AP-42 Section 11.7
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# PARTICULATE EMISSION TESTING FOR FLORIDA TILE CORPORATION LAWRENCEBURG, KENTUCKY APRIL 19, 1989

Submitted By:

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BRUCE LAWRIE

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## INTRODUCTION

On Wednesday, April 19, 1989, Air Systems Testing, Inc. *(AST)*, of Marietta, Georgia, performed compliance particulate and gaseous fluoride emission testing on the number six kiln exhaust at the Florida Tile Corporation plant located in Lawrenceburg, Kentucky. The testing was performed to determine if the particulate and gaseous fluoride emission levels were within the allowable rate defined by the Kentucky Bureau of Environmental Protection. *AST* field test personnel were Bruce Lawrie and Jerry Freeman.

*AST* would like to thank Mr. Jim Jefferies and his associates at Florida Tile, and Mr. Randy Reynolds with Lake Engineering for their assistance and cooperation throughout the testing program. We would also like to thank Mr. Jim Neal and Mr. Patrick Springston, both with the Kentucky Bureau of Environmental Protection, for their review of the test procedures and plant operation.

## SUMMARY OF TEST RESULTS

The summary of the results of the testing can be found below and on the following pages. Below is shown the results of each of the test repetitions and the average (which is used to determine compliance with state standards). The results are shown in pounds per hour for particulate and fluoride emissions. The particulate catch on test number one was voided because particulate in the bottom of the duct was entrained in the filter while sampling in the vertical test port. On tests two and three, only the horizontal port was used.

| Test No. | Particulate Emission Rate (pounds/hour) | Allowable Emission Rate (pounds/hour) | Fluoride Emission Rate (pounds/hour) |
|---|---|---|---|
| 1 | ---- | 3.40 | 2.95 |
| 2 | 1.06 | 3.40 | 3.73 |
| 3 | 1.45 | 3.40 | 4.20 |
| Average | 1.26 | 3.40 | 3.63 |

Thus, from the above table, kiln number six at Florida Tile, Lawrenceburg, Kentucky, is within allowable standards for particulate emissions.

**SUMMARY OF TEST RESULTS**
**Kiln #6 Exhaust**
**Particulate Emissions**

| | Test #2 | Test #3 |
|---|---|---|
| Volume @ Meter (Vm): | 38.237 | 38.919 |
| Sqrt Delta P: | 0.456 | 0.445 |
| Sampling Time (min): | 60 | 60 |
| Barometric Pressure (Pb): | 29.60 | 29.60 |
| Delta H (H): | 1.55 | 1.49 |
| Volume in Impingers (mls): | 34.5 | 32.5 |
| Stack Pressure (Ps): | 29.60 | 29.60 |
| Stack Temperature (Ts): | 736 | 735 |
| Meter Coefficient (Y): | 1.031 | 1.031 |
| Pitot Coefficient (Cp): | 0.84 | 0.84 |
| Meter Temperature (Tm): | 513 | 516 |
| Area Stack (As): | 11.54 | 11.54 |
| Area Nozzle (An): | 0.000524 | 0.000524 |
| Percent CO2 (%): | 0.0 | 0.0 |
| Percent O2 (%): | 21.0 | 21.0 |
| Percent N2 (%): | 79.0 | 79.0 |
| Milligrams: | 22.4 | 31.6 |
| | | |
| Molecular Weight Dry (Md): | 28.84 | 28.84 |
| Volume Water (Vwstd): | 1.62 | 1.53 |
| Volume Gas Sampled (Vmstd): | 40.280 | 40.754 |
| Wet Fraction (Bws): | 0.039 | 0.036 |
| Molecular Weight Wet (Ms): | 28.42 | 28.45 |
| Volume Gas Sampled (Vma): | 59.042 | 59.497 |
| Stack Gas Velocity, (Vs): | 30.63 | 29.86 |
| Volumetric Flowrate (Qs): | 14,468 | 14,160 |
| Volumetric Flowrate (Qa): | 21,208 | 20,672 |
| Grainloading, gr/dscf (cs): | 0.0086 | 0.0120 |
| Grainloading, gr/ACF (csi): | 0.0059 | 0.0082 |
| Emission Rate, #/Hour: | 1.06 | 1.45 |
| Percent Isokinetic Sampling: | 102.2 | 105.7 |

## SUMMARY OF TEST RESULTS
## Kiln #6 Exhaust
## Fluoride Emissions

| | Test #1 | Test #2 | Test #3 |
|---|---|---|---|
| Volume @ Meter (Vm): | 38.007 | 38.237 | 38.919 |
| Sqrt Delta P: | 0.459 | 0.456 | 0.445 |
| Sampling Time (min): | 60 | 60 | 60 |
| Barometric Pressure (Pb): | 29.60 | 29.60 | 29.60 |
| Delta H (H): | 1.49 | 1.55 | 1.49 |
| Volume in Impingers (mls): | 20.0 | 34.5 | 32.5 |
| Stack Pressure (Ps): | 29.60 | 29.60 | 29.60 |
| Stack Temperature (Ts): | 733 | 736 | 735 |
| Meter Coefficient (Y): | 1.031 | 1.031 | 1.031 |
| Pitot Coefficient (Cp): | 0.84 | 0.84 | 0.84 |
| Meter Temperature (Tm): | 508 | 513 | 516 |
| Area Stack (As): | 11.54 | 11.54 | 11.54 |
| Area Nozzle (An): | 0.000524 | 0.000524 | 0.000524 |
| Percent CO2 (%): | 0.0 | 0.0 | 0.0 |
| Percent O2 (%): | 21.0 | 21.0 | 21.0 |
| Percent N2 (%): | 79.0 | 79.0 | 79.0 |
| Milligrams: | 61.00 | 78.50 | 91.46 |
| | | | |
| Molecular Weight Dry (Md): | 28.84 | 28.84 | 28.84 |
| Volume Water (Vwstd): | 0.94 | 1.62 | 1.53 |
| Volume Gas Sampled (Vmstd): | 40.425 | 40.280 | 40.754 |
| Wet Fraction (Bws): | 0.023 | 0.039 | 0.036 |
| Molecular Weight Wet (Ms): | 28.59 | 28.42 | 28.45 |
| Volume Gas Sampled (Vma): | 58.048 | 59.042 | 59.497 |
| Stack Gas Velocity, (Vs): | 30.67 | 30.63 | 29.86 |
| Volumetric Flowrate (Qs): | 14,791 | 14,468 | 14,160 |
| Volumetric Flowrate (Qa): | 21,239 | 21,208 | 20,672 |
| Grainloading, gr/dscf (cs): | 0.0233 | 0.0301 | 0.0346 |
| Grainloading, gr/ACF (csi): | 0.0162 | 0.0205 | 0.0237 |
| Emission Rate, #/Hour: | 2.95 | 3.73 | 4.20 |
| Percent Isokinetic Sampling: | 100.4 | 102.2 | 105.7 |

## E.P.A. TEST PROCEDURES

The testing procedures followed were according to Methods 1, 2, 3, and 5, and Kentucky Method 130 for location of sampling points; measuring of stack gas velocity and volumetric flow rate; determination of $CO_2$, $O_2$, and dry molecular weight; determination of particulate matter concentrations; and determination of gaseous fluoride emission concentrations. These methods can be found in the *Code of Federal Regulations*, Title 40, Parts 53-60, revised as of July 1, 1986.

Method 1, determination of number and location of sampling points, was used to calculate the location of the sample points used on each traverse. The exact location of each point can be found in detail in Appendix C.

EPA Method 2 was used to calculate the stack gas velocity and volumetric flow rate. The S-type pitot tube on the pitot-probe assembly was fabricated according to design criteria in Method 2 that allows a pitot coefficient of 0.84 to be used in the calculations. The pre-test and post-test measurements on the pitot-probe assembly can be found in Appendix D. Stack gas temperatures used in the velocity calculations were obtained with a type "K" thermocouple and Omega digital thermometer. Leak checks were performed on the pitot-manometer assembly after each test and showed no leak.

Method 3 was used to determine dry molecular weight, including $CO_2$ and $O_2$ concentrations. The grab samples were analyzed immediately with a fyrite analyzer according to procedures outlined in Method 3.

Method 5, Determination of Particulate Matter from Stationary Sources, was used to determine particulate emission concentrations. The sampling train consisted of a calibrated nozzle, union, 316 seamless stainless steel liner heated with 50 feet of 0.4 ohms per foot nichrome wire, glass fiber filter and filter holder, four impingers, umbilical cord, pump, and control console. Filter box, impinger outlet, and dry gas meter temperatures were monitored throughout the test with bimetallic thermometers. The dry gas meter in the control console was calibrated against a Rockwell S-415 test meter that had been standardized with a Rockwell #1464 Bell Prover. The S-415 meter had a calibration coefficient (Y) of 0.999.

Kentucky Method 130 was used to determine gaseous fluoride concentrations. The distilled water impinger catch from the Method 5 testing was analyzed by the specific ion electrode method for fluoride concentrations.

## Sampling Procedures

The sampling area for the testing was located on the kiln exhaust stack. A platform was constructed to support the filter/impinger box while the probe traversed the stack. The schematic of the sampling location can be found in Appendix C.

Prior to each test, the sampling train was assembled for testing. 100 milliliters (ml) of distilled water was placed in each of the first two impingers, the third impinger was left empty, and 200.0 grams (g) of silica gel was placed in impinger number 4. The probe was secured in the sampling box, the filter holder assembly was installed, and the system was ready for pre-test leak checks.

After each test, leak checks were performed on the sampling train, Method 3 train, and each side of the pitot tubes. Next, the train was disassembled. The filter holder was removed and sealed to prevent loss of particulate matter. The probe and nozzle were cleaned with reagent grade acetone, with all sample exposed surfaces brushed and rinsed at least six times to insure all particulate matter was removed. This rinse was saved in a 500 ml polyethylene bottle. Next, the contents of the first three impingers were measured with a graduated cylinder, rinsed, and saved for further analysis for fluorides. The silica gel was returned to its container and sealed.

## Laboratory Procedures

The following procedures were followed for each repetition:

Container No. 1

A pre-numbed 81.5 millimeter glass fiber filter was desiccated for a minimum of 24 hours, weighed to a constant weight, and transferred to this container. Before the test, the filter was placed in a filter holder. After the test, the filter was carefully removed from the filter holder and returned to the container.

Container No. 2

All sample exposed surfaces between the nozzle and the filter were washed with acetone, including brushing and rinsing at least six times, until no particulate matter remained. The brushes were also rinsed with the acetone to remove any particulate adhering to them.

