Stationary Source Sampling Report
Mercury Emissions from the End Box and Hydrogen Systems
PPG, Lake Charles, LA
December, 1984

PPG Industries, Inc.
Environmental Testing Group
Barberton Technical Center
P. O. Box 31
Barberton, OH 44203

TABLE OF CONTENTS

APPENDICES

I. Introduction

Effective June 20, 1983, the State of Louisiana was delegated the authority to implement and enforce the National Emission Standards for Hazardous Air Pollutants (NESHAP) for stationary sources. Sections 76.18 of the Louisiana Emission Standards for Hazardous Air Pollutants (LESHAP) requires all LESHAP sources to demonstrate compliance with applicable regulations within ninety days of the effective date and yearly thereafter.

This report covers mercury emissions from the end box stack and hydrogen production at the chlor-alkali facility, Lake Charles complex during the period D cember 12 and 13, 1984. Sampling procedures, quality assurance, analytical methodology, and process related data are presented.

II. Abstract

Stationary source sampling was performed at the chlor-alkali facility, Lake Charles complex for mercury emissions December 12 and 13, 1984. The test results showed mercury emissions ranging 26 to 72 g/day at the end box stack and ≤11 to 140 g/day at the hydrogen system.

Testing was conducted in accordance with USEPA Test Methods 101 and 102 (40CFR61 Appendix B) with the following exceptions waived by the LESHAP Administrator: 1) One lane of the end box stack was sampled with the number of traverse points doubled due to structural interferences, 2) Non-isokinetic sampling was performed at the hydrogen system due to production constraints. Testing was witnessed in part by Mr. W. Coltrin, Louisiana Department of Natural Resources, Dept. of Environmental Quality.

III. Sampling Procedures

A. Sample Locations

1. End Box Stack (Appendix A)

Sample ports were installed on the south and east sides of the 12" ID end box stack 10'-9" downstream and 7'-8" upstream from any point of streamline disturbances such as bends, turns, constrictions, or expansions. Revised (48FR45035) Method 1 dictates an eight point traverse (four per lane). Building interferences negated sampling the west lane. The Administrator approved sampling the south lane only using eight traverse points instead of four. Traverse point locations and a stack diagram are shown in Appendix A.

2. Hydrogen System (Appendix B)

Routinely, the hydrogen produced at the mercury cell operation is sold as a raw material to a local chemical plant. If sales are interrupted for any reason, the hydrogen is used as boiler fuel. If an upset condition occurs in the cell operation, the hydrogen could be vented through the tertiary stack. Due to the size and pressure of the H_2 vent header and the potential disruption of product sales, the Administrator waived isokinetic sampling at this source. Integrated sampling was performed at the centroid of the PuraSiv bed vent lines (8"). Hydrogen flows were calculated based upon production. A flow diagram is shown in Appendix B.

B. Sampling Methods

1. End Box

Isokinetic sampling was performed at each of eight traverse points located along the north-south lane of the end box stack in accordance with Method 101 (40CFR61 Appendix B) included in this report as Appendix C. The recommended minimum sample duration of 2 hours was adhered to.

2. Hydrogen System

Integrated, non-isokinetic sampling was conducted for the minimum recommended 2 hours duration at the hydrogen system utilizing a Method 102 train (Appendix C) without the pitobe assembly. Hydrogen under pressure was valved into a mixing bottle from the discharge of the active PuraSiv® unit using 1/2" TFE tubing. Sampling was performed by attaching a short piece of 1/4" TFE tubing (valved) from the mixing bottle to the first impinger. To assure positive pressure in the mixing bottle at all times, the bottle was vented through a seal pot before being discharged to the atmosphere at a safe distance from the sampling equipment. The sample train orifice discharge was also vented away from the equipment for safety purposes. Appendix B shows a sampling flow diagram.

C. Analytical Methodology (Appendix C)

The analytical method employed for the determination of mercury followed the procedure detailed in Method 101 (40CFR61 Appendix B) included in this report as Appendix C.

IV. Results (Appendices D, E, and F)

The pertinent test results are presented in the following tables. Appendix D details sampling parameters, field sampling data sheets, and calculations. Appendix E contains the analytical quality assurance and results plus chain of custody. Appendix F presents sampling quality assurance.

A. End Box

	Test No. 84EB-1	84EB-2	84EB-3
	12/12/84 09:03-11:03	12/12/84 13:30-15:30	12/13/84 08:10-10:10
Stack Gas Flow Rate, Dry scfm*	2260	2653	2600
Sample Volume, Dry SCF	77.399	77.180	74.562
Mercury Found, µg	525	1450	525
Emission Rate, g/d	25.98	71.80	26.38
Isokinetic Sampling Rate, %	97.8	97.8	96.4

B. Hydrogen System

	Test No. 84PV-1	84PV-2	84PV-3
	12/13/84 05:54-07:54 East Bed	12/13/84 12:53-14:53 East Bed	12/13/84 19:53-21:53 East Bed
Hydrogen Flow Rate, Dry scf*/day	6.056^{E06}	6.889^{E06}	7.092^{E06}
Sample Volume, scf	65.897	65.046	73.359
Mercury Found, µg	<125	<125	1450
Emission Rate, g/d	≤11.49	≤13.24	140.18

---

*Std. cubic foot at 68°F, 29.92" Hg

V. Discussion

PPG Industries, Lake Charles has demonstrated compliance with the Louisiana Emission Standard for Hazardous Air Pollutants.

This report has been reviewed and approved by Mr. R. J. Samelson, Manager of Environmental Programs, Chemicals Group.

VI. Approvals

Signed: L. A. Kuryla 1/4/85
L. A. Kuryla Date

M. P. Hogan 1/4/84
M. P. Hogan Date

T. F. Gole 1/4/84
T. F. Gole Date

W. Hebert for 1/4/85
W. Hebert Date

M. Carver for 1/4/85
M. Carver Date

Approved: W. G. Krochta 1/7/85
W. G. Krochta Date

M. Wood (WSK) 1/7/85
M. Wood Date

H. J. Hoenes (WSK) 1/7/85
H. J. Hoenes Date

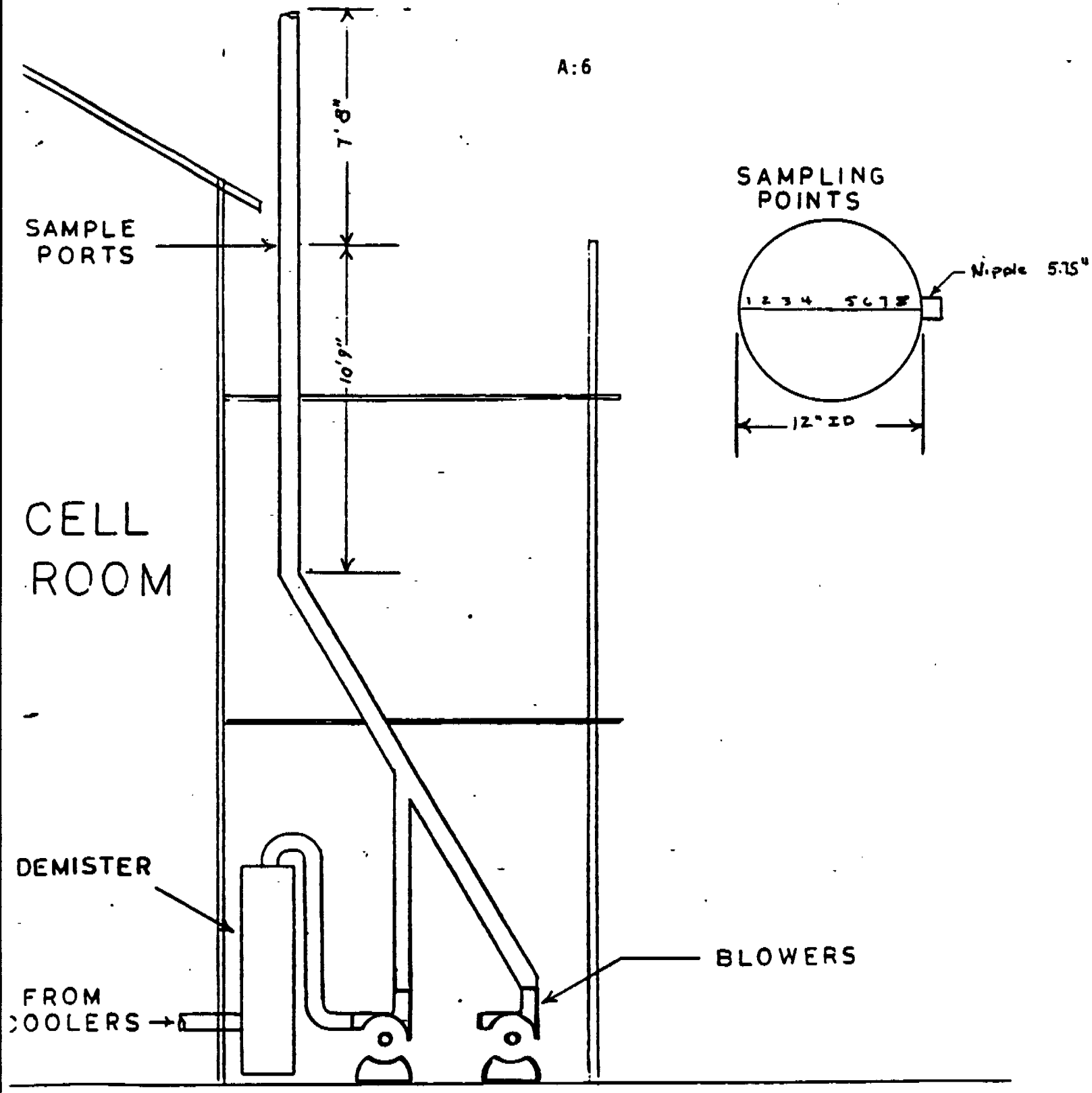
vvs

SL 025697

APPENDIX A

Sample Location - End Box

A:6



MERCURY CELL FUME SYSTEM

SL 025699

A:7

Preliminary Field Data

PLANT NAME PPG Lake Charles

LOCATION Mercury Cell

SAMPLING LOCATION End Box Stack

DUCT DEPTH
FROM INSIDE FAR WALL TO OUTSIDE OF PORT 17.75"

NIPPLE LENGTH 5.75

DEPTH OF DUCT 12.0"

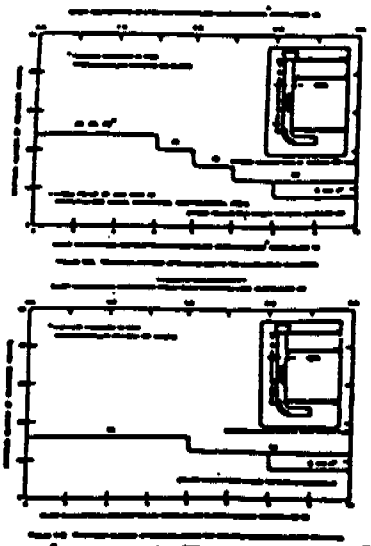
WIDTH (RECTANGULAR DUCT) _____

EQUIVALENT DIAMETER:

$D_E = \frac{2 \cdot \text{DEPTH} \cdot \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad \times \quad)}{(\quad + \quad)} =$ _____

DISTANCE FROM PORTS TO NEAREST FLOW DISTURBANCE:	UPSTREAM	DOWNSTREAM
FEET	10'-9"	7'-8"
STACK DIAMETERS	_____	_____

STACK AREA= $(R)^2 \pi$ _____ = 0.785 4 ft^2



One Lam, 8 Traverse pts

Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	3.2	.384	6.75 *
2	10.5	1.26	7.01
3	19.4	2.33	8.08
4	32.3	3.88	9.63
5	67.7	8.12	13.87
6	80.6	9.67	15.42
7	89.5	10.74	16.49
8	96.8	11.62	16.75
9			
10	* adjusted to 1.		"
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.0	9.0	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.4	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.9	20.1	16.9	14.6	12.9	11.6	10.5
6		93.4	80.6	65.8	75.0	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.6	64.6	36.6	28.3	23.6	20.6	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	22.0	19.6
9				94.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	78.9	71.7	61.8	38.8	31.5	27.2
11					93.3	83.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	73.0	64.5	58.2
14						98.2	91.5	85.4	78.0	73.0	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.2	88.4	83.9
19									96.1	91.3	86.9
20									98.7	94.0	89.8
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

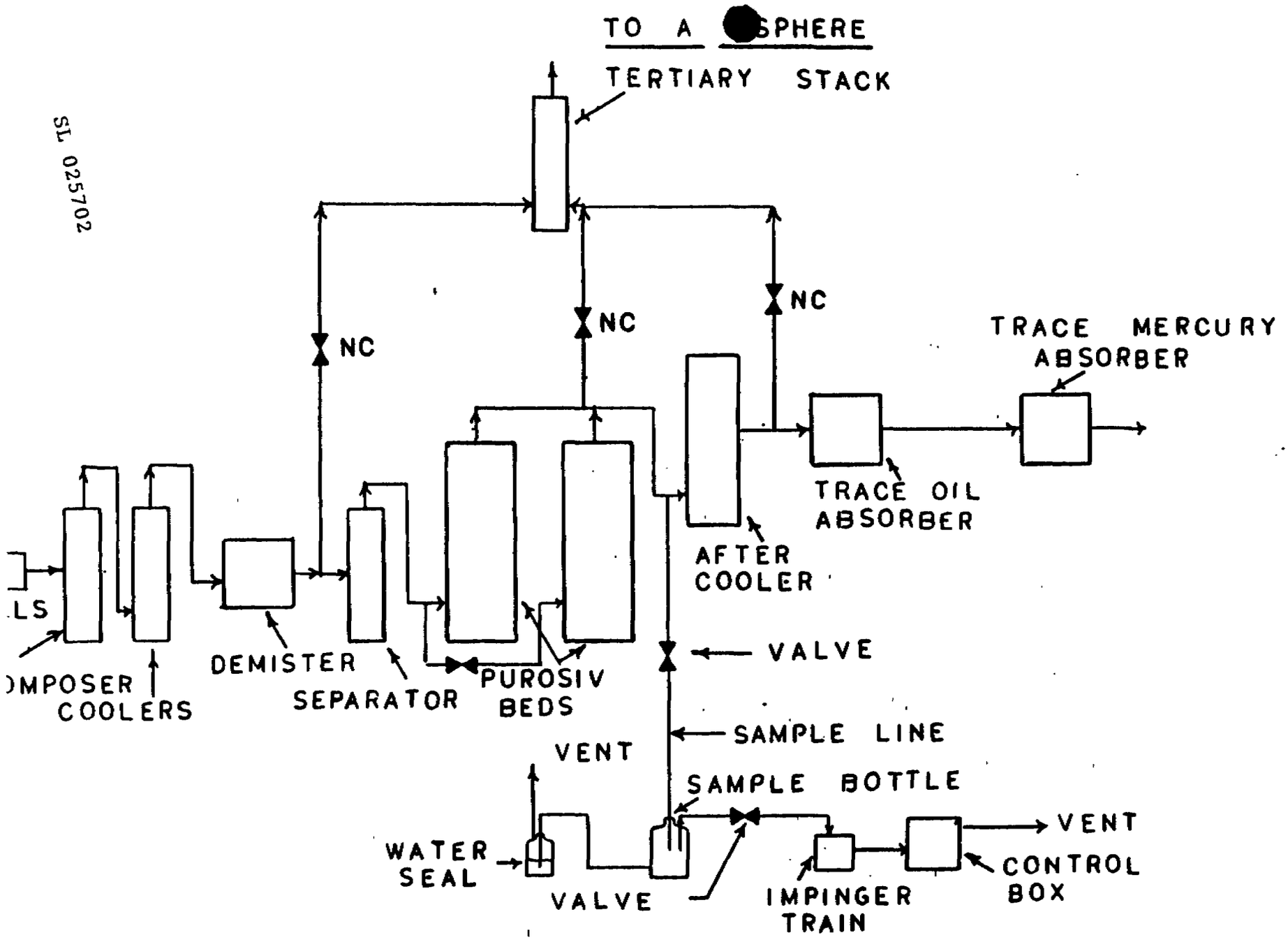
LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5

SL 025700

APPENDIX B

Sample Location - Hydrogen System



8:9

MERCURY CELL HYDROGEN SYSTEM

APPENDIX C

Sampling and Analytical Methods

APPENDIX B—TEST METHODS

METHOD 101—DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM CHLOR-ALKALI PLANTS—AIR STREAMS

1. *Applicability and Principle*—1.1 *Applicability.* This method applies to the determination of particulate and gaseous mercury (Hg) emissions from chlor-alkali plants and other sources (as specified in the regulations), where the carrier-gas stream in the duct or stack is principally air.

