLUME, DACF

35.32 35.5

TOTAL SAMPLE VOLUME, DSCF

2.57 2.61

MOISTURE CONTENT OF DUCT GAS, PERCENT

42771.

DUCT VOLUMETRIC FLOW, ACFM

27526.

DUCT VOLUMETRIC FLOW, DSCFM

502.1 512

AVERAGE DUCT VELOCITY, FPM

245.3

EXCESS AIR, PERCENT

0.00

AVERAGE DUCT GAS DENSITY, LBS/SCF

93.4 93.7

ISOKINETIC FACTOR, PERCENT

9963.320

F FACTOR, DSCF/PM BTU

EMISSION DATA

| ER / ACF | GR / DSCF |
|-------------|--------------|
|-------------|--------------|

| | | |
|-----------------------|-------|-------|
| Particulate Probe | 0.009 | 0.014 |
| Particulate Filter | 5.013 | 0.021 |
| Total Dry Particulate | 0.022 | 0.035 |

| | | |
|-------------------|-------|-------|
| Total Particulate | 5.001 | 0.001 |
|-------------------|-------|-------|

| | | |
|-------------------|-------|-------|
| Total Particulate | 5.023 | 0.035 |
|-------------------|-------|-------|

| LBS / HR | LBS / MMETU |
|-------------|----------------|
|-------------|----------------|

| | | |
|-----------------------|-------|-------|
| Particulate Probe | 3.292 | 0.070 |
| Particulate Filter | 4.866 | 0.104 |
| Total Dry Particulate | 8.158 | 0.174 |

| | | |
|-------------------|-------|-------|
| Total Particulate | 0.198 | 0.004 |
|-------------------|-------|-------|

| | | |
|-------------------|-------|-------|
| Total Particulate | 0.198 | 0.004 |
| | 8.356 | 0.178 |

TEST DATA -- EPA METHOD #5 -- TEST NO 1-4
 TRC PROJECT 1222-ESB

PENNSYLVANIA

STACK

JANUARY 25 1980 12:47 TC 14:29

TOTAL SAMPLING TIME, MINUTES

84.

AVERAGE SQUARE FOOT VELOCITY HEAD, IN H2O EXP .5

1.127

AVERAGE ORIFICE PRESSURE DROP, IN H2O

0.731

AVERAGE METER TEMPERATURE, DEG F

37.6

AVERAGE DUCT STATIC PRESSURE, IN H2O

0.36

AVERAGE DUCT TEMPERATURE

322.

TOTAL SAMPLE VOLUME, DACF

37.82

TOTAL SAMPLE VOLUME, DSCE

33.45

MOISTURE CONTENT OF DUCT GAS, PERCENT

2.32

DUCT VOLUMETRIC FLOW, ACFM

44710.

DUCT VOLUMETRIC FLOW, DSCEM

29367.

AVERAGE DUCT VELOCITY, FPM

625.

EXCESS AIR, PERCENT

249.6

AVERAGE DUCT GAS DENSITY, LBS/ACF

0.050

ISOKINETIC FACTOR, PERCENT

97.3

F FACTOR, DSCE/PM BTU

9968.320

EMISSION DATA

GR /
ACF

GR /
DSCE

PARTICULATE PRICE

0.009 0.013

PARTICULATE FILTER

0.011 0.017

STAN. BY PARTICULATE

0.020 0.030

STAN. BY Particulate

0.001 0.001

STAN. BY PARTICULATE

0.020 0.031

LBS/

LBS/

HR

MM TU

PARTICULATE PRICE

3.330 0.063

PARTICULATE FILTER

4.267 0.087

STAN. BY PARTICULATE

7.597 0.155

STAN. BY Particulate

0.200 0.004

STAN. BY PARTICULATE

7.797 0.159

APPENDIX H

COAL ANALYSES

GILBERT ASSOCIATES, INC., P. O. Box 1498, Reading, PA 19603/Tel. 215 775-2600

CERTIFICATE OF ANALYSIS

LABORATORY NO: 122915

RECEIVED: 1/31/80

REPORTED: 2/14/80

CLIENT: TRC - The Research Corp of New England, 125 Silas Deane Highway
Wethersfield, CT 06109SAMPLE DESCRIPTION: Analyses of coal - Sample #1
Project #1222-E80-C0
PO #6082