Container No. 3

200.0 grams of indicating, 6-16 mesh silica gel was weighed and sealed in this container. Before the test, it was added to impinger number four. After the test, if was returned to the container and sealed.

Container No. 4

The contents of impingers 1, 2, and 3 were measured with a graduated cylinder and saved in this container. The container was sealed.

The following procedures were followed for each sample:

Container No. 1

The filter was desiccated for at least 24 hours and weighed to a constant weight. Note: Before each weighing, the SP 180 electronic analytical balance was calibrated with a 100 gram and 1 gram class S weight.

Container No. 2

The contents of this container were transferred to a tared beaker. The volume of the rinse was recorded and the acetone in the sample evaporated. When the beaker was dry, it was desiccated and weighed to a constant weight.

Container No. 3

The silica gel was weighed to the nearest 0.5 gram.

Container No. 4

The contents of this container were transferred to Galbraith Laboratories for analysis for fluorides.

# APPENDIX A
# LABORATORY RESULTS

# PARTICULATE LABORATORY DATA SHEET

Test No.: 2 Source: KILN #6

Acetone Blank: Volume: 200 ml. Net Wt.: 0.0000 g.

Acetone Density: 0.785 g/ml. Residue: 0 g/ml.

## Filter

Filter No.: 301

Final Weight: 0.3566 g. 0.3570 g. AVG: 0.3568 g.

Tare Weight: 0.3505 g. 0.3507 g. AVG: 0.3506 g.

Net Weight: AVG: 0.0062 g.

## Probe Wash

Probe Wash Beaker No.: 10 Volume: 175 ml.

Final Weight: 128.2244 g. 128.2250 g. AVG: 128.2247 g.

Tare Weight: 128.2072 g. 128.2077 g. AVG: 128.2075 g.

Net Weight: AVG: 0.0162 g.

Less Acetone Blank Residue: 0 g.

TOTAL PARTICULATE MATTER COLLECTED: 0.0224 g.

# PARTICULATE LABORATORY DATA SHEET

Test No.: 3 Source: KILN #6

Acetone Blank: Volume: 200 ml. Net Wt.: 0.0000 g.

Acetone Density: 0.785 g/ml. Residue: 0 g/ml.

## Filter

Filter No.: 300

| | | | |
|---|---|---|---|
| Final Weight: | 0.3577 g. | 0.3580 g. | AVG: 0.3579 g. |
| Tare Weight: | 0.3535 g. | 0.3534 g. | AVG: 0.3535 g. |
| Net Weight: | | | AVG: 0.0044 g. |

## Probe Wash

Probe Wash Beaker No.: 11 Volume: 200 ml.

| | | | |
|---|---|---|---|
| Final Weight: | 129.9504 g. | 129.9500 g. | AVG: 129.9502 g. |
| Tare Weight: | 129.9228 g. | 129.9231 g. | AVG: 129.9230 g. |
| Net Weight: | | | AVG: 0.0272 g. |

Less Acetone Blank Residue: 0 g.

TOTAL PARTICULATE MATTER COLLECTED: 0.0316 g.

# CERTIFICATE OF ANALYSIS

P.O. BOX 51610, KNOXVILLE, TN 37950-1610
OTHER CARRIERS - 2323 SYCAMORE DR. KNOXVILLE, TN 37921
615/546-1335

Mr. Bruce Lawrie
Air Systems Testing
P.O. Box 6278
Marietta, Georgia 30065

May 8, 1989

Received: April 28th

Dear Mr. Lawrie:

Analysis of your compounds gave the following results:

| Your #, | Our #, | mg Fluoride/sample, |
|---|---|---|
| 1 | F-4326 | 61.0 |
| 2 | F-4327 | 78.5 |
| 3 | F-4328 | 91.46 |

Sincerely yours,

GALBRAITH LABORATORIES, INC.

Gail R. Hutchens
Exec. Vice-President

GRH:sc

## CHAIN OF CUSTODY FORM

Plant: FLORIDA TILE  Source: KILN #6

Date Sampled: 4/19/89  Run No.: 1-3

### SAMPLE RECOVERY

| Container No. | Description (if filter, give filter No.) |
|---|---|
| As marked | Filter #'s 301, 300 |
| As marked | Probe wash test 2 & 3, Acetone blank |
| As marked | Impinger catch tests 1, 2, & 3 |
| As marked | Impinger rinse tests 1, 2, & 3 |

Person Engaged in Sample Recovery:

Signature & Title: [signature]

Recovery Location: Fla Tile

Date & Time of Recovery: After each test

Sample Recipient, upon Recovery, if not Recovery person:

Signature: ____

Date & Time of Receipt: ____

Sample Storage: ____

Laboratory Person Receiving Sample:

Signature & Title: [signature]

Date & Time of Receipt: 4/20/89

Sample Storage: AST LAB

# APPENDIX B
# FIELD DATA SHEETS & CALCULATIONS

# PARTICULATE TEST FIELD DATA

Company: FLA TILE  Source: KILN #6  Test No.: 1

Date: APRIL 17 1989  Test Team: LAWRIE / FREEMAN

Nozzle Diameter: 0.310 in.  Nozzle Area (Sq.Ft.): 0.000524

Console No.: 1  Meter Calibration: 1.031

Stack Diameter: 46 in.  Stack Area: 11.54 Sq. Ft.

Assumed Moisture: 1 %  Stack Static Pressure: 0 " W.C.

Stack Temperature: ~275 oF  Meter Temperature: ~50 oF

Pressures:  Barometric: 29.60 in. Hg.  Stack: 29.60 in. Hg.

Probe No.: 5'#1  Filter/Impinger Box No.: ____  Cp = ____

~~Orsat~~/Fyrite:  % CO2 = 0  %O2 = 21  %N2 = 79

Molecular Weight of Gas:  Dry: ____  Wet: ____

K Factor: ____  Minutes/Point: 5.0

Time Start: 7:38  Time End: 9:15

Pretest leak checks ok

| Port | Point | Meter Volume 823.630 | ΔP | ΔH Desire | ΔH Actual | Temperatures: Stack | Box | Imp | Meter In | Meter Out | Vacuum |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SIDE | 1 | [illegible] | 0.20 | 1.40 | 1.40 | 270 | 220 | 38 | 45 | 45 | 6 |
| | 2 | 826.84 | 0.20 | 1.40 | 1.40 | 271 | 240 | 33 | 46 | 45 | 6 |
| | 3 | 829.95 | 0.20 | 1.40 | 1.40 | 272 | 240 | 34 | 49 | 45 | 6 |
| | 4 | 833.15 | 0.22 | 1.55 | 1.55 | 274 | 250 | 32 | 52 | 45 | 6 |
| | 5 | 836.38 | 0.23 | 1.60 | 1.60 | 274 | 245 | 32 | 53 | 45 | 6 |
| | 6 | 839.69 | 0.20 | 1.40 | 1.40 | 274 | 240 | 33 | 53 | 45 | 6 |
| | | STOP - | CHANGE PORTS | | | | | | | | |
| TOP | 1 | 842.837 | 0.15 | 1.1 | 1.1 | 272 | 220 | 34 | 45 | 44 | 5 |
| | 2 | 845.58 | 0.23 | 1.6 | 1.6 | 272 | 225 | 35 | 48 | 45 | 6 |
| | 3 | 848.82 | 0.23 | 1.6 | 1.6 | 272 | 245 | 35 | 52 | 45 | 6 |
| | 4 | 852.12 | 0.23 | 1.6 | 1.6 | 273 | 240 | 37 | 55 | 45 | 6 |
| | 5 | 855.16 | 0.23 | 1.6 | 1.6 | 278 | 230 | 37 | 55 | 45 | 6 |
| | 6 | 858.39 | 0.22 | 1.6 | 1.6 | 276 | 245 | 34 | 56 | 46 | 6 |
| | End | 861.637 | | | | | | | | | |

NOZZLE: 0.310, 0.310, 0.310, 0.309

Comments:  Post test leak check 0.020 CFM @ 6 " Hg.

Pitots: OK

Method 3 train @ ____ " Hg.: ____

| Moisture | |
|---|---|
| Imp 1-3: | 8 |
| S. Gel: | 12.0 |
| Total: | 20.0 |

# PARTICULATE TEST FIELD DATA

Company: FLA TILE Source: KILN #6 Test No.: 2
Date: APR 19, 1999 Test Team: LAWRE/FREEMAN
Nozzle Diameter: 0.310 in. Nozzle Area (Sq.Ft.): 0.000524
Console No.: 1 Meter Calibration: 1.031 Km = 0.699
Stack Diameter: 46 in. Stack Area: 11.54 Sq. Ft.
Assumed Moisture: 1 % Stack Static Pressure: 0 " w.c.
Stack Temperature: ~275 oF Meter Temperature: ~55 oF
Pressures: Barometric: 29.60 in. Hg. Stack: 29.60 in. Hg.
Probe No.: 5'#1 Filter/Impinger Box No.: ___ Cp =
Orsat/Fyrite: % CO2 = 0 %O2 = 21 %N2 = 79
Molecular Weight of Gas: Dry: ___ Wet: ___
K Factor: 7 Minutes/Point: 5.0
Time Start: 10:09 Time End: 11:09

| Point | Meter Volume | ΔP | ΔH Desire | ΔH Actual | Stack | Box | Imp | Meter In | Meter Out | Vacuum |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 863.433 | 0.20 | 1.4 | 1.4 | 270 | 225 | 34 | 46 | 45 | 3 |
| 2 | 866.60 | 0.20 | 1.5 | 1.5 | 275 | 250 | 35 | 52 | 46 | 3 |
| 3 | 869.85 | 0.20 | 1.5 | 1.5 | 277 | 255 | 35 | 55 | 46 | 3 |
| 4 | 873.08 | 0.23 | 1.7 | 1.7 | 276 | 240 | 35 | 58 | 47 | 0 |
| 5 | 876.30 | 0.23 | 1.7 | 1.7 | 279 | 260 | 36 | 59 | 47 | 3 |
| 6 | 879.93 | 0.20 | 1.5 | 1.5 | 279 | 250 | 36 | 60 | 48 | 3 |
| | | | | | | | | | | |
| 1 | — | 0.18 | 1.4 | 1.4 | 272 | 250 | 36 | 60 | 48 | 3 |
| 2 | 886.28 | 0.20 | 1.5 | 1.5 | 277 | 250 | 36 | 60 | 48 | 3 |
| 3 | 889.47 | 0.20 | 1.5 | 1.5 | 276 | 260 | 35 | 60 | 48 | 3 |
| 4 | 892.72 | 0.23 | 1.7 | 1.7 | 276 | 245 | 35 | 60 | 49 | 3 |
| 5 | 896.21 | 0.23 | 1.7 | 1.7 | 277 | 250 | 36 | 60 | 49 | 3 |
| 6 | 899.70 | 0.20 | 1.5 | 1.5 | 273 | 220 | 37 | 62 | 49 | 3 |
| END | 902.870 | | | | | | | | | |