1.2 *Principle.* Particulate and gaseous Hg emissions are withdrawn isokinetically from the source and collected in acidic iodine monochloride (ICl) solution. The Hg collected (in the mercuric form) is reduced to elemental Hg, which is then aerated from the solution into an optical cell and measured by atomic absorption spectrophotometry.

2. *Range and Sensitivity*—2.1 *Range.* After initial dilution, the range of this method is 0.5 to 120 μg Hg/ml. The upper limit can be extended by further dilution of the sample.

2.2 *Sensitivity.* The sensitivity of this method depends on the recorder/spectrophotometer combination selected.

3. *Interfering Agents*—3.1 *Sampling.* SO_2 reduces ICl and causes premature depletion of the ICl solution.

3.2 *Analysis.* ICl concentrations greater than 10^{-4} molar inhibit the reduction of the Hg (II) ion in the aeration cell. Condensation of water vapor on the optical cell windows causes a positive interference.

4. *Precision and Accuracy*—The following estimates are based on collaborative tests, wherein 13 laboratories performed duplicate analyses on two Hg-containing samples from a chlor-alkali plant and on one laboratory-prepared sample of known Hg concentration. The concentration ranged from 2 to 66 μg Hg/ml.

4.1 *Precision.* The estimated within-laboratory and between-laboratory standard deviations are 1.6 and 1.8 μg Hg/ml, respectively.

4.2 *Accuracy.* The participating laboratories that analyzed a 64.3-μg Hg/ml (in 0.1 M ICl) standard obtained a mean of 63.7 μg Hg/ml.

5. *Apparatus*—5.1 *Sampling Train.* A schematic of the sampling train is shown in Figure 101-1; it is similar to the Method 5 train (mention of Method 5 refers to Parts 60 of 40 CFR). The sampling train consists of the following components:

5.1.1 *Probe Nozzle, Pitot Tube, Differential Pressure Gauge, Metering System, Barometer, and Gas Density Determination Equipment.* Same as Method 5, Sections 2.1.1, 2.1.3, 2.1.4, 2.1.8, 2.1.9, and 2.1.10, respectively.

5.1.2 *Probe Liner.* Borosilicate or quartz glass tubing. The tester may use a heating system capable of maintaining a gas temperature of 120±14° C (248±25° F) at the probe exit during sampling to prevent water condensation.

NOTE: Do not use metal probe liners.

5.1.3 *Impingers.* Four Greenburg-Smith impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. For the first, third, and fourth impingers, the tester may use impingers that are modified by replacing the tip with a 13-mm-ID (0.5-in.) glass tube extending to 13 mm (0.5 in.) from the bottom of the flask.

5.1.4 *Acid Trap.* Mine Safety Appliances air line filter, Catalog number 81857, with acid absorbing cartridge and suitable connections, or equivalent.

5.2 *Sample Recovery.* The following items are needed:

5.2.1 *Glass Sample Bottles.* Leakless, with Teflon-lined caps, 1000- and 100-ml.

5.2.2 *Graduated Cylinder.* 250-ml.

5.2.3 *Funnel and Rubber Policeman.* To aid in transfer of silica gel to container; not necessary if silica gel is weighed in the field.

5.2.4 *Funnel.* Glass, to aid in sample recovery.

5.3 *Sample Preparation and Analysis.* The following equipment is needed:

5.3.1 *Atomic Absorption Spectrophotometer.* Perkin-Elmer 303, or equivalent, containing a hollow-cathode mercury lamp and the optical cell described in Section 5.3.2.

5.3.2 *Optical Cell.* Cylindrical shape with quartz end windows and having the dimensions shown in Figure 101-2. Wind the cell with approximately 2 meters of 24-gauge nichrome heating wire, and wrap with fiberglass insulation tape or equivalent; do not let the wires touch each other.

5.3.3 *Aeration Cell.* Constructed according to the specifications in Figure 101-3. Do not use a glass frit as a substitute for the blown glass bubbler tip shown in Figure 101-3.

5.3.4 *Recorder.* Matched to output of the spectrophotometer described in Section 5.3.1.

5.3.5 *Variable Transformer.* To vary the voltage on the optical cell from 0 to 40 volts.

5.3.6 *Hood.* For venting optical cell exhaust.

5.3.7 *Flowmetering Valve.*

5.3.8 *Flowmeter.* Rotameter or equivalent, capable of measuring a gas flow of 1.5 liters/min.

Pipet 5.0 ml from the "Intermediate Mercury Standard Solution" (8.2.4) into a 250-ml volumetric glass flask. Add 10 ml of the 5 percent H_2SO_4 and 2 ml of the 0.1 M ICl absorbing solution taken as a blank (7.2.3) and dilute to 250 ml with deionized distilled water. Mix thoroughly.

7. *Procedure*—7.1 *Sampling.* Because of the complexity of this method, testers should be trained and experienced with the test procedures to assure reliable results. Since the amount of Hg that is collected generally is small, the method must be carefully applied to prevent contamination or loss of sample.

7.1.1 *Pretest Preparation.* Follow the general procedure given in Method 5, Section 4.1.1, except omit the directions on the filter.

7.1.2 *Preliminary Determinations.* Follow the general procedure given in Method 5, Section 4.1.2, except as follows: Select a nozzle size based on the range of velocity heads to assure that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates below 28 liters/min (1.0 cfm).

Obtain samples over a period or periods that accurately determine the maximum emissions that occur in a 24-hour period. In the case of cyclic operations, run sufficient tests for the accurate determination of the emissions that occur over the duration of the cycle. A minimum sample time of 2 hours is recommended. In some instances, high Hg or high SO_2 concentrations make it impossible to sample for the desired minimum time. This is indicated by reddening (liberation of free iodine) in the first impinger. In these cases, the tester may divide the sample run into two or more subruns to insure that the absorbing solution is not depleted.

7.1.3 *Preparation of Sampling Train.* Clean all glassware (probe, impingers, and connectors) by rinsing with 50 percent HNO_3, tap water, 0.1 M ICl, tap water, and finally deionized distilled water. Place 100 ml of 0.1 M ICl in each of the first three impingers. Take care to prevent the absorbing solution from contacting any greased surfaces. Place approximately 200 g of preweighed silica gel in the fourth impinger. The tester may use more silica gel, but should be careful to assure that it is not entrained and carried out from the impinger during sampling. Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, determine and record the weight of the silica gel plus impinger to the nearest 0.5 g.

Install the selected nozzle using a Viton A O-ring when stack temperatures are less than 200° C (500° F). Use a fiberglass string gasket if temperatures are higher. See APTD-0576 (Citation 9 in Section 10) for details. Other connecting systems using either 316 stainless steel or Teflon ferrules may be used. Mark the probe with heat-resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point. Assemble the train as shown in Figure 101-1, using (if necessary) a very light coat of silicone grease on all ground glass joints. Grease only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease.

Note: An empty impinger may be inserted between the third impinger and the silica gel to remove excess moisture from the sample stream.

After the sampling train has been assembled, turn on and set the probe, if applicable, at the desired operating temperature. Allow time for the temperatures to stabilize. Place crushed ice around the impingers.

7.1.4 *Leak-Check Procedures.* Follow the leak-check procedures outlined in Method 5, Sections 4.1.4.1 (Pretest Leak Check), 4.1.4.2 (Leak Checks During Sample Run), and 4.1.4.3 (Post-Test Leak Check).

7.1.5 *Mercury Train Operation.* Follow the general procedure given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in Figure 101-4.

7.1.6 *Calculation of Percent Isokinetic.* Same as Method 5, Section 4.1.6.

7.2 *Sample Recovery.* Begin proper cleanup procedure as soon as the probe is removed from the stack at the end of the sampling period.

Allow the probe to cool. When it can be safely handled, wipe off any external particulate matter near the tip of the probe nozzle and place a cap over it. Do not cap off the probe tip tightly while the sampling train is cooling. Capping would create a vacuum and draw liquid out from the impingers.

Before moving the sampling train to the cleanup site, remove the probe from the train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate that might be present. Wipe off the silicone grease from the impinger. Use either ground-glass stoppers, plastic caps, or serum caps to close these openings.

Transfer the probe and impinger assembly to a cleanup area that is clean, protected from the wind, and free of Hg contamination. The ambient air in laboratories located in the immediate vicinity of Hg-using facilities is not normally free of Hg contamination.

Inspect the train before and during assembly, and note any abnormal conditions. Treat the sample as follows:

7.2.1 *Container No. 1* (Impinger and Probe). Using a graduated cylinder, measure the liquid in the first three impingers to

within ±1 ml. Record the volume of liquid present (e.g., see Figure 5-3 of Method 5). This information is needed to calculate the moisture content of the effluent gas. (Use only glass storage bottles and graduated cylinders that have been precleaned as in Section 7.1.3.) Place the contents of the first three impingers into a 1000-ml glass sample bottle.

Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover the Hg (and any condensate) from the probe nozzle, probe fitting, and probe liner as follows: Rinse these components with two 50-ml portions of 0.1-M ICl. Next, rinse the probe nozzle, fitting and liner, and each piece of connecting glassware between the probe liner and the back half of the third impinger with a maximum of 400 ml of deionized distilled water. Add all washings to the 1000-ml glass sample bottle containing the liquid from the first three impingers.

After all washings have been collected in the sample container, tighten the lid on the container to prevent leakage during shipment to the laboratory. Mark the height of the liquid to determine later whether leakage occurred during transport. Label the container to clearly identify its contents.

7.2.2 *Container No. 2* (Silica Gel). Note the color of the indicating silica gel to determine whether it has been completely spent and make a notation of its condition. Transfer the silica gel from its impinger to its original container and seal. The tester may use as aids a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. The small amount of particles that may adhere to the impinger wall need not be removed. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g; record this weight.

7.2.3 *Container No. 3* (Absorbing Solution Blank). For a blank, place 50 ml of the 0.1 M ICl absorbing solution in a 100-ml sample bottle. Seal the container. Use this blank to prepare the working mercury standard solutions (8.2.5).

7.3 *Sample Preparation.* Check the liquid level in each container to see whether liquid was lost during transport. If a noticeable amount of leakage occurred, either void the sample or use methods subject to the approval of the Administrator to account for the losses. Then follow the procedures below:

7.3.1 *Container No. 1* (Impinger and Probe). Carefully transfer the contents of Container No. 1 into a 1000-ml volumetric flask and adjust the volume to exactly 1000 ml with deionized distilled water.

7.3.2 *Dilutions.* Pipet a 2-ml aliquot from the diluted sample from 7.3.1 into a 250-ml volumetric flask. Add 10 ml of 5 percent H_2SO_4 and adjust the volume to exactly 250 ml with deionized distilled water. These solutions are stable for at least 72 hours.

NOTE: The dilution factor will be 250/2 for this solution.

7.4 *Analysis.* Calibrate the spectrophotometer and recorder and prepare the calibration curve as described in Sections 8.1 to 8.4.

7.4.1 *Mercury Samples.* Repeat the procedure used to establish the calibration curve with appropriately sized aliquots (1 to 5 ml) of each of the diluted samples (from Section 7.3.2) until two consecutive peak heights agree within ±3 percent of their average value. The peak maximum of an aliquot (except the 5-ml aliquot) must be greater than 10 percent of the recorder full scale. If the peak maximum of a 1.0-ml aliquot is off scale on the recorder, further dilute the original source sample to bring the Hg concentration into the calibration range of the spectrophotometer.

Run a blank and standard at least after every five samples to check the spectrophotometer calibration; recalibrate as necessary.

It is also recommended that at least one sample from each stack test be checked by the method of standard additions to confirm that matrix effects have not interfered in the analysis.

7.4.2 *Container No. 2* (Silica Gel). Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. (This step may be conducted in the field.)

8. *Calibration and Standards.*—Before use, clean all glassware, both new and used, as follows: brush with soap and water, liberally rinse with tap water, soak for 1 hour in 50 percent HNO_3, and then rinse with deionized distilled water.

8.1 *Flow Calibration.* Assemble the aeration system as shown in Figure 101-5. Set the outlet pressure on the aeration gas cylinder regulator to a minimum pressure of 500 mm Hg (10 psi), and use the flowmetering valve and a bubble flowmeter or wet test meter to obtain a flow rate of 1.5±0.1 liters/min through the aeration cell. After the flow calibration is complete, remove the bubble flowmeter from the system.

8.2 *Optical Cell Heating System Calibration.* Using a 50-ml graduated cylinder, add 50 ml of deionized distilled water to the bottle section of the aeration cell and attach the bottle section to the bubbler section of the cell. Attach the aeration cell to the optical cell; and while aerating at 1.5 liters/min, determine the minimum variable transformer setting necessary to prevent condensation of moisture in the optical cell and in the

99-127 O—82——41

SL 025706

connecting tubing. (This setting should not exceed 20 volts.)

8.3 *Spectrophotometer and Recorder Calibration.* The mercury response may be measured by either peak height or peak area.

NOTE: The temperature of the solution affects the rate at which elemental Hg is released from a solution and, consequently, it affects the shape of the absorption curve (area) and the point of maximum absorbance (peak height). Therefore, to obtain reproducible results, bring all solutions to room temperature before use.

Set the spectrophotometer wavelength at 253.7 nm, and make certain the optical cell is at the minimum temperature that will prevent water condensation. Then set the recorder scale as follows: Using a 50-ml graduated cylinder, add 50 ml of deionized distilled water to the aeration cell bottle and pipet 5.0 ml of the working mercury standard solution into the aeration cell.

NOTE: Always add the Hg-containing solution to the aeration cell after the 50 ml of deionized distilled water.

Place a Teflon-coated stirring bar in the bottle. Before attaching the bottle section to the bubbler section of the aeration cell, make certain that (1) the aeration cell exit arm stopcock (Figure 101-3) is closed (so that Hg will not prematurely enter the optical cell when the reducing agent is being added) and (2) there is no flow through the bubbler. If conditions (1) and (2) are met, attach the bottle section to the bubbler section of the aeration cell through the side arm of the cell and immediately stopper the side arm. Stir the solution for 15 sec, turn on the recorder, open the aeration cell exit arm stopcock, and then immediately initiate aeration with continued stirring. Determine the maximum absorbance of the standard and set this value to read 90 percent of the recorder full scale.

8.4 *Calibration Curve.* After setting the recorder scale, repeat the procedure in Section 8.3 using 0.0-, 1.0-, 2.0-, 3.0-, 4.0-, and 5.0-ml aliquots of the working standard solution (final amount of Hg in the aeration cell is 0, 200, 400, 600, 800, and 1000 ng, respectively). Repeat this procedure on each aliquot size until two consecutive peaks agree within 3 percent of their average value. (Note: To prevent Hg carryover from one sample to another, do not close the aeration gas tank valve and do not disconnect the aeration cell from the optical cell until the recorder pen has returned to the baseline.) It should not be necessary to disconnect the aeration gas inlet line from the aeration cell when changing samples. After separating the bottle and bubbler sections of the aeration cell, place the bubbler section into a 600-ml beaker containing approximately 400 ml of deionized distilled water. Rinse the bottle section of the aeration cell with a stream of deionized distilled water to remove all traces of the tin (II) reducing agent. Also, to prevent the loss of Hg before aeration, remove all traces of the reducing agent between samples by washing with deionized distilled water. It will be necessary, however, to wash the aeration cell parts with concentrated HCl if any of the following conditions occur: (1) A white film appears on any inside surface of the aeration cell, (2) the calibration curve changes suddenly, or (3) the replicate samples do not yield reproducible results.