- - - - -

| | | AS RECEIVED | DRY BASIS |
|---------------|--------|--------------|-----------|
| Moisture | % | 8.50 | |
| Ash | % | 12.3 | 13.4 |
| Heating value | Btu/lb | 11931 | 13039 |
| Sulfur | % S | 0.91 | 0.99 |
| Carbon | % C | 72.7 | 79.5 |
| Hydrogen | % H | 2.27* 3.22** | 2.48 |
| Nitrogen | % N | 0.76 | 0.83 |
| Oxygen | % O | 2.58* 10.1** | 2.82 |

* The hydrogen and oxygen values reported do not include the hydrogen and oxygen from the moisture.

** The hydrogen and oxygen values reported do include the hydrogen and oxygen from the moisture.

Respectfully submitted,


J. K. Kieffer, Supervisor
Laboratory Services

MAH

cc: L. A. Gammie
W. Wade

APPENDIX J

BOILER OPERATION DATA

APPENDIX K

EXAMPLE HEAT INPUT CALCULATION (TEST NO. 1-3)

PENNHURST TOTAL HEAT INPUT CALCULATION

Test 1-3

Heating Value = 11931 BTU/lb

Heat Input (F-Factor Method)

(E = Total Source Heat input in millions of BTU's per hour)

$$E = \frac{\frac{DSCF}{min.} \times \frac{60 \text{ min.}}{Hr.} \times \frac{100}{100 + \text{Excess Air}}}{F\text{-Factor}}$$

$$E = \frac{\frac{27526 \text{ DSCF}}{\text{Min.}} \times \frac{60 \text{ min.}}{Hr.} \times \frac{100}{345.3}}{\frac{9968.32 \text{ DSCF}}{\text{MMBTU}}} = 47.98 \frac{\text{MMBTU}}{\text{Hr.}}$$

Allowable Emission = 0.4 lbs/MMBTU.(1)

Average Steam Load = 16,000 lbs/hr - Boiler #1
16,000 lbs/hr - Boiler #3

(1) Section II, Chapter 123, Title 25 PA Code, Rules, Regulations, Environmental Resources.

APPENDIX L

DER INTERPRETATION OF PA 123.11



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Post Office Box 2063
Harrisburg, Pennsylvania 17120



April 10, 1980

Research Corporation
of New England
125 Silas Deane Highway
Wethersfield, Connecticut 06169

Attention: Mr. Lee Gammie

Gentlemen:

This will confirm my telephone discussion with Messrs. Ben Brown and Lee Gammie on April 8, 1980 regarding Pennsylvania's allowable particulate matter emission standards for combustion units, Section 123.11. The allowable emission rate contained in Section 123.11 applies to each individual combustion unit (boiler), based upon the actual heat input to that unit during a given period of time.

If a stack test is conducted on two or more combustion units having a common stack, the allowable emission rate for this situation would be calculated by determining the heat input for each of the combustion units individually and comparing the individual heat input to Section 123.11. If, for example, a stack test was conducted on three combustion units with a common stack each with an actual heat input of less than 50 million BTU's per hour, the allowable emission rate would be 0.4 pounds per million BTU's for each unit. The allowable emission rate to be compared with the measured emission rate would in that case be 0.4 pounds per million BTU's.

If two combustion units were tested with a common stack one having an actual heat input of 40 million BTU's per hour and the other having a heat input of 70 million BTU's per hour the allowable emission rate from the stack in pounds per million BTU's would be 0.357 pounds per million BTU's. This number would be obtained in the following manner.

$$\frac{40,000,000 \text{ BTU}}{\text{hr}} \quad | \quad \frac{.4 \text{ lb}}{10^6 \text{ BTU}} = 16 \text{ lb/hr}$$

$$A = 3.6E^{-0.56}$$

$$A = 3.6(70)^{-0.56}$$

$$A = 0.333$$

Research Corporation
of New England

-2-

April 10, 1980

$$\frac{70,000,000 \text{ BTU}}{\text{hr}} \quad | \quad \frac{.333 \text{ lb}}{10^6 \text{ BTU}} = 23.3 \text{ lb/hr}$$

$$\frac{16 + 23.3}{(40 \times 10^6) + (70 \times 10^6)} = \frac{39.3 \text{ lb}}{110 \times 10^6 \text{ BTU}} = 0.357 \text{ lb}/10^6 \text{ BTU}$$

The procedure outlined in this letter should be used in determining the allowable emission rate for reporting in the stack tests of tests conducted by TRC at the various State facilities.