Comments: Post test leak check 0.040 CFM @ 3 " Hg

Pitots: OK

Method 3 train @ N/A " Hg.: N/A

Moisture
Imp 1-3: 18
S. Gel: 16.5
Total: 34.5

# PARTICULATE TEST FIELD DATA

Company: Fla Tile  Source: Kiln #6  Test No.: 3
Date: April 19, 1989  Test Team: Laurie/Freeman
Nozzle Diameter: 0.310 in.  Nozzle Area (Sq.Ft.): 0.000524
Console No.: 1  Meter Calibration: 1.031
Stack Diameter: 46 in.  Stack Area: 11.54 Sq. Ft.
Assumed Moisture: 1 %  Stack Static Pressure: ____ " w.c.
Stack Temperature: ~275 oF  Meter Temperature: ~60 oF
Pressures: Barometric: 29.60 in. Hg.  Stack: 29.60 in. Hg.
Probe No.: 5'#1  Filter/Impinger Box No.: 1  Cp = ____
Orsat/Fyrite: % CO2 = 0  %O2 = 21  %N2 = 79
Molecular Weight of Gas: Dry: ____  Wet: ____
K Factor: 7  Minutes/Point: 5.0
Time Start: 11:37  Time End: 12:37

| Point | Meter Volume | ΔP | ΔH Desire | ΔH Actual | TEMPERATURES Stack | Box | Imp | Meter In | Meter Out | Vacuum |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 903.146 | 0.16 | 1.2 | 1.2 | 272 | 250 | 38 | 49 | 48 | 3" |
| 2 | 906.11 | 0.19 | 1.4 | 1.4 | 272 | 250 | 38 | 56 | 50 | 3 |
| 3 | 909.21 | 0.19 | 1.4 | 1.4 | 276 | 255 | 37 | 58 | 51 | 3 |
| 4 | 912.32 | 0.22 | 1.6 | 1.6 | 276 | 250 | 38 | 60 | 51 | 3 |
| 5 | 915.57 | 0.22 | 1.6 | 1.6 | 275 | 240 | 40 | 61 | 51 | 3 |
| 6 | 918.94 | 0.20 | 1.5 | 1.5 | 275 | 240 | 41 | 63 | 51 | 3 |
| 1 | 922.24 | 0.19 | 1.5 | 1.5 | 275 | 255 | 41 | 63 | 51 | 3 |
| 2 | 925.52 | 0.19 | 1.5 | 1.5 | 274 | 225 | 41 | 64 | 51 | 3 |
| 3 | 928.77 | 0.19 | 1.5 | 1.5 | 275 | 260 | 40 | 64 | 52 | 3 |
| 4 | 932.03 | 0.22 | 1.6 | 1.6 | 275 | 255 | 41 | 64 | 53 | 3 |
| 5 | 935.41 | 0.22 | 1.6 | 1.6 | 274 | 230 | 41 | 63 | 52 | 3 |
| 6 | 938.30 | 0.19 | 1.5 | 1.5 | 275 | 260 | 41 | 63 | 52 | 3 |
| End: | 942.065 | | | | | | | | | |

Comments: Post test leak check 0.000 CFM @ 3 " Hg.

Pitots: OK

Method 3 train @ N/A " Hg.: N/A

Moisture
Imp 1-3: 18
S. Gel: 14.5
Total: 32.5

# Particulate Emission Test Calculations

Company: Florida Tile    Source: Kiln #6    Test No.: 1
Date: April 19, 1989    Test Team: Bruce Lawrie / Jerry Freeman
Nozzle Diameter: 0.310 in.    Nozzle Area (Sq.Ft.): 0.000524
Console No.: 1    Meter Calibration: 1.031    Km: 0.699
Stack Diameter: 46 in.    Stack Area: 11.54 Sq.Ft.
Stack Moisture: 2.3%    Stack Static Pressure: 0.0 " w.c.
Stack Temperature: 273 oF    Meter Temperature: 48 oF
Pressures: Barometric: 29.60 in. Hg.    Stack: 29.60 in. Hg.
Probe No.: 5' #1    Filter/Impinger Box No.: 1    Cp = 0.84
Orsat/Fyrite: % CO2 = 0.0    %O2 = 21.0    %N2 = 79.0
Molecular Weight of Gas: Dry: 28.84    Wet: 28.59
K Factor: 7.0    Minutes/Point: 5.0    Number of Points: 12
Mls: 20.0    Milligrams:

| Vm | ^P | Sqrt ^P | ^H | Ts | Tm | Tm | I |
|---|---|---|---|---|---|---|---|
| 823.63 | 0.20 | 0.447 | 1.40 | 270 | 45 | 45 | 104.7 |
| 826.84 | 0.20 | 0.447 | 1.40 | 271 | 46 | 45 | 101.4 |
| 829.95 | 0.20 | 0.447 | 1.40 | 272 | 49 | 45 | 104.1 |
| 833.15 | 0.22 | 0.469 | 1.55 | 274 | 52 | 45 | 100.1 |
| 836.38 | 0.23 | 0.480 | 1.60 | 274 | 53 | 45 | 100.2 |
| 839.69 | 0.20 | 0.447 | 1.40 | 274 | 53 | 45 | 102.1 |
| 842.837 | 0.15 | 0.387 | 1.10 | 272 | 45 | 44 | 103.5 |
| 845.58 | 0.23 | 0.480 | 1.60 | 272 | 48 | 45 | 98.5 |
| 848.82 | 0.23 | 0.480 | 1.60 | 272 | 52 | 45 | 99.9 |
| 852.12 | 0.23 | 0.480 | 1.60 | 273 | 55 | 45 | 91.8 |
| 855.16 | 0.23 | 0.480 | 1.60 | 278 | 55 | 45 | 97.9 |
| 858.39 | 0.22 | 0.469 | 1.60 | 276 | 56 | 46 | 100.3 |
| 861.637 Final | | | | | | | |

## AVERAGES

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38.007 | | 0.459 | 1.49 | 273 | | 48 | 100.4 |
| | | | | 733 oR | | 508 | |

## CALCULATIONS

| | |
|---|---|
| Volume of Water Vapor Collected (cubic feet): | 0.94 |
| Dry gas volume through meter (cubic feet): | 40.435 |
| Stack gas moisture content by volume: | 2.3% |
| Stack gas wet molecular weight: | 28.59 |
| Actual stack gas volume sampled (cubic feet): | 58.08 |
| Stack gas velocity (feet per second): | 30.70 |
| Stack gas volumetric flow rate (dscf/minute): | 14802 |
| Stack gas volumetric flow rate (ACF/minute): | 21259 |
| Particulate concentration (grains/dscf): | 0.0000 |
| Particulate concentration (grains/ACF): | 0.0000 |
| Emission rate (pounds per hour): | 0.00 |
| Isokinetic sampling rate (percent): | 100.5 |

## Particulate Emission Test Calculations

Company: Florida Tile　　Source: Kiln #6　　Test No.: 2
Date: April 19, 1989　　Test Team: Bruce Lawrie / Jerry Freeman
Nozzle Diameter: 0.310 in.　　Nozzle Area (Sq.Ft.): 0.000524
Console No.: 1　　Meter Calibration: 1.031　　Km: 0.699
Stack Diameter: 46 in.　　Stack Area: 11.54 Sq.Ft.
Stack Moisture: 3.9%　　Stack Static Pressure: 0.0 " w.c.
Stack Temperature: 276 oF　　Meter Temperature: 53 oF
Pressures: Barometric: 29.60 in. Hg.　　Stack: 29.60 in. Hg.
Probe No.: 5' #1　　Filter/Impinger Box No.: 1　　Cp = 0.84
Orsat/Fyrite: % CO2 = 0.0　　%O2 = 21.0　　%N2 = 79.0
Molecular Weight of Gas: Dry: 28.84　　Wet: 28.42
K Factor: 6.8　　Minutes/Point: 5.0　　Number of Points: 12
Mls: 34.5　　Milligrams: 22.4

| Vm | ^P | Sqrt ^P | ^H | Ts | Tm | Tm | I |
|---|---|---|---|---|---|---|---|
| 863.433 | 0.20 | 0.447 | 1.40 | 270 | 46 | 45 | 101.3 |
| 866.60 | 0.20 | 0.447 | 1.50 | 275 | 52 | 46 | 103.7 |
| 869.85 | 0.20 | 0.447 | 1.50 | 277 | 55 | 46 | 102.9 |
| 873.08 | 0.23 | 0.480 | 1.70 | 276 | 58 | 47 | 101.4 |
| 876.50 | 0.23 | 0.480 | 1.70 | 279 | 59 | 47 | 101.8 |
| 879.93 | 0.20 | 0.447 | 1.50 | 279 | 60 | 48 | |
| | 0.18 | 0.424 | 1.40 | 272 | 60 | 48 | |
| 886.28 | 0.20 | 0.447 | 1.50 | 277 | 60 | 48 | 100.9 |
| 889.47 | 0.20 | 0.447 | 1.50 | 276 | 60 | 48 | 102.8 |
| 892.72 | 0.23 | 0.480 | 1.70 | 276 | 60 | 48 | 103.1 |
| 896.21 | 0.23 | 0.480 | 1.70 | 277 | 60 | 49 | 103.2 |
| 899.70 | 0.20 | 0.447 | 1.50 | 273 | 62 | 49 | 99.7 |
| 902.870 Final | | | | | | | |
| 1.200 Leak | | | | | | | |

### AVERAGES

| Vm | ^P | Sqrt ^P | ^H | Ts | Tm | Tm | I |
|---|---|---|---|---|---|---|---|
| 38.237 | | 0.456 | 1.55 | 276 | | 53 | |
| | | | | 736 oR | | 513 | |

### CALCULATIONS

| | |
|---|---|
| Volume of Water Vapor Collected (cubic feet): | 1.62 |
| Dry gas volume through meter (cubic feet): | 40.312 |
| Stack gas moisture content by volume: | 3.9% |
| Stack gas wet molecular weight: | 28.42 |
| Actual stack gas volume sampled (cubic feet): | 59.06 |
| Stack gas velocity (feet per second): | 30.63 |
| Stack gas volumetric flow rate (dscf/minute): | 14477 |
| Stack gas volumetric flow rate (ACF/minute): | 21208 |
| Particulate concentration (grains/dscf): | 0.0086 |
| Particulate concentration (grains/ACF): | 0.0059 |
| Emission rate (pounds per hour): | 1.06 |
| Isokinetic sampling rate (percent): | 102.4 |