Subtract the average peak height (or peak area) of the blank (0.0-ml aliquot)—which should be less than 2 percent of recorder full scale—from the averaged peak heights of the 1.0-, 2.0-, 3.0-, 4.0-, and 5.0-ml aliquot standards. If the blank absorbance is greater than 2 percent of full-scale, the probable cause is Hg contamination of a reagent or carry-over of Hg from a previous sample. Plot the corrected peak height of each standard solution versus the corresponding final total Hg weight in the aeration cell (in ng) and draw the best-fit straight line. This line should either pass through the origin or pass through a point no further from the origin than ±2 percent of the recorder full scale. If the line does not pass through or very near to the origin, check for nonlinearity of the curve and for incorrectly prepared standards.

8.5 *Sampling Train Calibration.* Calibrate the sampling train components according to the procedures outlined in the following sections of Method 5: Section 5.1 (Probe Nozzle), Section 5.2 (Pitot Tube), Section 5.3 (Metering System), Section 5.4 (Probe Heater), Section 5.5 (Temperature Gauges), Section 5.7 (Barometer). Note that the leak-check described in Section 5.6 of Method 5 applies to this method.

9. *Calculations*—9.1 *Dry Gas Volume.* Using the data from this test, calculate $V_{m(std)}$, the dry gas sample volume at standard conditions (corrected for leakage, if necessary) as outlined in Section 6.3 of Method 5.

9.2 *Volume of Water Vapor and Moisture Content.* Using the data obtained from this test, calculate the volume of water vapor $V_{w(std)}$ and the moisture content B_{ws} of the stack gas. Use Equations 5-2 and 5-3 of Method 5.

9.3 *Stack Gas Velocity.* Using the data from this test and Equation 2-9 of Method 2, calculate the average stack gas velocity v_s.

9.4 *Total Mercury.* For each source sample, correct the average maximum absorbance of the two consecutive samples whose peak heights agree within ±3 percent of their average for the contribution of the solution blank (see Section 8.4). Use the calibration curve and these corrected aver-

ages, to determine the final total weight of mercury in nanograms in the aeration cell for each source sample. Correct for any dilutions made to bring the sample in the working range of the spectrophotometer. Then calculate the Hg in μg (m_{Hg}) in the original solution as follows:

$$M_{Hg} = \frac{C_{Hg(aq)} D.F. V_s 10^{-3}}{S}$$

Eq. 101-1

Where:

$C_{Hg(aq)}$ = Total nanograms of mercury in aliquot analyzed (reagent blank subtracted).

D.F. = Dilution factor for the Hg-containing solution (before adding to the aeration cell; e.g., D.F. = 250/2 if the source samples were diluted as described in Section 7.3.2.)

V_s = Solution volume of original sample, 1000 ml for samples diluted as described in Section 7.3.1.

10^{-3} = Conversion factor, μg/ng.

S = Aliquot volume added to aeration cell, ml.

9.5 *Mercury Emission Rate.* Calculate the Hg emission rate R in g/day for continuous operations using Equation 101-2. For cyclic operations, use only the time per day each stack is in operation. The total Hg emission rate from a source will be the summation of results from all stacks.

$$R = K \frac{m_{Hg} v_s A_s (86{,}400 \times 10^{-9})}{(V_{m(std)} + V_{w(std)}) T_s / P_s}$$

Eq. 101-2.

Where:

A_s = Stack cross-sectional area, m^2 (ft^2).

86,400 = Conversion factor, sec/day.

10^{-9} = Conversion factor, g/μg.

T_s = Absolute average stack gas temperature, °K (°R).

P_s = Absolute stack gas pressure, mm Hg (in. Hg).

K = 0.3858 °K/mm Hg for metric units.
= 17.65 °R/in. Hg for English units.

9.6 *Isokinetic Variation and Acceptable Results.* Same as Method 5, Sections 6.11 and 6.12, respectively.

9.7 *Determination of Compliance.* Each performance test consists of three repetitions of the applicable test method. For the purpose of determining compliance with an applicable national emission standard, use the average of the results of all repetitions.

10. *Bibliography.* 1. Addendum to Specifications for Incinerator Testing at Federal Facilities. PHS, NCAPC. December 6, 1967.

2. Determining Dust Concentration in a Gas Stream. ASME Performance Test Code No. 27. New York, NY. 1957.

3. Devorkin, Howard, et al. Air Pollution Source Testing Manual. Air Pollution Control District. Los Angeles, CA. November 1963.

4. Hatch, W.R., and W.L. Ott. Determination of Sub-Microgram Quantities of Mercury by Atomic Absorption Spectrophotometry. Anal. Chem. 40:2085–87. 1968.

5. Mark, L.S. Mechanical Engineers' Handbook. McGraw-Hill Book Co., Inc. New York, NY. 1951.

6. Martin, Robert M. Construction Details of Isokinetic Source Sampling Equipment. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. APTD-0581. April 1971.

7. Western Precipitation Division of Joy Manufacturing Co. Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases. Bulletin WP-50. Los Angeles, CA. 1968.

8. Perry, J.H. Chemical Engineers' Handbook. McGraw-Hill Book Co., Inc. New York, NY. 1960.

9. Rom, Jerome J. Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. APTD-0576. April 1972.

10. Shigehara, R.T., W.F. Todd, and W.S. Smith. Significance of Errors in Stack Sampling Measurements. Stack Sampling News. 1(3):8–18. September 1973.

11. Smith, W.S., et al. Stack Gas Sampling Improved and Simplified with New Equipment. APCA Paper No. 67–119. 1967.

12. Smith, W.S., R.T. Shigehara, and W.F. Todd. A Method of Interpreting Stack Sampling Data. Stack Sampling News. 1(2):8–17. August 1973.

13. Specifications for Incinerator Testing at Federal Facilities. PHS, NCAPA. 1967.

14. Standard Method for Sampling Stacks for Particulate Matter. In: 1971 Annual Book of ASTM Standards, Part 23. ASTM Designation D-2928-71. Philadelphia, PA. 1971.

15. Vennard, J.K. Elementary Fluid Mechanics. John Wiley and Sons, Inc. New York. 1947.

16. Mitchell, W.J., and M.R. Midgett. Improved Procedure for Determining Mercury Emissions from Mercury Cell Chlor-Alkali Plants. J. APCA. 26: 674–677. July 1976.

17. Shigehara, R.T. Adjustments in the EPA Nomograph for Different Pitot Tube Coefficients and Dry Molecular Weights. Stack Sampling News. 2:4–11. October 1974.

18. Vollaro, R.F. Recommended Procedure for Sample Traverses in Ducts Smaller than 12 Inches in Diameter. U.S. Environmental Protection Agency, Emission Measurement Branch. Research Triangle Park, NC. November 1976.

19. Klein, R., and C. Hach. Standard Additions: Uses and Limitation in Spectrophotometric Measurements. Amer. Lab. 9:21. 1977.

20. Water, Atmospheric Analysis. In: Annual Book of ASTM Standards, Part 31. ASTM Designation D-1193-74. Philadelphia, PA. 1974.

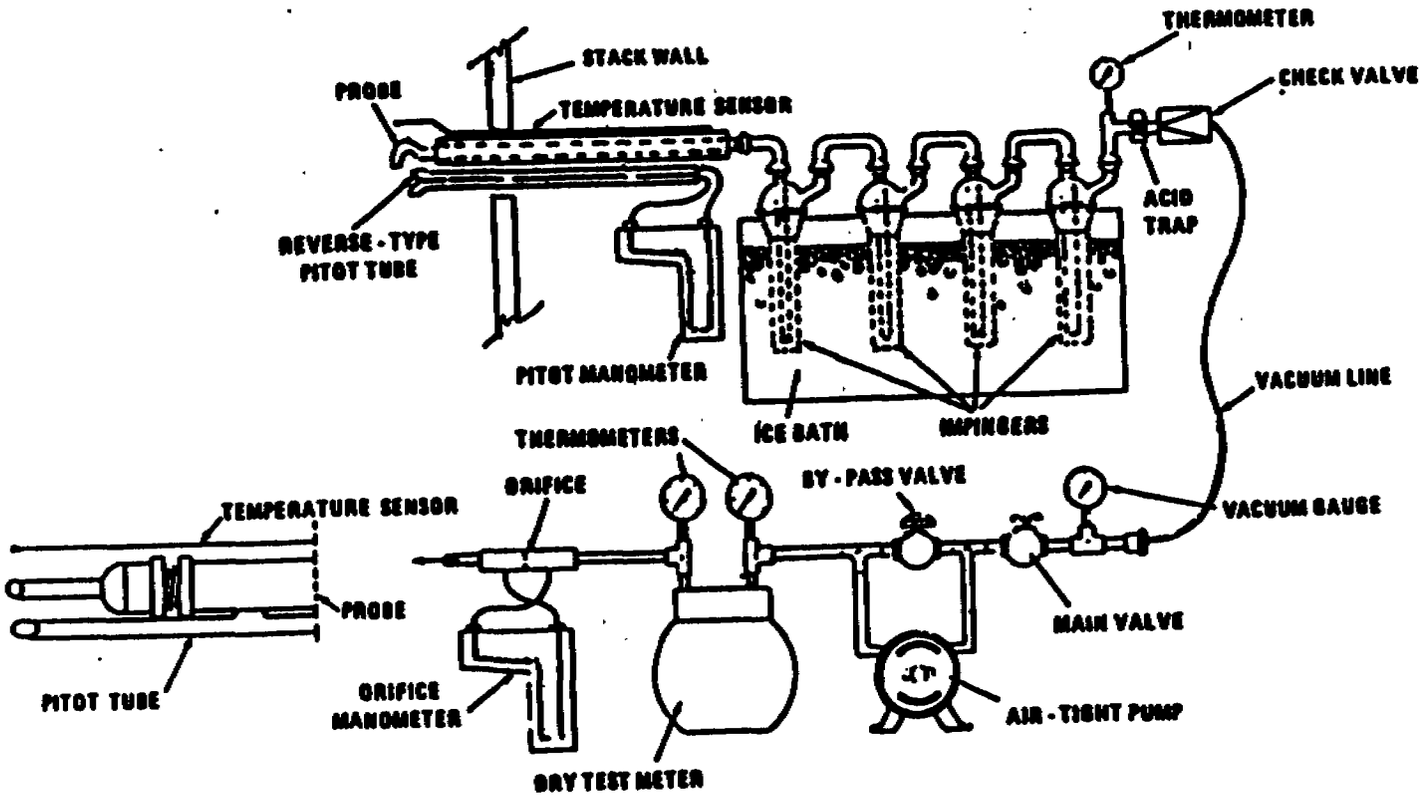


Figure 101-1 Mercury sampling train.

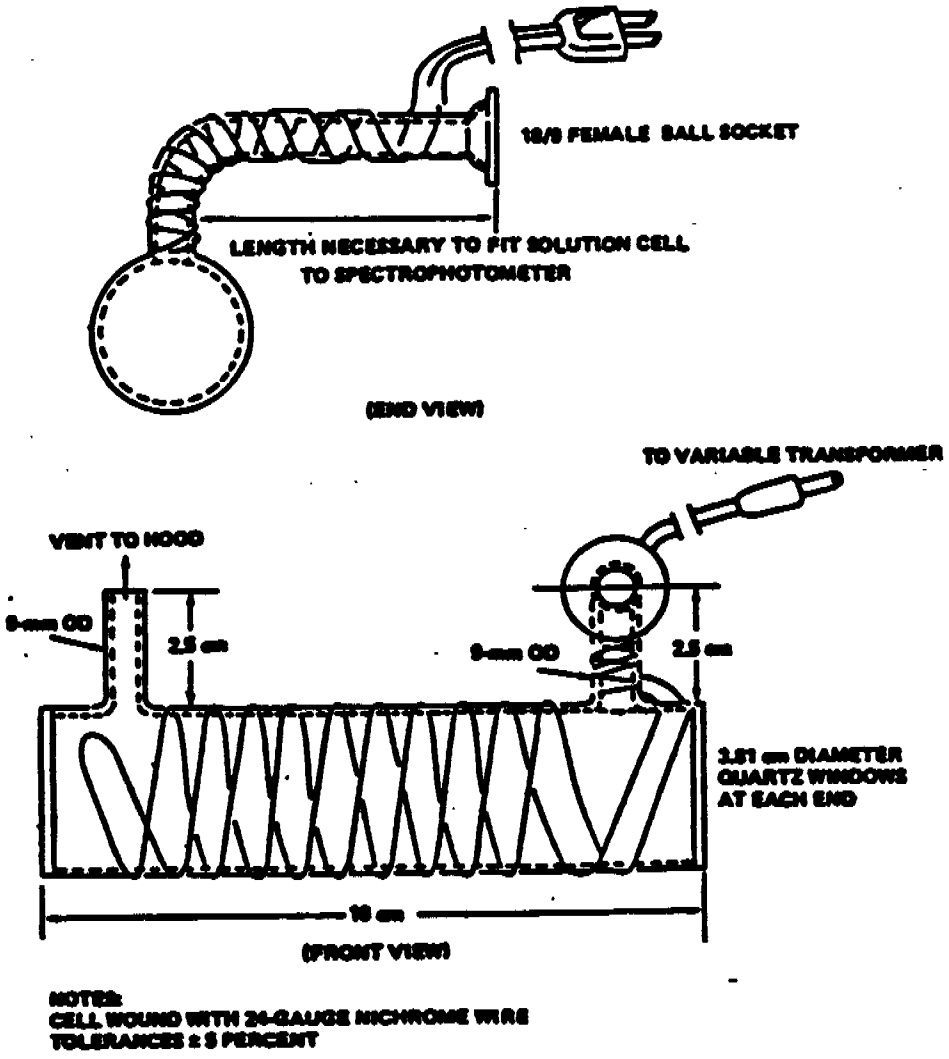


Figure 101-2. Optical cell.

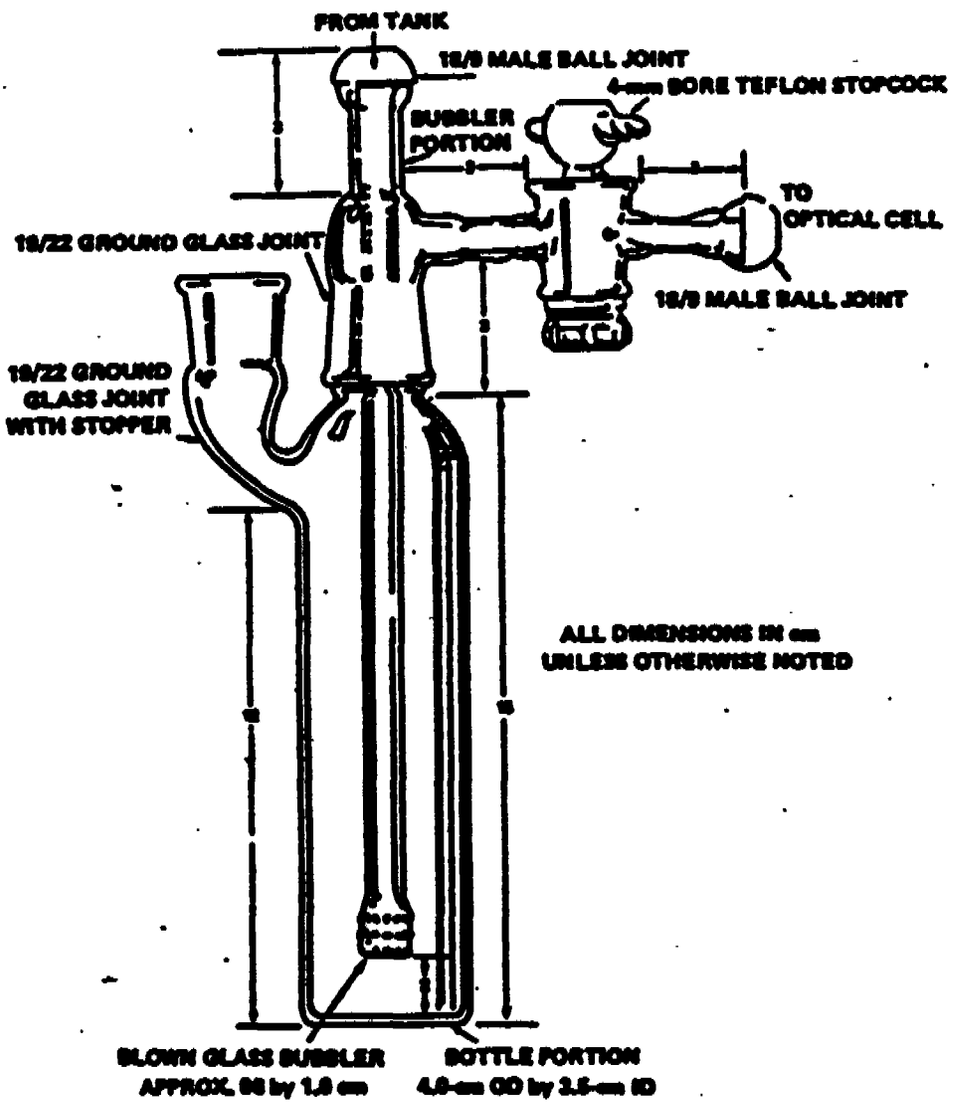


Figure 101-3. Aeration cell.