If you have further questions regarding this matter please contact me at (717) 787-4325.

Very truly yours,



James R. Benson
Chief, Abatement Monitoring and
Emission Inventory Section
Division of Abatement and Compliance
Bureau of Air Quality Control



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Post Office Box 2063
Harrisburg, Pennsylvania 17120
August 27, 1982



U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Attention: Mr. William H. Lamison, II
Environmental Engineer
Source Analysis Section, AMTB

Gentlemen:

As requested in your letter dated August 3, 1982, and as clarified by telephone with Mr. Lamison on August 23, 1982, enclosed are photocopies of stack test reports for tests conducted on anthracite coal-fired boilers. These reports include both Department and consultant tests. The majority of the 52 stack tests mentioned in my March 19, correspondence were conducted on bituminous-fired boilers.

Thank you for the opportunity to provide this data for inclusion in the development of emission factors for AP-42.

If you have any questions regarding these reports, please contact me at (717) 787-4324.

Very truly yours,

James R. Benson

JAMES R. BENSON, Chief
Abatement Monitoring and
Emission Inventory Section
Division of Abatement and Compliance
Bureau of Air Quality Control

List of Stack Test Reports
Sent to EPA - August 29, 1982

| <u>Firm</u> | <u>Test Date</u> | <u>Boiler I.D.</u> | <u>Tested By</u> |
|--------------------------------|------------------|--------------------|-------------------------|
| Ashland State General Hospital | 03/16/77 | #3 & #4 | DER |
| Armstrong World Industries | 11/13/74 | "C" | Armstrong |
| | 02/02/82 | "C" | Armstrong |
| | 02/02/82 | "C" | Armstrong |
| | 02/02/82 | "C" | DER |
| Magee Carpet Co. | 09/18/79 | #4 | Spotts, Stevens & McCoy |
| Norristown State Hospital | 01/29/80 | #3 | DER |
| | 01/29/80 | #4 | DER |
| | 01/29/80 | #3 & #4 | TRC |
| | 01/30/80 | #3 | DER |
| | 01/30/80 | #4 | DER |
| | 01/30/80 | #3 & #4 | TRC |
| Pennhurst Center | 01/23/80 | #1 & #3 | TRC |
| | 01/25/80 | #1 & #3 | TRC |
| | 01/25/80 | #1 & #3 | TRC |
| Tobyhanna Army Depot | 05/01-03/79 | #2 | Dept. of Army |
| | 07/16-20/79 | #2 | Dept. of Army |
| West Chester State | 11/23/76 | #3 | Roy Weston |
| | 11/23/76 | #3 | Roy Weston |
| | 11/24/76 | #4 | Roy Weston |
| | 11/24/76 | #4 | Roy Weston |
| | 04/04/77 | #3 | Roy Weston |
| | 04/04/77 | #3 | Roy Weston |
| | 04/05/77 | #3 | Roy Weston |
| | 04/06/77 | #4 | Roy Weston |
| | 04/06/77 | #4 | Roy Weston |
| | 04/07/77 | #4 | Roy Weston |

| <u>Firm</u> | <u>Test Date</u> | <u>Boiler I.D.</u> | <u>Tested By</u> |
|--------------------------|------------------|--------------------|------------------|
| Wilkes-Barre Stream Heat | 04/25/75 | #6 | Gannett Fleming |
| | 02/19/76 | #5 | DER |
| | 01/04/78 | #5 | DER |
| | 10/10/79 | #6 | DER |
| | 10/10/79 | #6 | DER |
| | 10/10/79 | #6 | DER |
| | 11/06/80 | #5 | Roy Weston |
| | 11/06/80 | #5 | Roy Weston |
| | 11/06/80 | #5 | Roy Weston |
| | 11/07/80 | #6 | Roy Weston |
| | 11/07/80 | #6 | Roy Weston |
| | 11/07/80 | #6 | Roy Weston |