# Particulate Emission Test Calculations

Company: Florida Tile    Source: Kiln #6    Test No.: 3
Date: April 19, 1989    Test Team: Bruce Lawrie / Jerry Freeman
Nozzle Diameter: 0.310 in.    Nozzle Area (Sq.Ft.): 0.000524
Console No.: 1    Meter Calibration: 1.031    Km: 0.699
Stack Diameter: 46 in.    Stack Area: 11.54 Sq.Ft.
Stack Moisture: 3.6%    Stack Static Pressure: 0.0 " w.c.
Stack Temperature: 275 oF    Meter Temperature: 56 oF
Pressures: Barometric: 29.60 in. Hg.    Stack: 29.60 in. Hg.
Probe No.: 5' #1    Filter/Impinger Box No.: 1    Cp = 0.84
Orsat/Fyrite: % CO2 = 0.0    %O2 = 21.0    %N2 = 79.0
Molecular Weight of Gas: Dry: 28.84    Wet: 28.45
K Factor: 6.9    Minutes/Point: 5.0    Number of Points: 12
Mls: 32.5    Milligrams: 31.6

| Vm | ^P | Sqrt ^P | ^H | Ts | Tm | Tm | I |
|---|---|---|---|---|---|---|---|
| 903.146 | 0.16 | 0.400 | 1.20 | 272 | 49 | 48 | 108.6 |
| 906.11 | 0.19 | 0.436 | 1.40 | 272 | 56 | 50 | 103.4 |
| 909.21 | 0.19 | 0.436 | 1.40 | 276 | 58 | 51 | 103.7 |
| 912.32 | 0.22 | 0.469 | 1.60 | 276 | 60 | 51 | 100.6 |
| 915.57 | 0.22 | 0.469 | 1.60 | 275 | 61 | 51 | 104.1 |
| 918.94 | 0.20 | 0.447 | 1.50 | 275 | 63 | 51 | 106.7 |
| 922.240 | 0.19 | 0.436 | 1.50 | 275 | 63 | 51 | 108.8 |
| 925.52 | 0.19 | 0.436 | 1.50 | 274 | 64 | 51 | 107.6 |
| 928.77 | 0.19 | 0.436 | 1.50 | 275 | 64 | 52 | 107.9 |
| 932.03 | 0.22 | 0.469 | 1.60 | 275 | 64 | 53 | 103.9 |
| 935.41 | 0.22 | 0.469 | 1.60 | 274 | 63 | 52 | 104.4 |
| 938.80 | 0.19 | 0.436 | 1.50 | 275 | 63 | 52 | 108.2 |
| 942.065 Final | | | | | | | |

## AVERAGES

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38.919 | | 0.445 | 1.49 | 275 | | 56 | 105.7 |
| | | | | 735 oR | | 516 | |

## CALCULATIONS

| | |
|---|---|
| Volume of Water Vapor Collected (cubic feet): | 1.53 |
| Dry gas volume through meter (cubic feet): | 40.764 |
| Stack gas moisture content by volume: | 3.6% |
| Stack gas wet molecular weight: | 28.45 |
| Actual stack gas volume sampled (cubic feet): | 59.47 |
| Stack gas velocity (feet per second): | 29.84 |
| Stack gas volumetric flow rate (dscf/minute): | 14163 |
| Stack gas volumetric flow rate (ACF/minute): | 20662 |
| Particulate concentration (grains/dscf): | 0.0120 |
| Particulate concentration (grains/ACF): | 0.0082 |
| Emission rate (pounds per hour): | 1.45 |
| Isokinetic sampling rate (percent): | 105.8 |

# TEST CALCULATIONS

## I. Determination of Moisture in Stack Gases

a. Volume of Water Vapor Collected (Cubic Feet):

Vwstd = 0.04707 * (Vlc)

b. Dry Gas Volume Through Meter (Cubic Feet):

Vmstd = 17.64 * Vm * Y * [(Pbar + (^H/13.6)) / Tm]

c. Moisture Content: (Bws)

Bws = Vwstd / [ Vwstd + Vmstd ]

d. Wet Molecular Weight: (Ms)

Ms = [ Md * (1-Bws) ] + [ 18.0 * Bws ]

## II. Actual Stack Gas Volume Sampled (Cubic Feet):

Vma = [ Vmstd * Ts * Pstd ] / [ (1-Bws) * Tstd * Ps

## III. Determination of Stack Gas Velocity & Volumetric Flow Rate

a. Stack Gas Velocity (Feet per Second):

Vs = Kp * Cp * (^P) * [SQRT (Ts / (Ps * Ms)) ]

b. Stack Volumetric Flow Rate (Cubic Feet per Minute):

1. Dry Standard Conditions (Qs)

   Qs = 60 * (1-Bws) * Vs * As * (Tstd/Ts) * (Ps/Pstd)

2. Actual Conditions (Qa)

   Qa = Vs * As * 60

## IV. Determination of Particulate Concentration (Grainloading)

a. Dry Standard Conditions: (cs)

cs = 0.01543 * ( Mn / Vmstd )

b. Actual Conditions: (csl)

csl = 0.01543 * ( Mn / Vma )

## V. Emission Rate (Pounds per Hour)

E = 60 * Qs * cs / 7000

## VII. Determination of Acceptability of Sampling Results: (I)

$$I = \frac{Ts * ((0.00267 * Vlc) + ((Vm*Y/Tm)*(Pbar+(\Delta H/13.6))))}{0.599 * \theta * Vs * Ps * An}$$

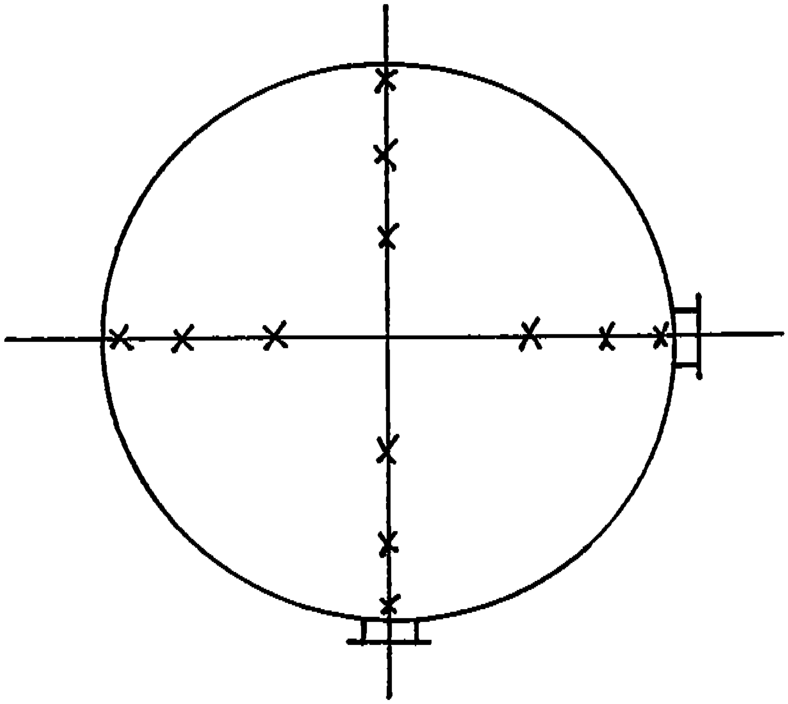
# NOMENCLATURE

| | |
|---|---|
| As | Cross-sectional area of stack, square feet |
| An | Cross-sectional area of nozzle, square feet |
| ACF | Actual cubic feet of gas at stack conditions |
| ACFM | Actual cubic feet of gas per minute at stack conditions |
| Bws | Proportion by volume of water vapor in gas stream |
| cs | Particulate concentration in stack gas, gr/dscf |
| cs1 | Particulate concentration in stack gas, gr/ACF |
| Cp | Pitot tube coefficient |
| delta H | Pressure drop across orifice meter, inches water |
| dp | Nozzle diameter, inches |
| delta P | Velocity head of stack gas, inches water |
| dscf | Cubic feet of dry gas corrected to standard conditions |
| E | Particulate emission rate, pounds/hour |
| Kp | Constant (85.49) |
| Mn | Total particulate matter collected, mg |
| I | Percent of isokinetic sampling |
| Pbar | Barometric pressure, inches mercury |
| Pm | Barometric pressure of dry gas meter, in. mercury |
| Ps | Absolute stack gas pressure, inches mercury |
| Pstd | Barometric pressure, standard conditions, 29.92 "Hg |
| Qa | Volumetric flow rate, actual conditions, ACF/min |
| Qs | Volumetric flow rate, dry standard conditions, dscf/min |
| Tm | Absolute average dry gas meter temperature, degree R |
| Ts | Absolute average stack gas temperature, degree R |
| Tstd | Absolute temperature at standard conditions, 528 R |

| | |
|---|---|
| -θ- | Total sampling time, minutes |
| Vlc | Total volume collected in impingers and silica gel, ml |
| Vm | Volume of gas sampled through gas meter, cubic feet |
| Vma | Stack gas volume sampled, ACF |
| Vmstd | Volume of gas sampled through gas meter, cubic feet |
| Vs | Average stack gas velocity, feet/sec |
| Vwstd | Volume of water vapor in gas sampled, standard cubic feet |
| Y | Dry gas meter calibration factor |

## APPENDIX C
## SCHEMATIC OF SAMPLING LOCATION

**Sampling Point Location**
**for**
**Kiln #6 Exhaust**



46 inch Diameter Stack

| Sampling Point | Distance From Stack Wall (Inches) |
|---|---|
| 1 | 2.0 |
| 2 | 6.7 |
| 3 | 13.6 |
| 4 | 32.4 |
| 5 | 39.3 |
| 6 | 44.0 |

## APPENDIX D
## TEST EQUIPMENT & CALIBRATION DATA

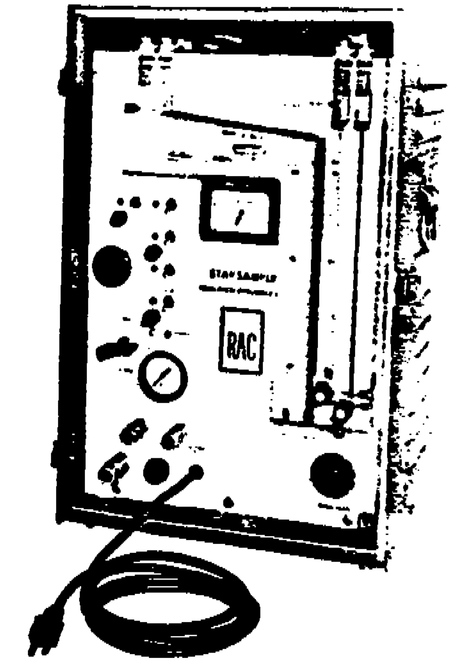


**FIGURE 2**
Standard Meter Control Case with dual-column inclined-vertical manometer for measuring pressure differentials across sampling orifice (Δ H) and pitot (Δ P) with ±1% accuracy.