PLANT _____
LOCATION _____
OPERATOR _____
DATE _____
RUN NO. _____
SAMPLE BOX NO. _____
FILTER BOX NO. _____
METER ΔH@ _____
C FACTOR _____
PITOT TUBE COEFFICIENT, C_p _____

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE _____
BAROMETRIC PRESSURE _____
ASSUMED MOISTURE, % _____
PROBE LENGTH, m (ft) _____
NOZZLE IDENTIFICATION NO. _____
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) _____
PROBE HEATER SETTING _____
LEAK RATE, m^3/min (cfm) _____
PROBE LINER MATERIAL _____
STATIC PRESSURE, mm Hg (in. Hg) _____
FILTER NO.[a] _____

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	VACUUM mm Hg (in. Hg)	STACK TEMPERATURE (Ts) °C (°F)	VELOCITY HEAD (Δp_s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft³)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		FILTER HOLDER[a] TEMPERATURE, °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °C (°F)
							INLET °C (°F)	OUTLET °C (°F)		
TOTAL							Avg.	Avg.		
AVERAGE							Avg.			

[a] If applicable

Fig. 101-4. Mercury field data.

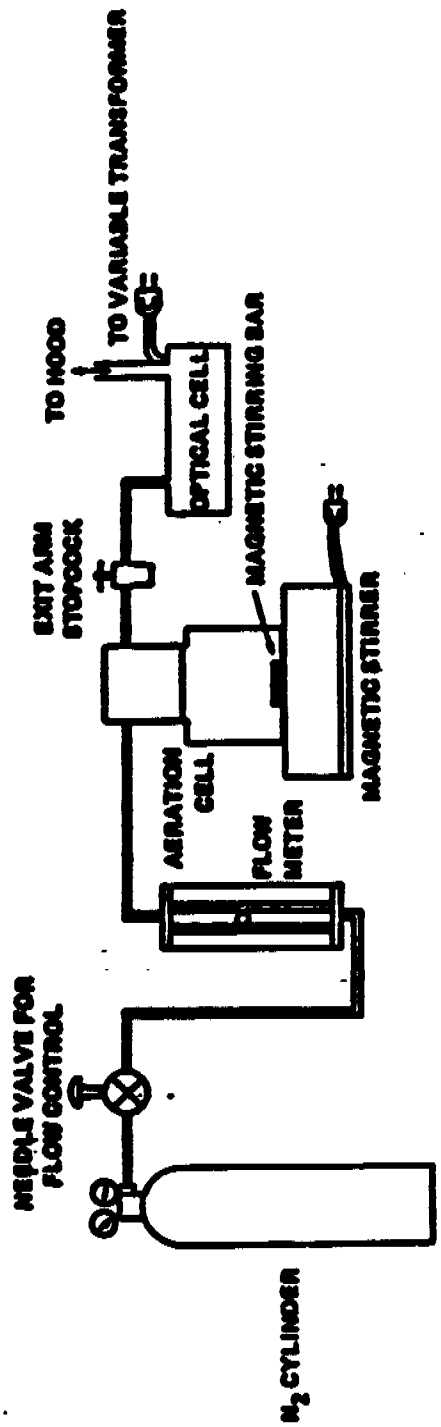


Figure 101-6. Schematic of aeration system.

Method 101, Section 8, except for the following variations:

8.1 *Optional Cell Heating System Calibration.* Same as method 101, Section 8.2, except use a 25-ml graduated cylinder to add 25 ml of deionized distilled water to the bubbler section of the aeration cell.

8.2 *Spectrophotometer and Recorder Calibration.* The mercury response may be measured by either peak height or peak area. (Note: the temperature of the solution affects the rate at which elemental Hg is released from a solution and, consequently, it affects the shape of the absorption curve (area) and the point of maximum absorbance (peak height). To obtain reproducible results, all solutions must be brought to room temperature before use.) Set the spectrophotometer wave length at 253.7 nm and make certain the optical cell is at the minimum temperature that will prevent water condensation.

Then set the recorder scale as follows: Using a 25-ml graduated cylinder, add 25 ml of deionized distilled water to the aeration cell bottle and pipet 5.0 ml of the working mercury standard solution into the aeration cell. (Note: Always add the Hg-containing solution to the aeration cell after the 25 ml of deionized distilled water.) Place a Teflon-coated stirring bar in the bottle. Add 5 ml of the 4 percent $KMnO_4$ absorbing solution followed by 5 ml of 15 percent HNO_3 and 5 ml of 5 percent $KMnO_4$ to the aeration bottle and mix well. Now, attach the bottle section to the bubbler section of the aeration cell and make certain that (1) the aeration cell exit arm stopcock (Figure 101-3 of Method 101) is closed (so that Hg will not prematurely enter the optical cell when the reducing agent is being added) and (2) there is no flow through the bubbler. Add 5 ml of sodium chloride hydroxylamine in 1-ml increments until the solution is colorless. Now add 5 ml of tin (II) solution to the aeration bottle through the side arm. Stir the solution for 15 seconds, turn on the recorder, open the aeration cell exit arm stopcock, and immediately initiate aeration with continued stirring. Determine the maximum absorbance of the standard and set this value to read 90 percent of the recorder full scale.

9. *Calculations*—9.1 *Dry Gas Volume, Volume of Water Vapor and Moisture Content, Stack Gas Velocity, Isokinetic Variation and Acceptable Results, and Determination of Compliance.* Same as Method 101, Sections 9.1, 9.2, 9.3, 9.6, and 9.7, respectively, except use data obtained from this test.

9.2 *Total Mercury.* For each source sample, correct the average maximum absorbance of the two consecutive samples whose peak heights agreed within ±3 percent of their average for the contribution of the field blank. Then calculate the total Hg content in μg in each sample. Correct for any dilutions made to bring the sample into the working range of the spectrophotometer.

9.3 *Mercury Emission Rate.* Calculate the Hg emission rate R in g/day for continuous operations using Equation 101A-1. For cycle operations, use only the time per day each stack is in operation. The total Hg emission rate from a source will be the summation of results from all stacks.

$$R = K \frac{m_{Hg} v_s A_s (86{,}400 \times 10^{-6})}{(V_{m(std)} + V_{w(std)})(T_s/P_s)}$$

Eq. 101A-1

Where:

m_{Hg} = Total Hg content in each sample, μg.
v_s = Average stack gas velocity, m/sec (fps).
A_s = Stack cross-sectional area, m^2 (ft^2).
86,400 = Conversion factor, sec/day.
10^{-6} = Conversion factor, g/μg.
$V_{m(std)}$ = Dry gas sample volume at standard conditions, corrected for leakage (if any), m^3 (ft^3).
$V_{w(std)}$ = Volume of water vapor at standard conditions, m^3 (ft^3).
T_s = Absolute average stack gas temperature, °K (°R).
P_s = Absolute stack gas pressure, mm Hg (in. Hg).
K = 0.3858 °K/mm Hg for metric units.
= 17.64 °R/in. Hg for English units.

10. *Bibliography.* 1. Same as Method 101, Section 10.

2. Mitchell, W. J., M. R. Midgett, J. C. Suggs, and D. Albrinck.

Test Methods to Determine the Mercury Emissions from Sludge Incineration Plants. U.S. Environmental Protection Agency. Research Triangle Park, North Carolina. Publication No. EPA-600/4-79-068. September 1979.

METHOD 102—DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM CHLOR-ALKALI PLANTS—HYDROGEN STREAMS

1. *Introduction*—Although similar to Method 101, Method 102 requires changes to accommodate the sample being extracted from a hydrogen stream. Conduct the test according to Method 101, except as shown below:

2. *Mercury Train Operation*—2.1 *Probe Heating System.* Do not use, unless otherwise specified.

2.2 *Glass Fiber Filter.* Do not use, unless otherwise specified.

2.3 *Safety Precautions.* The sampler must conduct the source test under conditions of utmost safety, because hydrogen and air

mixtures are explosive. Since the sampling train essentially is leakless, attention to safe operation can be concentrated at the inlet and outlet. If a leak does occur, however, remove the meter box cover to avoid a possible explosive mixture. The following specific precautions are recommended:

2.3.1 *Operate only the vacuum pump during the test.* The other electrical equipment, e.g., heaters, fans, and timers, normally are not essential to the success of a hydrogen stream test.

2.3.2 *Seal the sample port to minimize leakage of hydrogen from the stack.*

2.3.3 *Vent sampled hydrogen at least 3 m (10 feet) away from the train.* This can be accomplished by attaching a 13-mm-ID (0.50-in.) Tygon tube to the exhaust from the orifice meter. (NOTE: A smaller ID tubing may cause the orifice meter calibration to be erroneous.) Take care to ensure that the exhaust line is not bent or pinched.

2.4 *Setting of Isokinetic Rates.*

2.4.1 If a nomograph is used, take special care in the calculation of the molecular weight of the stack gas and in the setting of the nomograph to maintain isokinetic conditions during sampling (Sections 2.4.1.1 through 2.4.1.3 below).

2.4.1.1 *Calibrate the meter box orifice.* Use the techniques described in APTD-0576 (see Citation 9 in Section 10 of Method 101). Calibration of the orifice meter at flow conditions that simulate the conditions at the source is suggested. Calibration should either be done with hydrogen or with some other gas having a similar Reynolds Number so that there is similarity between the Reynolds Numbers during calibration and during sampling.

2.4.1.2 The nomograph described in APTD-0576 cannot be used to calculate the C factor because the nomograph is designed for use when the stack gas dry molecular weight is 29±4. Instead, the following calculation should be made to determine the proper C factor:

$$C = [\text{constants}]\,C_p\,\frac{T_s}{P_s}\,\frac{(1-B_{ws})^2}{(1-B_{ws})^2 + MW_s/M_d}$$

Where:

$\Delta H_@$ = Meter box calibration factor obtained in Section 2.4.1.1, in. H_2O.

C_p = Pitot tube calibration coefficient, dimensionless.

T_s = Absolute temperature of gas at the orifice, °R.

P_s = Absolute pressure of stack gas, in Hg.

P_m = Absolute pressure of gas at the meter, in Hg.

B_{ws} = Fraction by volume of water vapor in the stack gas.

M_d = Dry molecular weight of stack gas, lb/lb-mole.

NOTE: This calculation is left in English units, and is not converted to metric units because nomographs are based on English units.

2.4.1.3 Set the calculated C factor on the operating nomograph and select the proper nozzle diameter and K factor as specified in APTD-0576. If the C factor obtained in Section 2.4.1.2 exceeds the values specified on the existing operating nomograph, expand the C scale logarithmically so that the values can be properly located.

2.4.2 If a calculator is used to set isokinetic rates, it is suggested that the isokinetic equation presented in Citation 17 in the Bibliography of Method 101 be used.

2.5 *Sampling in Small (<13-in.-Diameter) Stacks.* When the stack diameter (or equivalent diameter) is less than 13 inches, conventional pitot tube-probe assemblies should not be used. For sampling guidelines, see Citations 13 & 14 in the Bibliography of Method 101.

METHOD 103—BERYLLIUM SCREENING METHOD

1. *Principle and applicability.*—1.1 *Principle.*—Beryllium emissions are isokinetically sampled from three points in a duct or stack. The collected sample is analyzed for beryllium using an appropriate technique.

1.2 *Applicability.*—This procedure details guidelines and requirements for methods acceptable for use in determining beryllium emissions in ducts or stacks at stationary sources, as specified under the provisions of § 61.14 of the regulations.

2. *Apparatus.*—2.1 *Sampling train.*—A schematic of the required sampling train configuration is shown in figure 103-1. The essential components of the train are the following:

2.1.1 *Nozzle.*—Stainless steel, or equivalent, with sharp, tapered leading edge.

2.1.2 *Probe.*—Shorthead Pyrex[1] glass.

2.1.3 *Filter.*—Millipore AA, or equivalent, with appropriate filter holder that provides a positive seal against leakage from outside or around the filter. It is suggested that a Whatman 41, or equivalent, be placed immediately against the back side of the Millipore filter as a guard against breakage of the Millipore. Include the Whatman 41 in the analysis. Equivalent filters must be at least 99.5 percent efficient (DOP Test) and amenable to the analytical procedure.

2.1.4 *Meter-pump system.*—Any system that will maintain isokinetic sampling rate, determine sample volume, and is capable of a sampling rate of greater than 0.5 cfm.

2.2 *Measurement of stack conditions (stack pressure, temperature, moisture and*

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

APPENDIX D

Sampling Parameters, Field Data and Results

4EB-1

D:25 12 in. ~~30.0~~
FIELD SAMPLING DATA
29.84 @ 0730
Amb. T 64

PPG INDUSTRIES

PLANT & LOCATION: Lake Charles Plant A
End Box Stack (Mercury Circuit)

ASSUMED: % H_2O ~2.0 ; T_s, °F 63

Pm, in. WG 30.00

DATE: 12/12/84 TEST NO.: 84EB-1

LEAK CHECKS

EQUIP.: MFG. Andersen METER BOX NO. B-4

INITIAL ½ FINAL

Y_D 0.9698 ΔH@: 2.00 SAMP. BOX NO. B-4

TRAIN: .001 @ 20" 0.002 @ 11"

OPERATOR M. Hogan / L. Kunyle

PITOT: IMP. 5.3" ok 7.8"

PITOBE: NO. 16 TYPE S Cp 0.84

WAKE 6.8 OK 8.0"

NOZZLE: NO. 1 ID, in. 0.189 Ft² 1.948 E-04

FIELD METER CHECK

STACK: DIMENSIONS 12", AREA 0.7854 Ft²

Cyclonic Flow ✓ =

K r Δ P REF.: 1.57 C FACTOR

One lane only N-S, 8 pt
15 min/pt. θ = 120 min.