## • design

Available as a complete system, RAC Staksamplr is comprised of four major subsystems: ① **a pitobe assembly** (combination of a heated, lined, stainless steel probe and a detachable pitot tube); ② an **operating/control console;** ③ a lightweight, modular, **two-piece sample case;** and ④ an integrated, modular **umbilical cord** that connects the sample case and pitobe to the control console. All subsystems are furnished assembled.

To facilitate on-site calculations, a **nomograph** is available with each system. A **monorail suspension-guidance assembly** for the sample case and pitobe also can be furnished as a standard accessory.

### Pitobes

RAC pitobes are furnished with three interchangeable sampling nozzles (¼", ⅜" and ½" ID), ball-joint connections, and quick-disconnect couplings. They are available in 3', 5' and 10' effective lengths. The 3' and 5' standard units can be supplied with stainless steel or Pyrex® glass-lined probes; the standard 10' unit has a stainless steel lined probe.

Glass-lined probes can be used for stack temperatures up to 800°F. For higher temperatures, stainless steel or special liners (optional) — or the RAC water-cooled pitobes (optional) — can be used. In addition, the pitot tube can be detached from the probe for quick, easy replacement. It also can be used separate from the probe for *traversing* prior to setting the Staksamplr in position.

### Control Console

#### STANDARD MODEL

The Standard Master Control Console (Meter Control Case) for the RAC Staksamplr contains the system's vacuum pump, inclined-vertical dual-column manometer, totalizing dry gas meter, thermometers, valves, and operating switches in a sturdy, louvered, steel cabinet with a hinged, removable access door. Clear plastic viewports on top of cabinet permit visual readings of two dial-type thermometers located in the inlet and outlet ports of the dry gas meter. This meter measures the volume of air drawn through the system during a sampling period and provides a digital readout of the total volume.

When the system is operating, the dual-column manometer is used to selectively monitor the pressure differentials across the sampling orifice (Δ H) and the pitot tube (Δ P). The manometer's vertical scale ranges from 1.1 to 10" water (0.1" minor division) and the inclined scale from 0 to 1.0" water (0.01" minor division). Full scale accuracy is ±1%.

#### LCD MODEL

Staksamplr LCD is a Lightweight, Compact, Digital stack sampling system that supplies a meter control console equipped with a liquid crystal display (LCD) temperature indicator for Type K Chromel-Alumel thermocouple sensors.

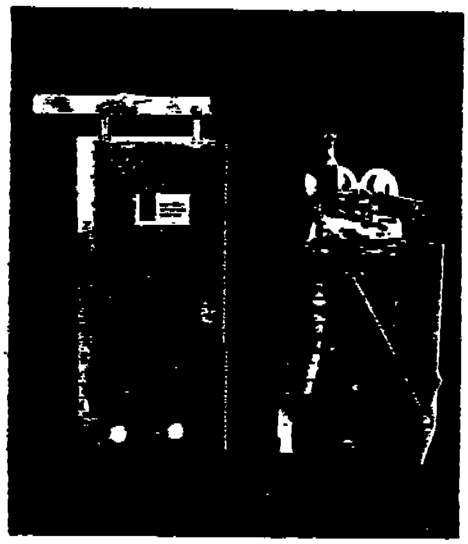


**FIGURE 4**
Two-module sample case with glassware installed. Door on thermostat-controlled heated compartment provides quicker access to particulate-collecting components. Modules are easily joined or separated by a slip-fit connection.

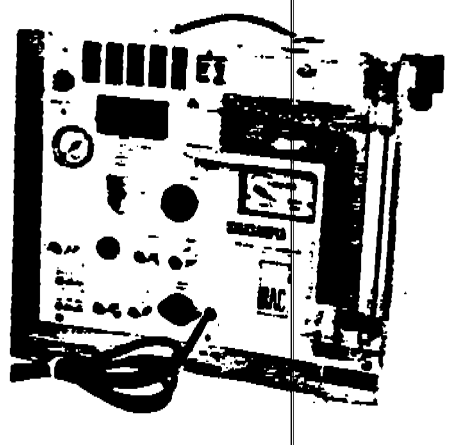


**FIGURE 3**
LCD Meter Console with liquid crystal display temperature indicator for Type K thermocouple sensors. Circuit breaker switches and external rotary vane pump are standard.

The LCD Meter Console contains the same basic components as the Standard Meter Control Case with the added features of a digital temperature readout indicator, temperature-indicating thermocouples rather than dial thermometers, circuit breaker switches instead of fuses, and an external high capacity rotary vane vacuum pump.

The external pump adds to the compactness of the unit, reduces noise and vibration during sampling periods, and is easily accessible for all service and maintenance work.

The LCD temperature indicator provides accurate digital readings for a minimum 6 different points in the sampling system. Individual temperature readings can easily be obtained for the (1) stack gas,(2) probe liner,(3) sample case heated compartment,(4) outlet of the last impinger,(5) dry gas meter inlet, and (6) dry gas meter outlet. The liquid crystal display readout is equipped with a thermostatically controlled heater to prevent sluggish response in cold weather and a field-selectable slide switch for conversion to either Fahrenheit or Celsius temperature scales. The digital display is easily removed through the front of the console for fast servicing and maintenance and provides glare-free readings even in direct sunlight.

### Sample Collecting Case

The RAC Modular Sample Case is a two-module configuration that features a lightweight aluminum construction as well as optimum ease and flexibility of operation. This case contains the system's standard all-glass sampling train (or optional stainless steel impingers-bubblers, P/N 201093-201092), and supports the pitobe in both the normal horizontal and vertical optional (P/N 201015) mounting positions.

A separate heated compartment contains the sampling train's particulate-collecting cyclone, flask, and filter, including a support bracket A cyclone eliminator and filter bypass are also available depending on sampling methods and conditions. An adjustable thermostat maintains a constant temperature with the compartment heavily insulated to reduce heat loss. A circulating fan minimizes thermal gradients and a hinged door provides easy access to the sampling train components.

A detachable ice bath compartment (or impinger module) contains the system's impingers and bubblers. This interchangeable module is insulated and watertight with a safety overflow feature and a convenient drain plug. The ice bath can accomodate a maximum of six impinger-bubbler units.

A slip-fit connection permits the two sample case modules to be joined or separated quickly and easily.

### Umbilical Cord

The RAC umbilical is an integrated multiconductor assembly containing both pneumatic and electrical conductors. It connects the sample-collecting case to the meter control case and conveys the main sample stream as well as the pitot tube stack velocity signals to the manometers. This cord is supplied in modular 25', 50', 75', 100', 200' and 300' lengths, and permits operating distances up to 300' (maximum) between the sampling case and control console without encountering a prohibitive pressure drop.

In addition, the RAC umbilical cord provides for a two-way intercom system when the control console is remote from the sampling site. Communications are accomplished by connecting sound-powered handsets (optional P/N 997525) to leads in the cord.

## • operation

Prior to actual stack sampling, a pre-survey is made of the specific installation to obtain necessary data on temperature, moisture content, and density of the gas stream to be sampled. Barometric pressure is taken at the sampling site, and the static pressure of the stack is obtained. Appropriate sample ports and suitable safe staging also are essential for the pre-survey.

To set up for sampling in the normal horizontal configuration, the monorail suspension-guidance assembly is attached to the stack at the access port by means of three bolts through its T-shaped endplate. The heated compartment is connected to the monorail, and a pitobe of desired length is inserted into the pitobe holder and connected to the sampling train's preassembled cyclone, flask, and filter. The ice bath compartment containing the preassembled glassware then is attached to the heated compartment, and the filter is connected to the first impinger unit.

The sample case and pitobe then are connected to the meter control case by the umbilical cord. For convenience, the control unit can be placed in any remote location up to 300' from the sampling site.

The monorail securely supports the sampling components, permitting the pitobe to be inserted and withdrawn easily to make velocity and sample traverses for isokinetic sampling.

If a series of samples is taken with one set-up, the heated compartment of the two-piece sample case remains attached to the monorail when the impinger modules and pitobes are interchanged.

During sampling operations, the system's vacuum pump draws a stack gas sample into the heated probe through the nozzle (proper size selected by nomograph calculations). The gas then enters the heated compartment of the modular sample case, where the cyclone and filter remove entrained particulate matter. It then is drawn into the 500 ml impinger-bubbler units, which are positioned in an ice bath (and may

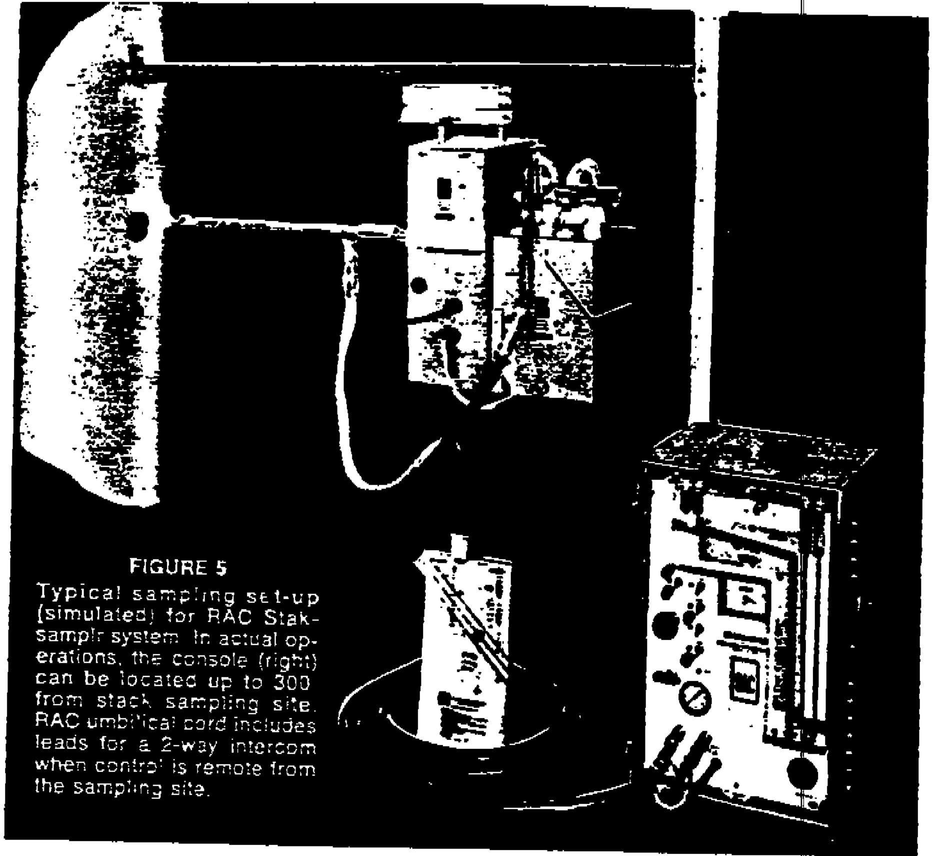


FIGURE 5
Typical sampling set-up (simulated) for RAC Stak-samplr system. In actual operations, the console (right) can be located up to 300 from stack sampling site. RAC umbilical cord includes leads for a 2-way intercom when control is remote from the sampling site.

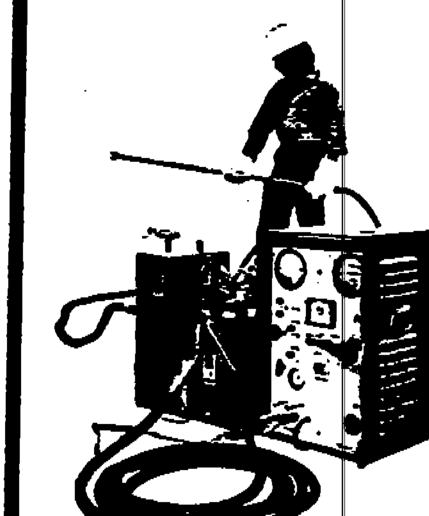


**FIGURE 6**
For sampling in constricted areas, RAC offers flexible, heated sampling lines that permit distances up to 20' between sample case & pitobe with no loss in sampling efficiency. A variable voltage device controls temp in flexible line and prevents burn-out of integral heating wires.

# • options & accessories

## Digital Temperature Display

Staksamplr LCD is a complete stack sampling system which provides accurate digital temperature readouts for 6 different points in the system. Thermocouples replace dial thermometers and are used to obtain temperature readings (1) in the stack, (2) at the probe liner, (3) in sample case heated compartment, (4) at outlet of last impinger, (5) at dry gas meter inlet, and (6) at dry gas meter outlet. The meter control case is equipped with a liquid crystal display (LCD) temperature indicator and external pump and is compatible with all existing RAC Staksamplrs.

## Large Filter Holders

When a high volume of particulate matter is encountered, interchangeable 3" (80 mm, P/N 201012) and 4" (110mm, P/N 201013) glass units can be substituted for 2.5" (64mm, P/N 997065) particle filter in sample case heated compartment. All sizes of RAC filter holders are equipped with a fritted glass disc to support the filter media.

## Water-Jacketed Pitobes

These jacketed units use circulating water to withstand stack temps over 800°F; available in 3', 5' & 10' effective lengths.

## Stainless Steel Impingers-Bubblers

For applications in which breakage of glassware is a common problem, RAC offers optional stainless steel impingers (P/N 201093) & bubbler units (P/N 201092) with ball-joint connections. These unbreakable all-metal units are interchangeable with the std glassware.

## Sectionalized Pitot Tube

Three modular sections provide an S-type pitot with effective lengths of 10' & 15'

## Digital Pocket Pyrometer

Pocket-sized, battery powered thermocouple pyrometer provides stable, accurate temperature readings. Type K thermocouple (supplied separately) attaches to pitobe and provides temperatures over a range of 50° to 1900°F (P/N 992726) or 10° to 1100°C (P/N 992726-1).

## Slide Rule Nomograph

Performs presampling and during-sampling isokinetic calculations easily and accurately; handy, standard, slide rule body; very accurate and versatile, no assumptions are necessary; calculates nozzle diameter and isokinetic sampling rate (P/N 201014); optional slide rule (P/N 201127) available if meter moisture content is greater than 2.5% and/or dry molecular weight is not 29 ± 1.

## Special Probe Liners

In addition to the standard Pyrex glass and Type 304 stainless steel liners furnished as standard with RAC probes, optional liners made of Teflon, Type 316 stainless steel, quartz, and Inconel also are available on special order. These liners are furnished in standard lengths of 3', 5' or 10' (except for Pyrex glass and quartz) and special lengths can be supplied to order.

## Flexible Sampling Lines

For sampling operations in confined or physically restricted areas, RAC offers flexible, heated, sample-collecting lines that allow the pitobe to be separated from the sample case by distances up to 20' with no loss in sampling efficiency. Available in 5', 10', 15' & 20' lengths, these flexible lines can be used for gas streams with temps up to 300°F (max), and have std ball-joint connections at both ends. A variable voltage device controls temp range in the sample line and prevents burn-out of integral heating wires. Pitot extension lines may be required.

## Stack Interface

This instrument adapts the Staksamplr control console for use with the RAC Stack Gas Train sample case, which uses midget (30 ml) impingers for sampling moisture *(EPA Method 4)* and $SO_2$ *(EPA Method 6)* in stacks or ducts; has flowmeter to monitor the low flow rates required, drying tube & connections for sampling pitot & electrical lines (P/N 997503).

## Andersen In-Stack Fractionating Sampler

Precision, multi-stage, stainless steel unit collects & automatically classifies particles into 8 sizes (ranging from +20.0 microns down to 0.36 microns dia) according to their aerodynamic characteristics; isokinetic techniques can be used for sampling in stacks with velocities from 100 to 12,000 fpm & temps to 1500°F; adapts to all RAC pitobes (P/N 201037).

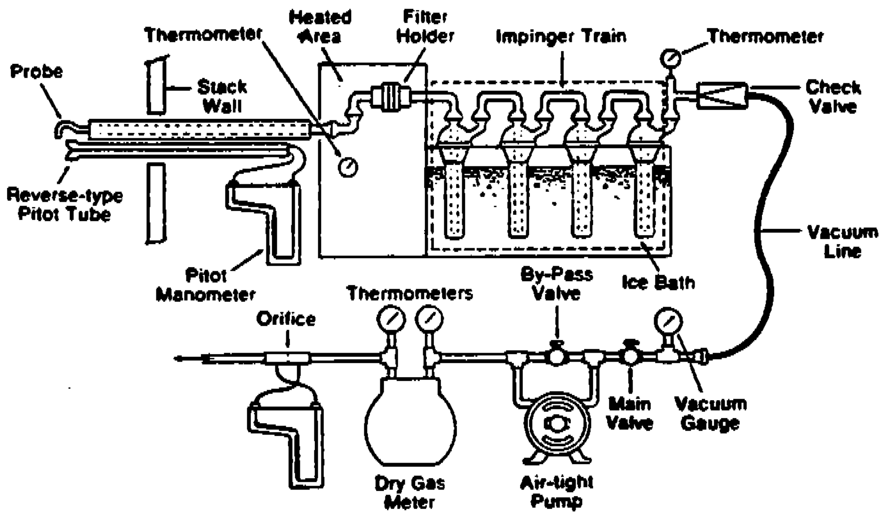
## Gas Stream Hygrometer

Uses matched (0—220°F) wet-bulb and dry-bulb thermometers to measure percent of water vapor in stack gas streams with temps below 212°F; stainless steel construction (P/N 997517).

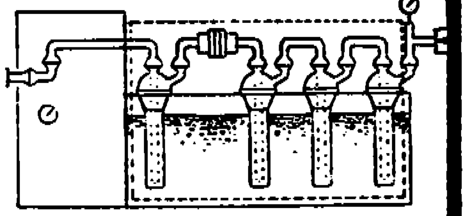
## Alundum Thimble Filter (in-stack)

Uses 45 x 127mm Alundum (ceramic) thimble of coarse porosity for dry collection of particles entrained in gas streams with temps to 1500°F; glass-fiber anc

**RAC Staksamplr Schematic of EPA Particulate Sampling Train (Method 5)**
Same basic configuration used to sample Beryllium & Mercury Vapor
(Federal Register, Vol. 36, Nos. 234 [Be, Hg] & 247)




**Configuration of Sample Case for sampling $SO_2$, $SO_3$ & $H_2SO_4$ MIST (Method 8)**
Heated area is by-passed; particulate filter positioned between 1st & 2nd impingers; all other components same as for particulate sampling.
(Federal Register, Vol. 36, No. 247)



## AST Meter/Orifice Calibration

Console No.: 1        Calibration Date: January 30, 1989

| Time (min) | ^H | ^cm | Gas Volume Calibration Meter Initial | Gas Volume Calibration Meter Final | Gas Volume Dry Gas Meter Initial | Gas Volume Dry Gas Meter Final | Tcm | T1 | T2 |
|---|---|---|---|---|---|---|---|---|---|
| 17.00 | 0.5 | 0.0 | 678.202 | 684.857 | 71.070 | 77.607 | 61 | 63<br>71 | 60<br>61 |
| 15.00 | 1.0 | 0.0 | 684.857 | 693.037 | 77.607 | 85.553 | 61 | 70<br>76 | 61<br>63 |
| 12.00 | 1.5 | 0.0 | 693.292 | 701.480 | 85.906 | 93.950 | 61 | 74<br>79 | 63<br>64 |
| 10.00 | 2.0 | 0.0 | 701.480 | 709.267 | 93.950 | 101.649 | 61 | 76<br>80 | 64<br>66 |
| 7.00 | 2.5 | 0.0 | 709.267 | 715.378 | 101.649 | 107.646 | 62 | 79<br>81 | 66<br>66 |

Pb = 29.00

| | | | |
|---|---|---|---|
| H = 0.5 | MCF = 1.022 | Qm = 0.391 | Km = 0.701 |
| H = 1.0 | MCF = 1.040 | Qm = 0.545 | Km = 0.691 |
| H = 1.5 | MCF = 1.032 | Qm = 0.683 | Km = 0.706 |
| H = 2.0 | MCF = 1.027 | Qm = 0.781 | Km = 0.699 |
| H = 2.5 | MCF = 1.034 | Qm = 0.874 | Km = 0.699 |
| AVERAGES: | MCF = 1.031 | Qm = 0.655 | Km = 0.699 |