Plant Test No. Date

Comments	Clock Time	Dry Gas Meter, CF	Pitot ΔP in. H_2O	√ΔP	Orifice ΔH in H_2O	Dry Gas Temp., °F In	Dry Gas Temp., °F Out	Pump Vacuum In. Hg Gauge	Oven Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
603	0	408.900	1.3	1..	2.00	73	75	8.0	288	45	-.40	63
	5	413.400	1.3		2.00	100	74	8.2	282	44		63
1	10	416.400	1.3		2.00	107	76	8.5	258	46		64
	15	420.175	1.25		1.90	112	78	8.5	250	48		65
—	20	424.965	1.25		1.90	115	81	8.5	240	47		
2	25	427.850	1.25		1.90	117	84	8.5	237	47		
	30	431.690	~~1.25~~ 1.20		~~1.90~~ 1.83	119	87	8.5	233	48	-0.50	65
—	35	435.540	1.20		1.83	120	89	8.5	232	48		
3	40	439.390	1.20		1.85	120	91	8.5	225	47		66
—	45	443.248	1.15		1.75	121	92	8.5	256	47		
	50	447.000	1.15		1.75	120	92	8.0	253	47		
4	55	450.775	1.15		1.75	121	93	8.0	251	46	-0.45	67
—	60	454.485	0.99		1.50	120	94	7.0	249	46		
	65	457.975	0.99		1.50	119	95	7.0	245	46		
5	70	461.475	0.99		1.50	119	95	7.0	246	47	-0.47	66
—	75	465.002	0.92		1.42	118	95	7.0	247	48		
	80	468.380	0.93		1.44	118	96	7.0	250	48		
	85	471.785	0.93		1.44	118	95	7.0	250	48	-.48	66
—	90	475.170	0.83		1.28	119	95	6.0	250	48		
—	95	478.410	0.83		1.28	118	96	6.0	248	49		
7	100	481.620	0.83		1.28	118	96	6.0	248	49	-.48	66

FIELD DATA

D:26

Plant _____ Test No. _____ Date _____

Comments	Clock Time	Dry Gas Meter, CF	Pitot ΔP in. H2O	√ΔP	Orifice ΔH in H2O	Dry Gas Temp., °F Avg.	Pump Vacuum In. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H2O	Stack Temp. °F
8	11.5	490.835	0.75		1.10	118.96	6.0	247	50	-0.45	66
11:03 off	120	493.818									

Vm = 84.918 Ft³

x Yd 0.9698

= 82.353 Ft³(Dry)

x̄√ΔP = 1.0206

(x̄√ΔP)² 1.042

from 1025

562.5°R

x̄ Pm = 1.60 "WG

x̄ Pm = 29.56 "Hg

Pm abs = 29.56 "Hg

x̄ Ps = -0.46 "WG

x̄ Ps = -0.03 "Hg

Ps abs = 29.81 "Hg

Additional Comments: EAST FAN Down operating

x̄ Ts = 65 °F

x̄ Ts = 525 °R

SL 025719

PPG INDUSTRIES

ORSAT ANALYSIS

Test No. 84 EB-1 Date 12-12-84

Sampl L cation End Box Stack Analyzed by M. Hogan

Sample Type Integrated Bag

Volume (30 L minimum) _____

Time (4 hrs. max. after sampling) 1135

Orsat Leak Checks(Mandatory)

Before OK

After OK

Orsat Test No.	CO_2	+	O_2	O_2	CO	N_2
1	0.0		20.8	20.8	0	79.2
2	0.0		20.8	20.8	0	79.2
3	0.0		20.8	20.8	0	79.2
4	—		—	—	—	—
5	—		—	—	—	—
6	—		—	—	—	—
AVE.	—		—	—	—	—

Ambient Air 20.8%

M. Hogan

SL 025720

84EB-1

0:28

PARTICULATE DATA SHEET

EPA INDUSTRIES

Date 12/ /84 Test No. 84EB-1 Plant Lake Charles Masonry Cement - End Box Stack

Impinger #1	757.2 g	Impinger #2	980.7 g	Impinger #3	555.5 g
	636.2 g		607.2 g		691.2 g
	121.0 g		-26.5 g		-75.7 g

Silica gel 759.9 g Total H_2O 34.1

No. ____ 744.6 g

15.3 g

100ml 0.1M HCl in Impingers 1, 2, 3

~~Filter No.~~ _____ Bottle No. _____ Blank No. _____ Bottle No. _____

				Date	Time	Rel. Hum.	Analyst
Gross filter wt.	mg	Gross blk wt.	mg				
	mg		mg	12/12/84	1200		[illegible]
Avg. gross wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg	12/11/84	1000		[illegible]
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate on filter _____ mg

Acetone Wash Beaker No. _____ Mls used _____ Blank Beaker No. _____ Mls used _____

				Date	Time	Rel. Hum.	Analyst
Gross wash wt.	mg	Gross blk wt.	mg				
	mg		mg				
Avg. gross wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg				
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate in wash _____ mg

Total particulate on filter _____ mg
Total particulate in acetone wash _____ mg
Total particulate _____ mg
Total H_2O _____ ml

REMARKS:

Sample place washings → 1 for Hg analysis

SL 025721

84EB-2

D:29

FIELD SAMPLING DATA P_c 27.79 @ 12:06

PPG INDUSTRIES

PLANT & LOCATION Lake Charles Plant 4
End Box Stack (Effluent Emission)

DATE: 12/12/84 TEST NO.: 84EB-2

EQUIP.: MFG. Anderson METER BOX NO. B-4

Y_D 0.9698 Δ H@: 2.00 SAMP. BOX NO. B-4

OPERATOR MH/LHK

PITOBE: NO. 16 TYPE S C_p 0.84

NOZZLE: NO. 1 ID, in. 0.189 Ft^2 1.948^{E-04}

STACK: DIMENSIONS 12", AREA 0.7854 Ft^2

K r Δ P REF.: 1.57 C FACTOR

ASSUMED: % H_2O 2.0 ; T@ °F 63

Pm, in. WG 30.00

LEAK CHECKS

	INITIAL	FINAL
TRAIN:	15" .001"	10" @ 2.0"
PITOT: IMP.	8.6" OK	7.4 OK
WAKE	7.5" OK	6.3 OK

FIELD METER CHECK

One Lam only N-S 8 pt
Plant Test No. Date 15 min/pt Θ=120.

Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H_2O	√Δ P	Orifice Δ H in H_2O	Dry Gas Temp., °F In / Out	Pump Vacuum In. Hg Gauge	Oven & Blower Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
1330	0	502.118	1.20		1.85	99 89	6.0	238	48	-041	66
	5	505.995	1.25		1.90	106 83	6.2	240	47		
1	10	509.900	1.25		1.90	114 84	6.3	245	48		
	15	513.920	1.25		1.90	116 86	6.5	248	47	-045	66
	20	517.945	1.25		1.90	118 88	6.2	249	47		
2	25	521.900	1.25		1.90	118 90	6.2	250	47		
	30	525.160	1.20		1.85	121 92	6.2	251	45	-0.43	65
	25	528.985	1.05		1.70	120 94	6.0	254	46		
3	40	531.960	1.05		1.60	120 94	6.0	254	47		
	45	535.290	1.15		1.75	121 95	6.0	256	46	-0.40	65
	50	540.010	1.15		1.75	123 97	6.1	256	46		
4	55	543.800	1.15		1.75	123 98	6.1	258	47		
	60	547.603	1.05		1.61	123 98	5.8	258	47	-0.37	65
	65	551.283	1.05		1.61	122 99	5.8	255	48		
5	70	554.830	1.05		1.61	122 99	5.8	254	47		
	75	558.435	0.94		1.44	121 99	5.3	253	45	-0.38	65
	80	561.833	0.93		1.43	121 98	5.3	250	46		
6	85	565.220	0.93		1.43	121 98	5.3	250	45		
	90	568.608	0.79		1.21	119 98	5.0	251	45	-0.92	65
	95	571.764	0.79		1.21	118 98	5.0	251	46		
7	100	574.888	0.80		1.22	118 98	5.0	251	46		

SL 025722

FIELD DATA

0:30

Plant________ Test No.________ Date________

Comments	Clock Time	Dry Gas Meter, CF	Pitot ΔP in. H_2O	$\sqrt{\Delta P}$	Orifice ΔH in H_2O	Dry Gas Temp., °F	Pump Vacuum In. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
8	115	584.323	0.82		1.25	117 96	.51	253	46		
15:30	120	587.467									
						566					65
											525

Vm = 85.349 Ft³	$\bar{x}\sqrt{\Delta P}$ = 1.0180	$\bar{x}$ Pm = 1.59 "WC	$\bar{x}$ Ps = -0.39 "WC
x Yd 0.9698	$(\bar{x}\sqrt{\Delta P})^2$ 1.036	$\bar{x}$ Pm = 0.12 "Hg	$\bar{x}$ Ps = -0.02 "Hg
= 82.771 Ft³(Dry)		Pm abs = 29.91 "Hg	Ps abs = 29.97 "Hg

Additional Comments:

$\bar{x}$ Ts = 65 °F

$\bar{x}$ Ts = 525 °R

SL 025723

84EB-2

D:31

PARTICULATE DATA SHEET

EPC INDUSTRIES

Date 12/12/84 Test No. 84EB-2 Plant Lake Charles Mercury Cement

Impinger #1	636.4 g	Impinger #2	651.4 g
	628.2 g		642.0 g
	8.2 g		9.4 g
Impinger #3	602.1 g		
	600.8 g		
	1.3 g		

Silica gel 763.6 g Total H_2O 32.1
No. ____ 750.4 g
13.2 g

1, 2, 3 0.1 M HCl 100 ml

Filter No. _____ Bottle No. _____ Blank No. _____ Bottle No. _____

				Date	Time	Rel. Hum.	Analyst
Gross filter wt.	mg	Gross blk wt.	mg				
	mg		mg	12/12/84	1600		T Gile
Avg. gr ss wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg	12/12/84	1210		T Gile
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate on filter _____ mg

Acetone Wash Beaker No. _____ Mls used _____ Blank Beaker No. _____ Mls used _____

				Date	Time	Rel. Hum.	Analyst
Gr ss wash wt.	mg	Gross blk wt.	mg				
	mg		mg				
Avg. gr ss wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg				
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate in wash _____ mg

Total particulate on filter _____ mg
T tal particulate in acetone wash _____ mg
Total particulate _____ mg
Total H_2O 32.1 ml

REMARKS:

Sample of wash → lab for analysis

EPG INDUSTRIES

ORSAT ANALYSIS

Test No. 84 EB-2 Date 12-12-84

Sample Location ~~End Box~~ Scrubber Stack Analyzed by W. Hebert

Sample Type Grab

Volume (30 L minimum) _____

Time (4 hrs. max. after sampling) _____

Orsat Leak Checks(Mandatory)

Before OK

After _____

Orsat Test No.	CO_2	+	O_2	O_2	CO	N_2
1	0		20.9	20.9	0	79.1
2	0		20.9	20.9	0	79.1
3						
4						
5						
6						
AVE.						

M. Hogan

Ambient air 20.9 % O_2

SL 025725

84EB-3

0:33

FIELD SAMPLING DATA

T_{bar} 29.70

PPG INDUSTRIES

PLANT & LOCATION: Lake Charles Plant A — ASSUMED: % H_2O 2 ; T_s, °F 65

End Box Slash (Missing Casing)

Pm, in. WG 29.75

DATE: 12/3/84 TEST NO.: 84EB-3

LEAK CHECKS

EQUIP.: MPG. Andersen METER BOX NO. B-4 — INITIAL ½ FINAL

Y_D 0.968 Δ H@: 2.00 SAMP. BOX NO. B-4 — TRAIN: 18" ok ____ 13" OK

OPERATOR MH/MC. — PITOT: IMP. 5.3 ok 9.3 OK 9.3OK

PITOBE: NO. 16 TYPE S C_p 0.84 — WAKE 8.6 ok ____ 4.7 OK

NOZZLE: NO. 1 ID, in. 0.187 Ft^2 1.948^{E-04}

FIELD METER CHECK

STACK: DIMENSIONS 12", AREA 0.7854 Ft^2

K or Δ P REF.: 2.57 C FACTOR ____

One Zone only N-5 8 pt 15 min/pt Σ=120 min

Plant ____ Test No. ____ Date ____

08:10 Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H_2O	$\sqrt{\Delta P}$	Orifice Δ H in H_2O	Dry Gas Temp., °F (in / out)	Pump Vacuum In. Hg Gauge	Oven/Filter Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
	0	600.788	1.15	1.072	1.75	86 / 72	7.5	245	55	-.5	62
1	5	604.335	1.15	1.072	1.75	101 / 73	8.0	216	49		
	10	607.750	1.20	1.095	1.85	110 / 76	8	225	47		
	15	611.620	1.20	1.095	1.85	111 / 79	8.0	229	46	-0.45	63
	20	615.350	1.20	1.095	1.85	112 / 80	8.0	233	46		
2	25	619.075	1.20	1.095	1.85	114 / 82	8.0	234	45		
	30	623.160	1.20	1.095	1.85	115 / 85	8.0	247	44	-0.42	64
	35	626.440	1.20	1.095	1.85	115 / 85	7.5	250	43		
3	40	630.210	1.20	1.095	1.85	115 / 85	7.8	250	43		
	45	634.200	1.05	1.024	1.62	112 / 87	6.0	250	43	-0.44	64
	50	638.200	1.05	1.024	1.62	116 / 87	7.0	253	41		
4	55	640.650	0.87	0.933	1.45	118 / 80	7.0	255	41		
	60	644.340	1.0	1.000	1.54	120 / 88	7.0	258	42	-0.40	64
	65	647.981	1.03	1.015	1.60	122 / 89	7.0	258	42		
5	70	651.270	1.00	1.000	1.54	122 / 89	7.0	259	42		
	75	654.750	0.91	0.954	1.40	122 / 90	6.2	259	41	-0.44	65
	80	658.120	0.91	0.954	1.40	121 / 90	6.2	260	41		
6	85	661.500	0.92	0.959	1.42	121 / 91	6.2	261	41		
	90	664.810	0.7[illegible]	0.883	1.19	119 / 92	[illegible]	[illegible]	[illegible]	-0.[illegible]	64
	95	[illegible]	[illegible]	0.883	[illegible]	115 / [illegible]	[illegible]	[illegible]	[illegible]		
7	100	[illegible]	0.75	0.866	1.15	113 / [illegible]	5.5	[illegible]	44		

SL 025726

FIELD DATA

D:34

Plant _____ Test No. 84 EB-3 Date 12/13/84

Comments	Clock Time	Dry Gas Meter, CF	Pitot ΔP in. H2O	√ΔP	Orifice ΔH in H2O	Dry Gas Temp., °F Avg.	Pump Vacuum in. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in. H2O	Stack Temp. °F
8	115	679.400	0.71	0.843	1.09	84 90	5.5	267	44		
	120	682.623									
				$\bar{Y}$ .9950	$\bar{Y}$ 1.54	100				$\bar{X}$ -.44	$\bar{X}$ .64
10:10					.11	560				-.03	

Vm = 81.835 Ft³ x Yd 0.9698 = 79.364 Ft³(Dry)	$\bar{x}\sqrt{\Delta P}$ = 0.9950 $(\bar{x}\sqrt{\Delta P})^2$ = 0.9900	$\bar{x}$ Pm = 1.54 "WC $\bar{x}$ Pm = 0.11 "Hg Pm abs = 29.81 "Hg	$\bar{x}$ Ps = -0.44 "WC $\bar{x}$ Ps = -0.03 "Hg Ps abs = 29.67 "Hg

dditional Comments:

$\bar{x}$ Ts = 64 °F

$\bar{x}$ Ts = 524 °R

SL 025727

84 EB-3

D:35

PARTICULATE DATA SHEET

Date 12/ /84 Test No. 84 EB-3 Plant Lake Charles Mercury Cell Circuit, Emission Points

Impinger #1	637.4 g	Impinger #2	647.6 g	Impinger #3	602.3 g
	628.1 g		641.3 g		601.4 g
	9.3 g		6.3 g		0.9 g

Silica gel 754.9 g Total H_2O 29.9
N. ____ 741.5 g
13.4 g

Filter No. _____ Bottle No. _____ Blank No. _____ Bottle No. _____

				Date	Time	Rel. Hum.	Analyst
Gross filter wt.	mg	Gross blk wt.	mg				
	mg		mg	12/13/84	1045		
Avg. gross wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg	12/12/84	1600		
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate on filter _____ mg

Acetone Wash Beaker No. _____ Mls used _____ Blank Beaker No. _____ Mls used _____