### CALCULATIONS

$$MCF = \frac{(\text{Cm Final} - \text{Cm Initial})\ (\text{Tdgm})\ (\text{Pcm})}{(\text{DGM Final} - \text{DGM Initial})\ (\text{Tcm})\ (\text{Pdgm})}$$

$$Qm = \frac{\text{DGM Volume}}{\text{Time}} \times \frac{(\text{T2 Avg.} + 460)}{(\text{T1+T2 Avg.} + 460)} \times (\text{MCF})$$

$$Km = (Qm)\ [\ \text{Sqrt}\ (Pm * Mm / Tm / \hat{}H)\ ]$$

AST, Inc.
Post Test Meter Calibration
Console #1

| ^H | ^cm | V1cm | V2cm | V1dgm | V2dgm | Tcm | T1 | T2 |
|---|---|---|---|---|---|---|---|---|
| 1.0 | 0.0 | 878.302 | 883.364 | 326.200 | 331.187 | 66 | 68 | 65 |
| | | | | | | | 77 | 66 |
| 1.0 | 0.0 | 883.364 | 888.489 | 331.187 | 336.237 | 66 | 74 | 66 |
| | | | | | | | 82 | 67 |
| 1.0 | 0.0 | 888.489 | 894.299 | 336.237 | 341.992 | 66 | 80 | 67 |
| | | | | | | | 85 | 68 |

Pb = 29.00

MCF = 1.018
MCF = 1.024
MCF = 1.024

Average MCF = 1.022

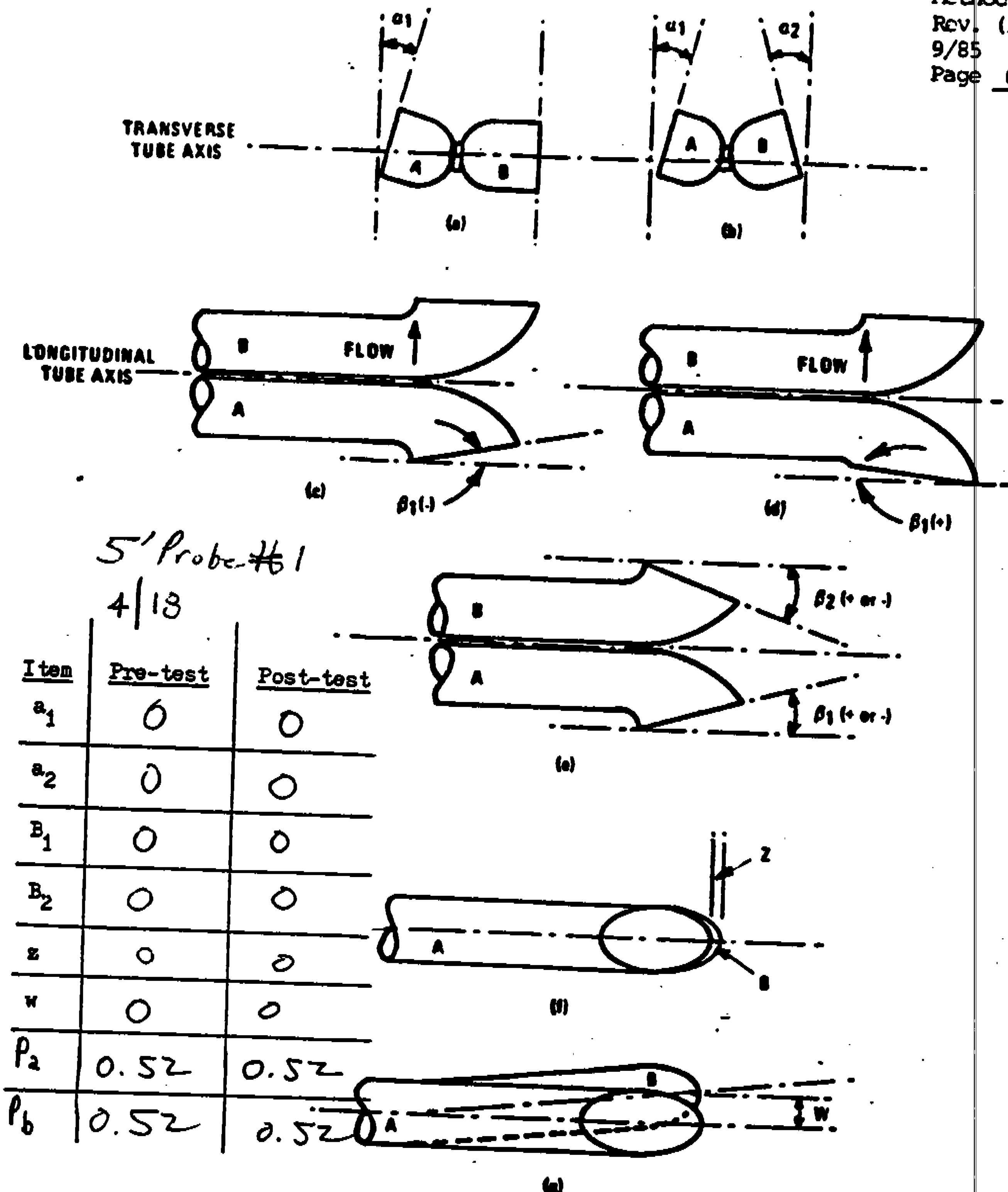
Calibrated by: JOB Lan[signature]    Date: 5/12/89

THERMOCOUPLE/THERMOMETER CALIBRATIONS

| Device | Reading (oF) | ASTM Reference Thermometer (oF) |
| --- | --- | --- |
| #1 METER INLET | 32/207 | 33/211 |
| #1 METER OUTLET | 32/207 | 33/211 |
| 3' #1 PROBE | 33/212 | 33/211 |
| 5' #1 PROBE | 33/211 | 33/211 |
| FILTER BOX #1 | 215 | 211 |
| IMP. OUTLET T/C | 33/212 | 33/211 |
| IMP OUT THERMOMETER | 30 | 33 |
| | | |
| | | |
| | | |
| | | |

JB Lane

3/27/89

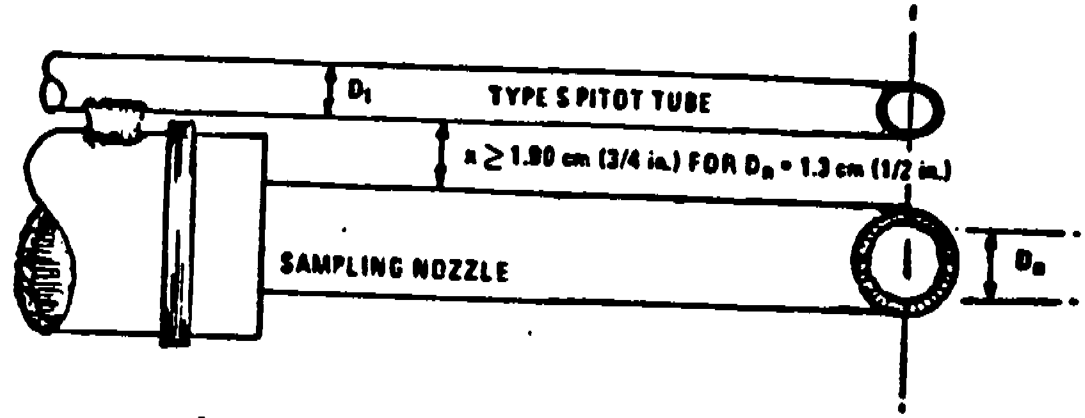



5' Probe #1

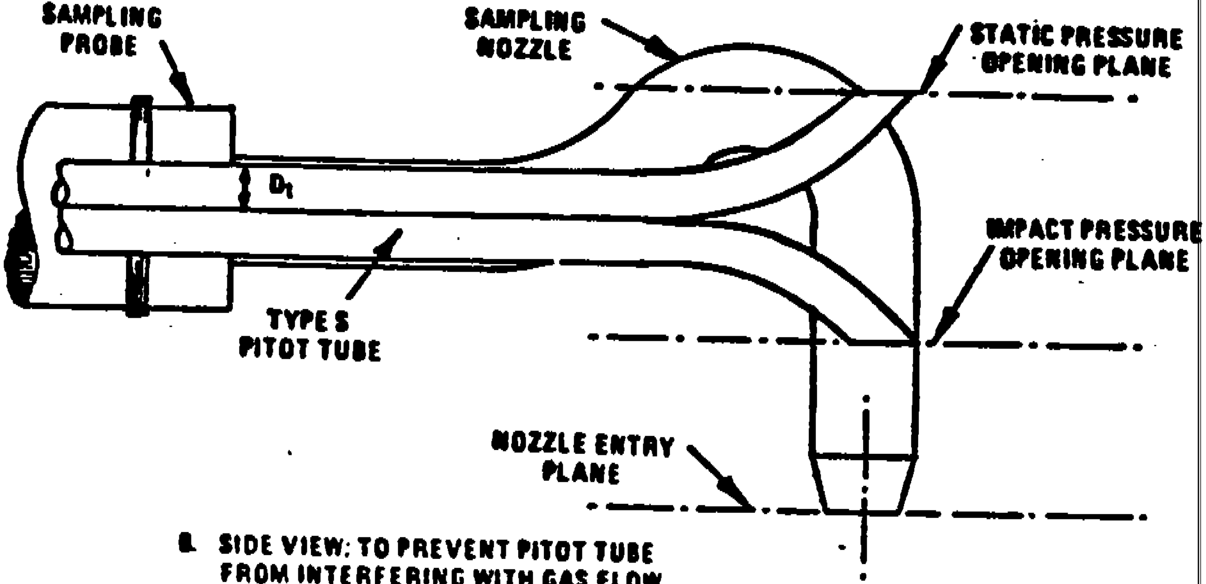
4/18

| Item | Pre-test | Post-test |
|---|---|---|
| $a_1$ | 0 | 0 |
| $a_2$ | 0 | 0 |
| $B_1$ | 0 | 0 |
| $B_2$ | 0 | 0 |
| z | 0 | 0 |
| w | 0 | 0 |
| $P_a$ | 0.52 | 0.52 |
| $P_b$ | 0.52 | 0.52 |

Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of $\bar{C}_{p(s)}$ so long as $\alpha_1$ and $\alpha_2 < 10°$, $\beta_1$ and $\beta_2 < 5°$, $z < 0.32$ cm (1/8 in.) and $w < 0.08$ cm (1/32 in.) (citation 11 in Section 6).




A. BOTTOM VIEW; SHOWING MINIMUM PITOT-NOZZLE SEPARATION.




B. SIDE VIEW: TO PREVENT PITOT TUBE FROM INTERFERING WITH GAS FLOW STREAMLINES APPROACHING THE NOZZLE, THE IMPACT PRESSURE OPENING PLANE OF THE PITOT TUBE SHALL BE EVEN WITH OR ABOVE THE NOZZLE ENTRY PLANE.

Figure 2-6. Proper pitot tube - sampling nozzle configuration to prevent aerodynamic interference; buttonhook - type nozzle; centers of nozzle and pitot opening aligned; $D_t$ between 0.48 and 0.95 cm (3/16 and 3/8 in.).

| Measurement | Pre-test | Post-test |
|---|---|---|
| $D_t$ | 3/8 | 3/8 |
| $D_n$ | 0.310 | |
| x | 0.6 | 0.6 |

Pre-test "Z" = 2.0

Post-test "Z" = 2.0

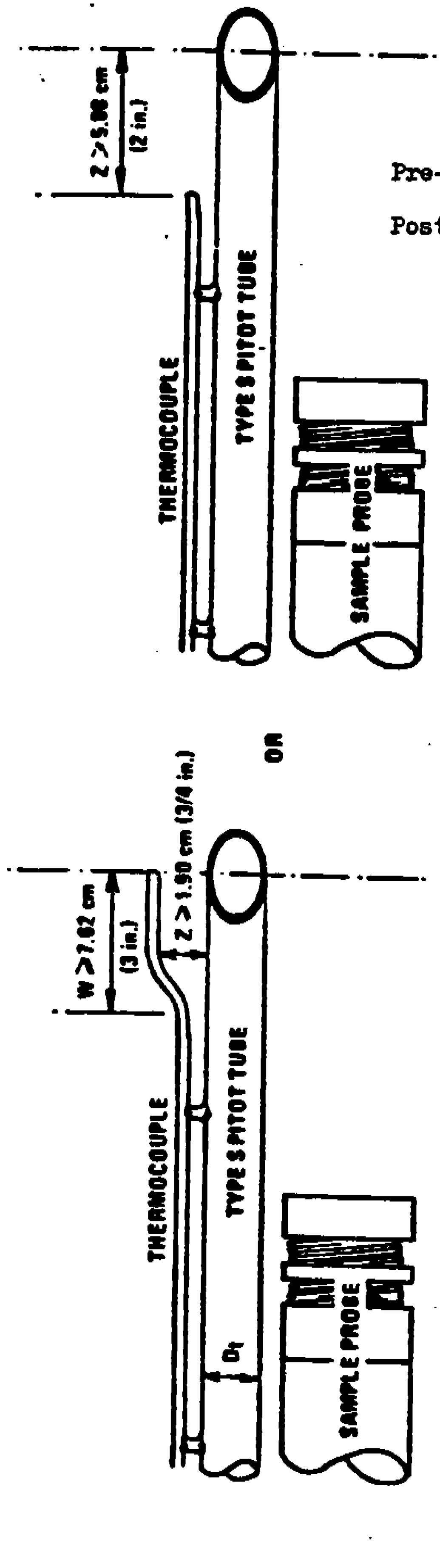



Figure 2.7. Proper thermocouple placement to prevent interference; $D_t$ between 0.48 and 0.95 cm (3/16 and 3/8 in.).

# APPENDIX E
# PROCESS DATA

| | | | |
|---|---|---|---|
| **Lake Engineering Inc.** | CLIENT VZOKIVA TILE | JOB NO. | COMPUTED BY [illegible] |
| | PROJECT LAWRENCEBURG, KY | DATE CHECKED | DATE 4/19/8[illegible] |
| | DETAIL STACK TEST | CHECKED BY | PAGE NO. 1 |

Production rate – Kiln No. 6

Schedule: 24 hrs/day, 7 days/wk, 49 wks/yr.

38.5 cars/day × 825 sq ft tile/car = 31,762.5 ft²/day

Tile @ 3.2 lbs/sq.ft. × 31,762.5 = 101,640 lbs/day

= 4235 lbs/hr.

Per Richie Royalty
and Bill Taylor

Lake Engineering Inc.

CLIENT: Florida Tile
PROJECT: Lawrenceburg, KY
DETAIL: Kiln No. 6
Oper. Record

JOB NO.:
DATE CHECKED:
CHECKED BY:

COMPUTED BY: Kmp
DATE: 4/[illegible]/91
PAGE NO. 1 of 1

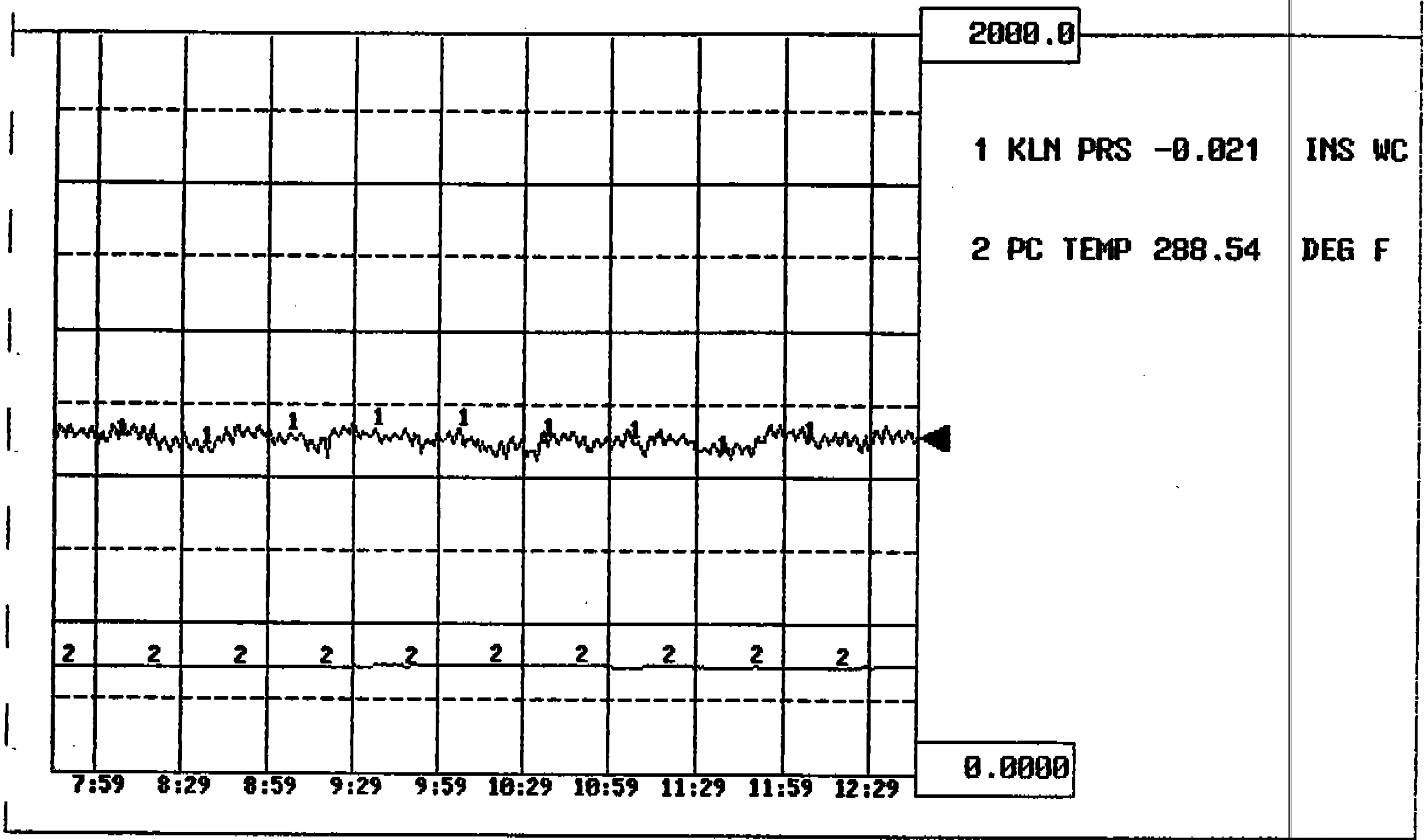
4/19/89

| Clock Time hr:min:sec | Pressure Control Exhaust Temp (°F) | Kiln Press (in W.G.) |
|---|---|---|
| 7:15:31 | 284.25 | -0.011 |
| 7:45:30 | 283.86 | -0.017 |
| 8:15:31 | 284.70 | -0.027 |
| 8:45:29 | 285.79 | -0.022 |
| 9:15:29 | 286.32 | -0.029 |
| 9:45:28 | 288.42 | -0.019 |
| 10:15:28 | 290.35 | -0.028 |
| 10:45:27 | 288.60 | -0.020 |
| 11:15:26 | 288.29 | -0.024 |
| 11:45:26 | 287.25 | -0.031 |
| 12:15:25 | 286.11 | -0.022 |
| 12:45:24 | 288.68 | 0.022 |

Group 18 PRESS / EXH TEMP 04-19-89 12:45:27

SAVED

PT 2 U1 AI 21 PC EXHAUST T/C **288.54 DEG F**



| POINT OF EMISSION | AFFECTED FACILITY | CONDITIONS |
|---|---|---|
| 69 (-) | Forniker Kiln | 1. The processing rate of tiles shall not exceed 497.3 lbs/hour and 200.0 tons/year.<br>2. Particulate emissions shall not exceed 0.52 lb/hour and 0.21 ton/year as measured by EPA Reference Method 5, 40 CFR 60, Appendix A.<br>3. The opacity of visible emissions shall not equal or exceed 20% as measured by EPA Reference Method 9, 40 CFR 60, Appendix A. |
| **KILNS** | | |
| 39 (-) | Kiln #6 | 1. The processing rate of tiles shall not exceed 4,435 lbs/hour and 18,254 tons/year.<br>2. Particulate emissions shall not exceed 3.40 lbs/hour and 14.00 tons/year as measured by EPA Reference Method 5, 40 CFR 60, Appendix A.<br>3. The opacity of visible emissions shall not equal or exceed 20% as measured by EPA Reference Method 9, 40 CFR 60, Appendix A.<br>4. Refer to General Condition 11.<br>5. Refer to General Conditions 3(a) and 12. |

**GENERAL CONDITIONS:**

1. The owner and/or operator of the affected facilities specified on this permit shall furnish to the Division for Air Quality the following:
   a) Written notification, postmarked within 15 days, of the date construction commenced. (See Condition 2)
   b) Written notification of the actual date of start-up and the date of achieving the maximum production rate of each of the affected facilities listed on this permit. This notification must be postmarked within 15 days after each of the above mentioned events. (See Condition 3)
   c) Within 15 days after demonstration of compliance, an application for a permit to operate. (See Condition 3)