				Date	Time	Rel. Hum.	Analyst
Gr ss wash wt.	mg	Gross blk wt.	mg				
	mg		mg				
Avg. gross wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg				
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate in wash _____ mg

Total particulate on filter _____ mg
Total particulate in acetone wash _____ mg
Total particulate 29.9 mg
Total H_2O _____ ml

REMARKS:

O_2 20.9 @ 0820
Ambient 20.9 @ 0830

MW 31.6 x 18 = 0.284
O_2 = .209 (.984) x 32 = 6.58
N_2 = .791 (.984) x 28 = 21.794
28.662

SL 025728

PPG INDUSTRIES

ORSAT ANALYSIS

Test No. 84-EB-3 Date 12-13-84

Sample Location End Box Scrubber Stack Analyzed by M. Hogan

Sample Type Integrated Bag

Volume (30 L minimum) _____

Time (4 hrs. max. after sampling) _____

Orsat Leak Checks (Mandatory)

Before OK

After OK

Orsat Test No.		CO_2	+	O_2	O_2	CO	N_2
0820	1	—		20.9	20.9	—	79.1
	2	—		—	—	—	—
	3	—		—	—	—	—
	4	—		—	—	—	—
	5	—		—	—	—	—
	6	—		—	—	—	—
	AVE.	—		—	—	—	—

Ambient Air 20.9 @ 0830

M. Hogan

SL 025729

PARTICULATE EMISSIONS SAMPLING REPORT

PLANT-NAME AND ADDRESS

LAKE CHARLES

TEST TEAM LEADER

KURYLA

TEST 1 84ER-1

TEST 2 84ER-2

TEST 3 84ER-3

RUN NUMBER		1	2	3
TEST DATE		12/12/84	12/12/84	12/13/84
TB	TIME-START	903	1330	810
TF	TIME-FINISH	1103	1530	1010
TT	NET TIME OF TEST,MIN.	120.0	120.0	120.0
FNP	NET SAMPLING POINTS	8.	8.	8.
DN	SAMPLING NOZZLE DIA., IN.	0.189	0.189	0.189
CP	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
PM	AVERAGE ORIFICE PRESSURE DROP, IN. H2O	1.60	1.59	1.54
VM	VOLUME OF DRY GAS SAMPLED CU. FT. AT METER CONDITIONS	82.353	82.771	79.364
TM	AVERAGE GAS METER TEMP DEGREES F	102.5	106.0	100.0
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, SCF	77.399	77.180	74.562
VW	TOTAL H2O COLLECTED IN IMPINGERS & SILICA GEL,ML.	34.10	32.10	29.90
VWV	VOLUME OF WATER VAPOR AT STANDARD CONDITIONS, SCF	1.605	1.511	1.407
PMV	PERCENT MOISTURE BY VOL.	2.0	1.9	1.9
FMD	MOLE FRACTION DRY GAS	0.980	0.981	0.981
PCO2	PERCENT CO2 BY VOL.,DRY	0.0	0.0	0.0
PO2	PERCENT O2 BY VOL.,DRY	20.80	20.90	20.90
PCO	PERCENT CO BY VOL.,DRY	0.0	0.0	0.0
PN2	PERCENT N2 BY VOL.,DRY	79.20	79.10	79.10
FMWD	MOLEULAR WT-DRY STK GAS	28.83	28.84	28.84
FMW	MOLECULAR WT-STK GAS	28.61	28.63	28.64
PB	BAROMETRIC PRESSURE,IN. HG.	29.84	29.79	29.70
PSI	STATIC PRES OF STK GAS IN. WG IN. H2O	-0.46	-0.39	-0.44
PS	STACK PRES,ABS. IN. HG.	29.806	29.761	29.668
TS	AVERAGE STACK TEMP. DEG. F	65.0	65.0	64.0
DPS	SQ OF AVE OF SQ RTS OF DELTA P S STACK GAS,IN. H2O	1.0420	1.0360	0.9950
VS	AVE STK GAS VELOCITY,FPS	57.52	57.38	56.26
AS	STACK AREA,FT. SQRD	0.8	0.8	0.8
QS	STK FLOW RATE,DRY,DSCFM	2660.	2653.	2600.
QA	ACTUAL STK FLOW RATE,ACFM	2710.	2704.	2651.
PERI	PERCENT ISOKINETIC	97.8	97.8	96.4

SL 025730

D:38

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS [illegible]

VMSTD = (17.647*VM*(PB+PM/13.6))/(TM+460)

VMSTD = 17.647* 82.353*(29.840 1.600/13.6) / 542.5 = 77.399 DSCF

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

VWV = .04707*VW

VWV = 0.04707* 34.10 = 1.605 SCF

PERCENT MOISTURE IN STACK GAS

PMW = (100*VWV)/(VMSTD+VWV)

PMW = 100.* 1.61 / 77.399+ 1.61 = 2.0 PERCENT

MOLE FRACTION OF DRY STACK GAS

MD = (100.-PMW)/100.

MD = 100.- 2.0 / 100. = 0.980

AVERAGE MOLECULAR WEIGHT OF DRY STACK GAS

MWD = (PCO2*.44)+(PO2*.32)+(PN2+PCO)*.28

MWD = (0.0 *44/100)+(20.8*32/100)+((79.2+0.0)* 28/100 =28.83

MOLECULAR WEIGHT OF STACK GAS

MW = MWD*MD + 18*(1-MD)
MW = 28.83*0.980 + 18*(1-0.980) = 28.61

STACK GAS VELOCITY AT STACK CONDITIONS

VS = 85.49*CP*SQRT((DPS*(TS+460))/(PS*MW))

VS = 85.49*0.840*SQRT(1.042* 525.)*SQRT(1/(29.81*28.61)) = 57.5 FPS

STACK GAS VOLUMETRIC FLOW AT DRY STANDARD CONDITIONS

QS = (1058.*VS*AS*MD*PS)/(TS+460)

QS = 1058.0* 57.5* 0.[illegible]*.980*29.81 / 525.0 = 2640. DSCFM

STACK GAS VOLUMETRIC FLOW AT STACK CONDITIONS

QA = VS*AS*60

QA = 57.51504 * .7854000 * 60 = 2710.339 ACFM

PERCENT ISOKINETIC

PERI = 1.667*(TS+460)*((.002670*VW)+(VM*(PB+PM/13.6)/(TM+460)) / VS*TT*PS*MD*AN*.005454

PERI = 1.667*(65.000 +460)*((.002670* 34.100) + (82.353 / 102.50 + 460 * (29.840 + 1.6000 / 13.6))) / 57.515 * 120.00 * 29.804 * .[illegible] * .[illegible] * [illegible] = 97.763 %

SL 025731

84 PV-1

D:39

FIELD SAMPLING DATA

PB 29.69

PPG INDUSTRIES

PLANT & LOCATION: Lake Charles Hydrogen System

ASSUMED: % H_2O ____ ; T_s, °F ____

Ps, in. WG ____

DATE: 12/13/84 TEST NO.: 84 PV-1

LEAK CHECKS

EQUIP.: MFG. RAC METER BOX NO. B-3

INITIAL ½ FINAL

Y_D 0.9801 Δ H@: N/A SAMP. BOX NO. B-2 TRAIN: .001@15" .002@7"

OPERATOR AK / WH

PITOT: IMP. — X" —

PITOBE: NO. N/A TYPE ____ C_p ____

WAKE — — —

NOZZLE: NO. — ID, in. — Ft^2 —

FIELD METER CHECK

STACK: DIMENSIONS ____, AREA ____ Ft^2

K or Δ P REF.: ____ C FACTOR ____

Plant ____ Test No. ____ Date ____

05:54 Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H_2O	$\sqrt{\Delta P}$	Orifice Δ H in H_2O	Dry Gas Temp., °F In	Dry Gas Temp., °F Out	Pump Vacuum in. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
East Bed	0	029.212			0.15	70	70	3				
	10	034.330			0.10	74	72	3				
	20	040.050			0.09	78	74	3				
	30	045.780			0.09	79	76	3				
	40	051.530			0.09	80	77	3				
sampling system purged & ready to start @ 07:54	50	57.258			0.09	86	78	3				
	60	062.950			0.09	80	78	3				
	70	68.680			0.09	78	78	3				
	80	74.385			0.09	80	79	3				
	90	80.100			0.09	79	78	3				
	100	85.810			0.09	79	79	3				
	110	91.510			0.09	78	78	3				
off 07:54	120	97.198				77	53	2				

V_m = 67.986 × 0.9801 = 66.663

V_{ms} = (17.647)(66.663)(29.20 / 532) = 65.064 dscf

65.897 total

SL 025732

H_2O = 0.04707 × 17.7 = 0.833 scf

%H_2O = 0.833 / (66.663 + 0.833) × 100 = 1.26 (MF = 0.987)

FIELD DATA

D:40

Plant_____ Test No._____ Date_____

Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H2O	√Δ P	Orifice Δ H in H2O	Dry Gas Temp., °F Avg.	Pump Vacuum In. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H2O	Stack Temp. °F

Vm = _____ Ft³

x Yd_____

= _____ Ft³(Dry)

$\bar{x}\sqrt{\Delta P}$ = _____

$(\bar{x}\sqrt{\Delta P})^2$ _____

$\bar{x}$ Pm = _____ "WC

$\bar{x}$ Pm = _____ "Hg

Pm abs = _____ "Hg

$\bar{x}$ Ps = _____ "WC

$\bar{x}$ Ps = _____ "Hg

Ps abs = _____ "Hg

Additional Comments:

$\bar{x}$ Ts = _____ °F

$\bar{x}$ Ts = _____ °R

SL 025733

84 PV-1

D:41

PPG INDUSTRIES

PARTICULATE DATA SHEET

Date 12/13/84 Test No. 84 PV-1 Plant Lake Charles, H2 Syn

Impinger #1	563.9 g	Impinger #2	629.7 g	Impinger #3	560.5 g
	560.5 g		629.5 g		560.5 g
	3.4 g		0.2 g		g

Silica gel No. ____ 681.1 g; 667.0 g; 14.1 g Total H_2O 17.7

100 ml 0.1 M HCl in impingers 1, 2, 3

Filter No. _____ Bottle No. _____ Blank No. _____ Bottle No. _____

				Date	Time	Rel. Hum.	Analyst
Gross filter wt.	mg	Gross blk wt.	mg	12/13/84	0811		Wayne Miller
	mg		mg				
Avg. gross wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg	12/11/84	1100		J Gle
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate on filter _____ mg

Acetone Wash Beaker No. _____ Mls used _____ Blank Beaker No. _____ Mls used _____

				Date	Time	Rel. Hum.	Analyst
Gross wash wt.	mg	Gross blk wt.	mg				
	mg		mg				
Avg. gross wt.	mg	Avg. gross wt.	mg				
Tare wt.	mg	Tare wt.	mg				
Particulate wt.	mg	Blank wt.	mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate in wash _____ mg

Total particulate on filter _____ mg
Total particulate in acetone wash _____ mg
Total particulate _____ mg
Total H_2O _____ ml

REMARKS:

Impingers plus washings → 1 l for analysis

SL 025734

8" PV-2

D:42

FIELD SAMPLING DATA

PPG INDUSTRIES

PLANT & LOCATION: Lake Charles Hydrogen System

ASSUMED: % H_2O Lb 29.70 ; T_s, °F

P_m, in. WG

DATE: 12/13/84 TEST NO.: 84 PV-2

LEAK CHECKS

EQUIP.: MFG. RAC METER BOX NO. B-3

INITIAL ½ FINAL

Y_D 0.9801 Δ H@: — SAMP. BOX NO. B-1

TRAIN: .002 @19" .0010 7"

OPERATOR LK/WH

PITOT: IMP. ____ ____ ____

PITOBE: NO. — TYPE — C_p —

WAKE ____ ____ ____

NOZZLE: NO. — ID, in. — Ft^2 —

FIELD METER CHECK

STACK: DIMENSIONS —, AREA — Ft^2

K r Δ P REF.: C FACTOR

Plant Test No. Date

Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H_2O	$\sqrt{\Delta P}$	Orifice Δ H in H_2O	Dry Gas Temp., °F Ave.	Pump Vacuum in. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
12:53	0	97458			0.10	71 72	3				
? a. Bad	10	102.948			0.08	76 74	3				
5 min. sample 1 min purge	20	108.599			0.07	80 77	3				
	30	114.215			0.07	82 79	3				
	40	119.826			0.07	82 80	3				
	50	125.455			0.07	83 81	3				
	60	131.075			0.07	83 82	3				
	70	136.694			0.07	83 82	3				
	80	142.330			0.07	84 83	3				
	90	147.952			0.07	84 83	3				
	100	153.585			0.07	84 83	3				
14:53	110	159.212			0.07	84 83	3				
	120	164868				X 80.6 °F/540.6 °R					
	V_m = 67.410 X 0.9801 = 66.069										
	V_{mstd} = (17.647)(66.069)(29.71/540.6) = 64.076										
	V_{wstd} = 0.04707 X 20.6 = 0.970										
	%H_2O = 0.970 /					X 100					

SL 025735

FIELD DATA

D:43

Plant_____ Test No._____ Date_____

Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H2O	√Δ P	Orifice Δ H in H2O	Dry Gas Temp., °F Avg.	Pump Vacuum in. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H2O	Stack Temp. °F

Vm = _____ Ft³

x Yd_____

= _____ Ft³(Dry)

$\bar{x}\sqrt{\Delta P}$= _____

$(\bar{x}\sqrt{\Delta P})^2$_____

$\bar{x}$ Pm = _____ "WG

$\bar{x}$ Pm = _____ "Hg

Pm abs.= _____ "Hg

$\bar{x}$ Ps = _____ "WG

$\bar{x}$ Ps = _____ "Hg

Ps abs.= _____ "Hg

Additional Comments:

SL 025736

$\bar{x}$ Ts = _____ °F

$\bar{x}$ Ts = _____ °R

8/4 PV-2

D:44

PARTICULATE DATA SHEET

INDUSTRIES

Date 12/13/84 Test No. 84/PV-2 Plant Lake Charles H2 System

Impinger #1	567.3 g	Impinger #2	631.0 g	Impinger #3	561.5 g
	561.3 g		630.4 g		560.9 g
	6.0 g		0.6 g		0.6 g

Silica g No. ____ 1 694.5 g
691.1 g
13.4 g

Total H_2O 20.6

100 ml 0.1 M ICl in impingers 1, 2, 3

Filter No. _____ Bottle No. _____ Blank No. _____ Bottle No. _____

				Date	Time	Rel. Hum.	Analyst
Gross filter wt.	_____ mg	Gross blk wt.	_____ mg	12/13/84	1510	_____	_____
	_____ mg		_____ mg	_____	_____	_____	_____
Avg. gross wt.	_____ mg	Avg. gross wt.	_____ mg				
Tare wt.	_____ mg	Tare wt.	_____ mg	12/17/84	_____	_____	Wayne Nelson
Particulate wt.	_____ mg	Blank wt.	_____ mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate on filter _____ mg

Acetone Wash Beaker No. _____ Mls used _____ Blank Beaker No. _____ Mls used _____

				Date	Time	Rel. Hum.	Analyst
Gross wash wt.	_____ mg	Gross blk wt.	_____ mg	_____	_____	_____	_____
	_____ mg		_____ mg	_____	_____	_____	_____
Avg. gross wt.	_____ mg	Avg. gross wt.	_____ mg				
Tare wt.	_____ mg	Tare wt.	_____ mg	_____	_____	_____	_____
Particulate wt.	_____ mg	Blank wt.	_____ mg				

Particulate wt. _____ mg
Blank wt. _____ mg
Weight of particulate in wash _____ mg

Total particulate on filter _____ mg
Total particulate in acetone wash _____ mg
Total particulate _____ mg
Total H_2O _____ ml

REMARKS:

Impingers plus washings → 1 l for analysis

84 PV-3

D:45

FIELD SAMPLING DATA

PB 29.79

PPG INDUSTRIES

PLANT & LOCATION: Lake Charles Hydrogen System

ASSUMED: % H_2O _____ ; T_s, °F _____

Pm, in. WG _____

DATE: 12/3/84-1 TEST NO.: 84 PV-3

LEAK CHECKS

EQUIP.: MFG. DAC METER BOX NO. B-3

INITIAL ½ FINAL

Y_D 0.9801 Δ H@: N/A SAMP. BOX NO. B-1

TRAIN: 002 @ 20" _____

OPERATOR LAK/W.Hebert/TC

~~PITOT. IMP.~~ train .001 @ 6" Final

PITOBE: NO. — TYPE — C_P —

WAKE _____ _____ _____

NOZZLE: NO. — ID, in. — Ft^2 —

FIELD METER CHECK

STACK: DIMENSIONS —, AREA — Ft^2

_____

K or Δ P REF.: _____ C FACTOR _____

_____

Plant _____ Test No. _____ Date _____

Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P, in. H_2O	$\sqrt{\Delta P}$	Orifice H in H_2O	Dry Gas Temp., °F Ave.	Pump Vacuum In. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H_2O	Stack Temp. °F
19:53	0	165.063	0.1			70 71	2				
Cont Bal	10	171.378	0.09			76 73	2				
	20	177.720	0.09			78 76	2				
	30	184.015	0.09			80 77	2				
	40	190.320	0.08			81 79	2				
15 min Sample Line Purge	50	196.615	0.09			82 80	2				
	60	202.910	0.09			83 80	2				
	70	209.245	0.09			83 81	2				
	80	215.500	0.09			83 81	2				
	90	221.814	0.09			83 81	2				
	100	228.118	0.09			83 82	2				
	110	234.420	0.09			84 82	2				
21:53	120	240.736				X 79.5 °F / 539.5 °R					

V_m = 75.673 × .9801 = 74.167

V_{ms} = (17.64) (74.167) (539.5 / 539.5) = 72.295 dscf

H_2O = 0.04707 × 22.6 = 1.064 scf

93.359 total

%H = 1.064 / (72.295 + 1.064) × 100 = 1.45

(MFDC 0.985)

SL 025738

FIELD DATA

D:46

Plant_____ Test No._____ Date_____

Comments	Clock Time	Dry Gas Meter, CF	Pitot Δ P in. H2O	√Δ P	Orifice Δ H in H2O	Dry Gas Temp., °F Avg.	Pump Vacuum in. Hg Gauge	Filter Temp. °F	Impinger Temp. °F	Stack Press. in H2O	Stack Temp. °F

Vm = _____ Ft³

x Yd_____

= _____ Ft³(Dry)

$\bar{x}\sqrt{\Delta P}$= _____

$(\bar{x}\sqrt{\Delta P})^2$_____

$\bar{x}$ Pm = _____ "WG

$\bar{x}$ Pm = _____ "Hg

Pm abs.= _____ "Hg

$\bar{x}$ Ps = _____ "WG

$\bar{x}$ Ps = _____ "Hg

Ps abs.= _____ "Hg

Additional Comments:

SL 025739

$\bar{x}$ Ts = _____ °F

$\bar{x}$ Ts = _____ °R

84 PV-3

D:47

EPA INDUSTRIES

PARTICULATE DATA SHEET

Date 12/13/84 Test No. 84 PV-3 Plant Lake Charles A2 System

Impinger #1	568.4 g	Impinger #2	629.5 g	Impinger #3	560.16 g
	560.8 g		629.6 g		560.4 g
	7.6 g		-.1 g		0.12 g

Silica gel No. ____ 683.9 g
669.0 g
14.9 g

Total H_2O 22.6

Filter No. _____ Bottle No. _____ Blank No. _____ Bottle No. _____

				Date	Time	Rel. Hum.	Analyst
Gross filter wt.	____ mg	Gross blk wt.	____ mg	12/14/84	0:20		TCK
	____ mg		____ mg				
Avg. gross wt.	____ mg	Avg. gross wt.	____ mg				
Tare wt.	____ mg	Tare wt.	____ mg	12/13/84	1530		TGH
Particulate wt.	____ mg	Blank wt.	____ mg				

Particulate wt. ____ mg
Blank wt. ____ mg
Weight of particulate on filter ____ mg

Acetone Wash Beaker No. _____ Mls used _____ Blank Beaker No. _____ Mls used _____

				Date	Time	Rel. Hum.	Analyst
Gross wash wt.	____ mg	Gross blk wt.	____ mg				
	____ mg		____ mg				
Avg. gross wt.	____ mg	Avg. gross wt.	____ mg				
Tare wt.	____ mg	Tare wt.	____ mg				
Particulate wt.	____ mg	Blank wt.	____ mg				

Particulate wt. ____ mg
Blank wt. ____ mg
Weight of particulate in wash ____ mg

Total particulate on filter ____ mg
Total particulate in acetone wash ____ mg
Total particulate ____ mg
T tal H_2O ____ ml

REMARKS:

Sample plus washings → 1 l for analysis

SL 025740

APPENDIX E

Analytical QA and Results, Emission Calculations and Chain of Custody

E:49

CHEMICALS PPG INDUSTRIES INTEROFFICE / LAKE CHARLES

TO L. A. Kuryla DATE Dec. 20, 1984

FROM M. G. Carver MC. SUBJECT Hg Analyses

Attached are the results from the analyses of the samples obtained while stack sampling the Mercury Cell End Box (EB) Stack and the Purasieve (PURA) Unit.

Also included is the calibration curve data and spiked recov ry analyses.

If you have any questions concerning these data, please call.

ce

Attachments

cc: M. W. Wood
W. H. Cooper
H. J. Hoenes
K. S. Komoroski

SL 025742

MERCURY ANALYSES DATA FROM
DECEMBER 12 & 13

E:50

STANDARDIZATION

Hg (actual) (ug)	Hg (analyzed) (ug)
1.0	0.89
0.80	0.68
0.60	0.55
0.40	0.38
0.20	0.18
0.00	0.00

SPIKED RECOVERY DATA

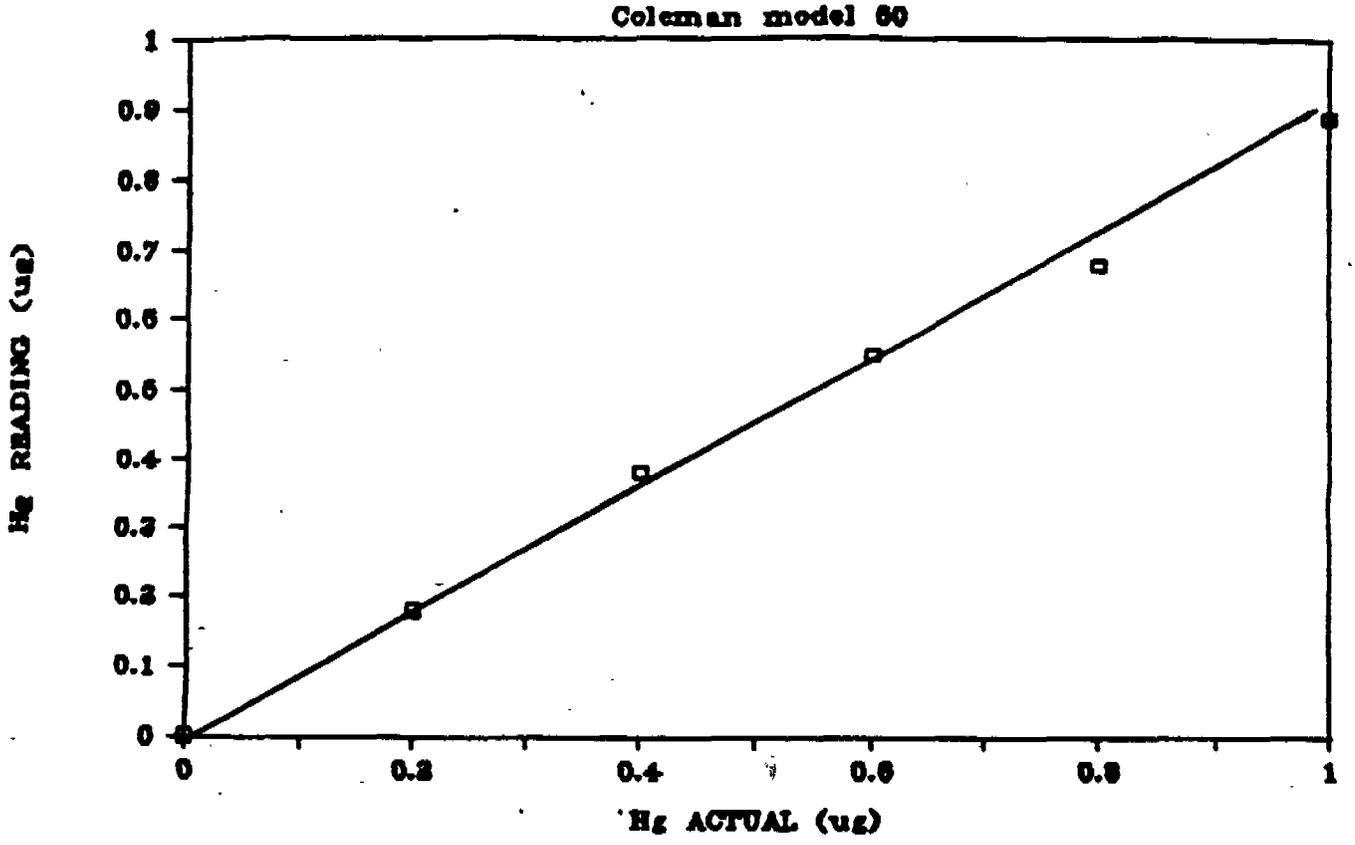
Sample	Hg spiked (ug)	Hg rec. (ug)	% rec
PURA-2	0.88	0.88	100
EB-2	1.02	0.97	95.1
BLANK	0.00	0.00	--

SAMPLE ANALYSES DATA

RUN ID	Hg (ug)
PURA-1	< 125
PURA-2	< 125
PURA-3	1450
EB-1	525
EB-2	1450
EB-3	525

E:51

ACTUAL –VS– INSTRUMENT RDING



SL 025744

BARBERTON TECHNICAL CENTER End Box Barberton, Ohio

Mercury Emission Rate Calculations
(Eq. 101A-1, 40 CFR 61, Appx B)

84 EB-1

$$R = \frac{(17.647)(525\,mg)(57.5)(0.7854)(86{,}400^{E-06})}{[77.379 + 1.605]\left(\frac{525}{29.81}\right)} = 25.98\ g/day$$

84 EB-2

$$R = \frac{(17.647)(1450\,mg)(57.4)(0.7854)(86{,}400^{E-06})}{[77.180 + 1.511]\left(\frac{525}{29.76}\right)} = 71.80\ g/day$$

84 EB-3

$$R = \frac{(17.647)(525)(56.3)(0.7854)(86{,}400^{E-06})}{[74.562 + 1.407]\left(\frac{524}{29.67}\right)} = 26.38\ g/day$$

$$\bar{X}R = 41.4\ g/day$$

SL 025745

Form C-38-918 Rev. 3/15/71

E:53

Hydrogen System (Purity)

BARBERTON TECHNICAL CENTER Barberton, Ohio

Mercury Emissions Rate Calculations

84 PV-1, Exit, 05:54-07:54, 12/13/84

H_2 flow rate @ 70° = $6.079^{E06} \times \frac{528}{530} = 6.056^{E06}$ SCF_{68}°/Day

Hg conc. $\frac{< 1.25^{E-04}\ g}{65.897\ scf} = \leq 1.897^{E-06}$ g/scf

$R = \leq 1.897^{E-06} \times 6.056^{E06} = \leq 11.49$ g/Day

84 PV-2, Exit, 12:53-14:53, 12/13/84

H_2 flow rate @ 70° = $6.915^{E06} \times \frac{528}{530} = 6.889^{E06}$ SCF_{68}°/Day

Hg conc. $\frac{< 1.25^{E-04}\ g}{65.046\ scf} = \leq 1.922^{E-06}$ g/scf

$R = \leq 1.922^{E-06} \times 6.889^{E06} = \leq 13.24$ g/Day

84 PV-3, Exit, 19:53-21:53, 12/12/84

H_2 flow rate @ 70° = $7.119^{E06} \frac{528}{530} = 7.092^{E06}$ SCF_{68}°/Day

Hg conc. $\frac{< 1.45^{E-03}\ g}{73.359\ scf} = 1.977^{E-05}$ g/scf

$R = 1.977^{E-05} \times 7.092^{E06} = 140.18$ g/Day

SL 025746

CHAIN OF CUSTC RECORD

OJ. NO. 1/a

PROJECT NAME Lake Charles Mercury Comprehensive

LERS: (Signature)
Kuegle

NO.	DATE	TIME	GRAB	COMP	STATION LOCATION	NO. OF CONTAINERS	Turbine Hall Sample Time Clean up	REMARKS
	12/6/84	1130	✓		End Box Stack	1	✓	Sample 84 EB-1
	12/12/84	16:44	✓		" " "	1	✓	Sample 84 EB-2
	12/13/84	0811	✓		Hr System	1	✓	Sample 84 PV-1
	12/13/84	10:45	✓		End Box Stack	1	✓	Sample 84 EB-3
	12/13/84	15:10	✓		Hr System	1	✓	Sample 84 PV-2
	12/13/84	22:20	✓		Hr System	1	✓	Sample 84 PV-3
								All Samples for Hg analysis - Blanks will be Prepared by W Hebert

uished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
n G Kuegle	12/13/84 22:20	Wayne P. Hebert 12-13-84 2220			
uished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
uished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

SL 025747

E:54

APPENDIX F

Sampling QA

CALIBRATIONS & QUALITY ASSURANCE

GENERAL

All measuring equipment PPG uses is initially calibrated before use. Equipment which can change calibration is both checked upon return from each field use and is also periodically recalibrated in full. When an instrument is found out of calibration, it is so noted in the report and appropriate adjustments are made t the final results. The equipment is then repaired and recalibrated or retired as needed. Specific equipment is handled as follows:

PITOT TUBE

All pitot tubes used by PPG, whether separate or attached to a sampling probe, are calibrated using EPA geometry standards. In general, if a type "S" pitot tube is assembled correctly, and positioned properly in relation to the probe nozzle, it will have an average Cp of 0.84. As long as it is not damaged, it should not change its calibration. The recalibration schedule for pitot tubes is related to the physical condition and usage of the pitot tube, not a fixed time schedule. Pitot tubes are calibrated before each field use.

DRY GAS METER AND ORIFICE METER

All PPG meter boxes are calibrated upon purchase and at least once every six months against a secondary test meter (one calibrated against a wet test meter) according to their usage history. Basic procedures are outlined in the EPA Publication No. APTD-0576. The only differences are in the choice of flow rates used and the volumes metered at each flow rate. After each field use, quick checks are performed to insure all changes of less than 2%. These checks compare the orifice against the dry gas meter. If greater than 2% changes occur, recalibration and repair are instituted. EPA and PPG Method 5 audit orifices are also used in the field or at the laboratory.

NOZZLES

Each nozzle is calibrated upon purchase, and thereafter whenever it becomes apparent that the nozzle has become damaged. Each nozzle is inspected upon return to laboratory from each field use. The diameter is measured on four different axes, with the high and low readings differing by no more than 0.004 inches as a tolerance.

TEMPERATURE MEASURING INSTRUMENTS

After each field use, the thermocouples or thermometers are calibrated against an ASTM precision mercury-in-glass thermometer across a wide range of temperatures. If the initial reading is not within ±1.5% of the absolute temperature reading of the standard thermometer, the instrument is adjusted until it is in the acceptable range.

MAGNEHELIC GAUGES

After each field use, each magnehelic gauge is calibrated against an inclined manometer at three different settings (low, medium, high) over the range of the individual gauges. If the readings differ more than ±5% from the monometer readings, the magnehelics are recalibrated.

BAROMETER

After each field use, each barometer is checked against a mercury barometer.

SOURCE ANALYSIS

PPG Industries, Barberton Technical Center, actively participates in the EPA quality assurance audit program, i.e., Methods 3, 5, 6, & 7.

INTER-LABORATORY STUDY RESULTS

DATE PRINTED: 12/06/84

(JUNE 1984)

POLLUTANT - BCM

127009
MR. LYNN A. RUBYLE
PPG INDUSTRIES INC.
P. O. BOX 31
BARBERTON, OH 44203

UNITS - CUBIC METERS

SITE - 004 b-4 (and mean)

SAMPLE NUMBER	REPORTED VALUE	EPA VALUE	PERCENT DIFFERENCE
214	0.2619	0.2613	.2
214	0.2611	0.2614	-.1
214	0.2614	0.2614	-.1

Note: B-4 not used between audit and CCH testing

SL 025751

INTER-LABORATORY STUDY RESULTS DATE PRINTED: 12/06/84

(JUNE 1984)

POLLUTANT - BOD

127009
MR. LYNN A. KURTZ
PPG INDUSTRIES INC.
P. O. BOX 31
BARBERTON, OH 44203

UNITS - CUBIC METERS

(RAC).

B-3

SITE - 003

SPECIFIC PROCESS	RECORDED VALUE	ERA VALUE	PERCENT DIFFERENCE
214	0.259e	0.269	-.7
214	0.259e	0.269	-.8
214	0.259e	0.269	-.8

Note: B-3 not used between audit and LCH -ity testing

SL 025752

SL 025753

DATE: 2/14/83 CALIBRATION METER IDENTIFICATION: Rockwell 190-5 S/N 29043 Y = .9962

METER BOX IDENTIFICATION: 0-3 S/N 1536 BAROMETRIC PRESSURE (P_b): 28.91 → 28.89 in. Hg

APPROXIMATE FLOW RATE (Q) cfm	ORIFICE READING (ΔH) in. H_2O	CALIBRATION METER GAS VOLUME (V_{d_1}) ft^3	METER BOX METER GAS VOLUME (V_d) ft^3	TEMPERATURE: CALIBRATION METER INLET ($t_{d_{1i}}$) °F	CALIBRATION METER OUTLET ($t_{d_{1o}}$) °F	CALIBRATION METER AVERAGE ($\bar{t}_{d_1}$) °F	METER BOX METER INLET (t_{di}) °F	METER BOX METER OUTLET (t_{do}) °F	METER BOX METER AVERAGE ($\bar{t}_d$) °F	TIME (θ) min.	METER BOX METER COEFFICIENT (Y_d)	($\Delta H@$)
.41	0.5	4.074	4.197	76.3	75.7	76			84	10.00	.9802	1.76
.53	0.9	5.346	5.568	77	76	76.5			90.3	10.00	.9788	1.82
.68	1.5	6.813	7.163	77	76.7	76.8			96	10.00	.9777	1.85
.87	2.5	8.694	9.171	78	77	77.5			100.3	10.00	.9782	1.88
1.02	3.5	10.231	10.764	78	77.7	77.8			104.7	10.00	.9855	1.89
										$\bar{Y}$ =	.9801	1.84

Leak ✓ OK

2/14/83 D.J. Clinton

$$\Delta H@ = \frac{0.0317\,\Delta H}{P_b\,(\bar{t}_d + 460)(\theta)}\left[\frac{(\bar{t}_{d_1} + 460)(\theta)}{V_{d_1}(Y_1)}\right]^2$$

$$Y_d = Y_{d_1}\frac{V_{d_1}}{V_d}\cdot\frac{(\bar{t}_d + 460)}{(\bar{t}_{d_1} + 460)}\cdot\frac{P_b}{\left(P_b + \frac{\Delta H}{13.6}\right)}$$

WHERE: $\Delta H@$ = ORIFICE PRESSURE DIFFERENTIAL THAT GIVES 0.75 cfm OF AIR AT 70° F AND 29.92 inches OF MERCURY, in. H_2O.
TOLERANCE = ± 0.15

B-4

Ambient 73°F

Y_{ds} 0.9888

-.118

Anderson Rockwell 29043 Control Unit - 1/83

25.142 "H

DATE: 12 Jan 84

CALIBRATION METER IDENTIFICATION:

METER BOX IDENTIFICATION: Anderson (B-4) S/N 783-184

BAROMETRIC PRESSURE (P_b): 29.142 in. Hg

APPROXIMATE FLOW RATE (Q) cfm	ORIFICE READING (ΔH) in. H_2O	CALIBRATION METER GAS VOLUME (V_{dc}) ft^3	METER BOX METER GAS VOLUME (V_d) ft^3	TEMPERATURE: CALIBRATION METER INLET (t_{dci}) °F	CALIBRATION METER OUTLET (t_{dco}) °F	CALIBRATION METER AVERAGE (T_{dc}) °R	METER BOX METER INLET (t_{di}) °F	METER BOX METER OUTLET (t_{do}) °F	METER BOX METER AVERAGE (T_d) °R	TIME (θ) min.	METER BOX METER COEFFICIENT (Y_d)	$\Delta H@$
0.39	0.5	4.007	4.227			535			553.2	10.134	0.9680	1.85
0.54	1.0	5.435	5.766			535			560.9	10.032	0.9747	1.95
0.64	1.5	6.513	6.942			535.5			560.9	10.016	0.9680	2.03
0.74	2.0	7.450	7.962			535.5			564.8	10.009	0.9703	2.05
0.82	2.5	8.359	8.966			536			566.4	10.033	0.9680	2.05
0.90	3.0	9.165	9.918			536			567.3	10.053	0.9696	2.05

$\bar{X}$ 0.9698 $\bar{X}$ 2.00

σ 0.0026 σ 0.082

$$\Delta H@ = \frac{0.0319}{P_b\,(T_d + 460)} \left[\frac{T_{dc} + 460}{V_{dc}\,(Y_d)} \right]^2$$

$$Y_d = Y_{dc} \frac{V_{dc}}{V_d} \cdot \frac{(T_d + 460)}{(T_{dc} + 460)} \cdot \frac{P_b}{\left(P_b + \frac{\Delta H}{13.6}\right)}$$

WHERE: $\Delta H@$ = ORIFICE PRESSURE DIFFERENTIAL THAT GIVES 0.75 cfm OF AIR AT 68° F AND 29.92 inches OF MERCURY, in. H_2O.
TOLERANCE = ± 0.15

Figure 4. Example data sheet for calibration of meter box gas meter against a calibration dry gas meter (English units).

Comments: Anderson's Control unit calibration is attached - however the metering system was found to be leaking upon receipt of the unit.

J. G. Kunkle 1/17/84

SL 025754

Dedicated DGM 5 Point Spirometer

Meter Box Identification B-4 SN 783-184 Calibrated by: Anderson Date: 11-83

Calibration Meter Identification SS-29043 Yds = 0.9888

Calibrated by: M. Hogan Date: 1-2-85 Barometric Pressure (P_b): 29.31 in Hg

Approximate Flow Rate (Q) cfm	Orifice Reading (ΔH) in H_2O	Calibration Meter Gas Volume (V_{ds}) ft^3 (Y_d ..9888)	Meter Box Meter Gas Volume (V_d) ft^3	Temperature: Calibration Meter Inlet (t_{ds1}) °F	Calibration Meter Outlet (t_{dso}) °F	Calibration Meter Average (t_{ds}) °F	Meter Box Meter Inlet (t_{d1}) °F	Meter Box Meter Outlet (t_{do}) °F	Meter Box Meter Average (t_d) °F	Time (Q) min.	Meter Box Meter Coefficient Y_d	($\Delta H@$)
	0.5	5.900	4.166	74	74	75	104	82	93	10	0.9734	1.85
	0.5	5.908	4.187	74	76	75	107	84	97	10	0.9740	1.82
	1.0	6.368	5.917	75	77	76	116	94	105	10	0.9705	1.92
	1.0	5.367	5.007	74	77	76	117	96	107	10	0.9702	1.91
	1.5	6.431	7.015	74	77	76	126	99	113	10	0.9748	1.98
	1.5	6.413	7.004	74	77	76	129	100	115	10	0.9705	1.98
	2.0	7.364	8.088	74	77	76	130	102	116	10	0.9748	1.53
	2.0	7.367	8.091	74	77	76	130	102	116	10	0.9775	1.58
	2.5	8.324	9.130	76	77	76	125	90	107	10	0.9810	1.59
	2.5	8.317	9.121	75	77	76	126	95	111	10	0.9793	1.58
	3.0	9.018	9.838	75	77	76	125	99	112	10	0.9730	2.01
	3.0	9.024	9.846	75	77	76	125	100	113	10	0.9727	2.01

$\bar{X}$ = 0.9750 $\bar{X}$ = 1.95

$$\Delta H@ = \frac{0.0317\,\Delta H}{P_b(t_d + 460)}\left(\frac{(t_{ds} + 460)0}{V_{ds}(Yds)}\right)^2 \qquad Y_d = Y_{ds}\,\frac{V_{ds}}{V_d}\cdot\frac{(t_d + 460)}{(t_{ds} + 460)}\cdot\frac{P_b}{(P_b + \frac{\Delta H}{13.6})}$$

M. Hogan
1-2-85

WHERE: $\Delta H@$ = Orifice Pressure Differential that gives 0.75 cfm of air at 70°F and 29.92" of mercury, in H_2O. Tolerance ±0.15

SL 025755

F:60

Dedicated DGM 5 Point Spirometer

Meter Box Identification B-3

Calibrated by: M. Hogan Date: 1-23-85

Calibrated by: Anderson Date: 11-83

Calibration Meter Identification 29043 Yds = 0.9888

Barometric Pressure (P_b): 29.31 in Hg

29.39 (8-7-85)

Approximate Flow Rate (Q) cfm	Orifice Reading (ΔH) in H_2O	Calibration Meter Gas Volume (V_{ds}) ft³ Y_{ds} 0.9888	Meter Box Meter Gas Volume (V_d) ft³	Temperature: Calibration Meter Inlet (t_{dsi}) °F	Calibration Meter Outlet (t_{dso}) °F	Calibration Meter Average (t_{ds}) °F	Meter Box Meter Inlet (t_{di}) °F	Meter Box Meter Outlet (t_{do}) °F	Meter Box Meter Average (t_d) °F	Time (θ) min.	Meter Box Meter Coefficient Y_d	(ΔHθ)
	0.5	3.951	4.134	74	76	75	97	89	93	10	0.9847	1.80
	0.5	4.030	4.182	74	77	76	101	91	96	10	0.9841	1.74
	1.0	5.581	5.783	74	77	76	105	94	100	10	0.9853	1.79
	1.0	5.818	6.026	74	77	76	108	96	102	10	0.9827	1.83
	1.5	6.761	7.004	74	77	76	110	98	104	10	0.9845	1.82
	1.5	6.984	7.235	74	77	76	114	100	107	10	0.9926	1.80
	2.0	7.785	8.131	74	77	76	115	101	108	10	0.9905	1.85
	2.0	7.757	8.160	70	75	73	109	94	101	10	0.9874	1.82
	2.5	8.558	8.613	71	74	73	112	98	105	10	1.0403	1.84
	2.5	8.574	8.668	71	74	73	112	98	105	10	0.9560	1.84
	3.0	9.425	9.589	71	74	73	113	99	106	10	1.0105	1.84
	3.0	9.187	9.630	71	74	73	115	98	107	10	0.9548	1.93

SL 025756

1-2-85 Pbar 29.34

$\bar{X}$ = 0.9915 $\bar{\Delta H\theta}$ = 1.83

$$\Delta H\theta = \frac{0.0317\,\Delta H}{P_b(t_d + 460)}\left(\frac{(t_{ds} + 460)\theta}{V_{ds}(Yds)}\right)^2 \qquad Y_d = Y_{ds}\,\frac{V_{ds}}{V_d}\cdot\frac{(t_d + 460)}{(t_{ds} + 460)}\cdot\frac{P_b}{(P_b + \frac{\Delta H}{13.6})}$$

WHERE: ΔHθ = Orifice Pressure Differential that gives 0.75 cfm of air at 70°F and 29.92" of mercury, in H_2O.
Tolerance ±0.15

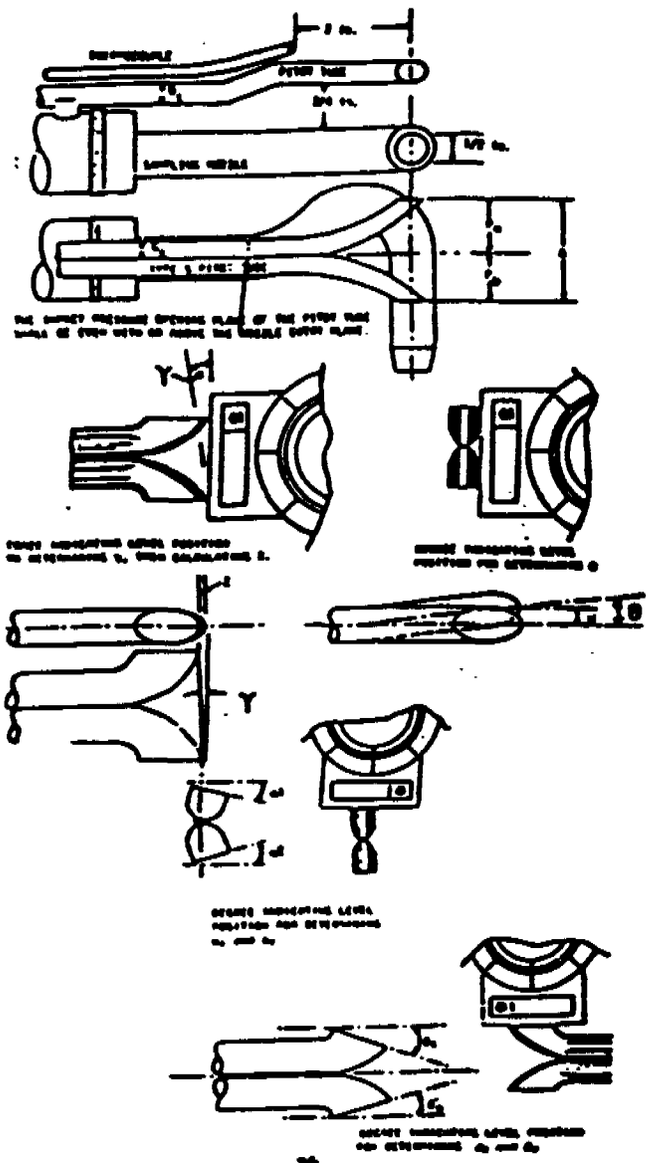
M. Hogan
1-3-85

PITOT TUBE INSPECTION DATA SHEET

Company Name: PPG Industries

Pre-sample Date 11/26/84

Post Sample Date 1-3-85



YES	level?	Yes
NO	obstructions?	No
NO *	damaged?	No
4°	$-10° < \alpha_1 < +10°$	3°
1°	$-10° < \alpha_2 < +10°$	0°
0°	$-5° < \beta_1 < +5°$	0°
2°	$-5° < \beta_2 < +5°$	1°
0°	γ	0°
1°	θ	0°
0.815	A	0.811
0.40	$1.05\ D_t < P_a < 1.5\ D_t$	0.40
0.42	$1.05\ D_t < P_b < 1.5\ D_t$	0.411
.375	$3/16" \leq D_t \leq 3/8"$	0.375
0	$A \tan \gamma < 0.125"$	0
0.014	$A \tan \theta < 0.03125"$	0
YES	$P_a = P_b \pm 0.063"$	Yes

Comments: * SLIGHT BURR ON STATIC SIDE OF TUBE OPENING, FILED TO SMOOTHNESS

Pitot tube/probe number 16 meets or exceeds all specifications criteria and/or applicable design features* and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Thomas F Gole

Date 11/27/84

*See 40 CFR 60, Vol. 42, No. 160, Method 2. Verify the minimum inch setback of the thermocouple and the minimum 3/4 inch duration between the pitot tube and the nozzle as shown at the top of this page.

M. Hogan 1-3-85