AP42 Section:	10.7
Related:	2
Title:	Royal Oak Enterprises, Inc. Kenbridge, VA Missouri type charcoal Kiln #5. Proposed Emissions Test Plan. December 10, 1997 Royal Oak Enterprises, Inc. Kenbridge, VA Missouri type charcoal Kiln #5. Emissions Test Summary Report. March 16, 1998 Source Emissions Report prepared for Shell Engineering and Assoc. Inc, regarding Charcoal Kiln #5 at Roayl Oak Enterprises. Feb 1998 *New source test information post 1995 supplement.*

FAX TRANSMISSION

TO: Ron Ryan

FROM: Richard Marinshaw
Midwest Research Institute
401 Harrison Oaks Boulevard, Suite 350
Cary, North Carolina 27513
(919) 677-0249, Ext. 5359
FAX: 919-677-0065

Dallas
here's copy of response on charcoal. Looks fine to me. Are you satisfied? or coffee?
Ron 4-3-96

DATE: April 1, 1996

RECEIVING FAX NUMBER: 541-0684

SENDING FAX NUMBER: 919-677-0065

THIS FAX CONSISTS OF 5 PAGES (INCLUDING THIS PAGE)

In response to your 3/26/96 memorandum to Dallas Safriet regarding the FIRE entries for charcoal, the following paragraphs should help to resolve your questions:

Total PM

The emission factors were reported as "total PM" rather than as "filterable PM" because the factors are based on a combination of two mass balances and an emission test in which both the front and back half fractions of a modified Method 5 train were combined. Therefore, the factors represent both filterable and condensible PM.

POM

The emission factors on Table 10.7-2 of the revised AP-42 section were inadvertently left out of the information that Brian Shrager provided to Dallas. That table includes emission factors for methane, ethane, methanol, and POM. Attached are the FIRE data sheets for each of these emission factors.

I will return the originals (hard copies) of the data entry sheets to you. Please let me know if you need any additional information.

Ex

December 8, 1997

MEMORANDUM

SUBJECT: Final Trip Report, Royal Oak Enterprises, Inc. / Kenbridge, VA

FROM: Clyde E. Riley, Field Monitor
Emission Measurement Center, EMAD, OAQPS, USEPA (MD-19)

TO: Project File

I. Purpose of Program

To assess feasibility of testing air emissions being generated from uncontrolled charcoal-making kilns. The primary emissions data will be used to determine compliance with Virginia's process weight rate regulation as well as by EPA Region III for emission inventory input.

II. Place and Date

- Royal Oak Plant Kenbridge, VA
- Survey Dates; November 24 - 25, 1997.

III. Principal Participants

Royal Oak Enterprises, Inc.
Mr. Robert G. Gossett, VP Operations
900 Ashwood Parkway, Suite 800
Atlanta, GA 30338
(770) 393-1430

Mr. Paul McAllister, Plant Manager
P.O. Box 403
Kenbridge, VA 23944
(804) 676-8238

Shell Engineering & Associates, Inc.:
Mr. David L. Seidel, Manager Special Projects
2403 West Ash
Columbia, MO
(573) 445-0106

Air Source Technologies:

Mr. Daniel Soderberg, Project Manager
11635 W. 83rd Terrace
Lenexa, KS 66214
(913) 492-1613

USEPA

Region III:
Ms. Angela McFadden, Environmental Engineer
841 Chestnut Building
Philadelphia, PA 19107-4431
(215) 566-2324

OAQPS, EMAD, EMC:
Mr. Gene Riley, Environmental Protection Spec.
Mail Drop 19
Research Triangle Park, NC 27711
(919) 541-5239

Environmental Supply Company, Inc.:

Dr. Lewis Ballard, Principal
2142 E. Geer Street
Durham, NC 27704
(919) 956-9688

IV. Daily Log and Discussion

November 24, 1997 (Monday 15:30)

Arrived at Kenbridge plant. Met with program participants and discussed proposed program activities. Air Source Technologies (AST) was to setup their sampling equipment and be ready to start testing at 06:30 Tuesday morning. Particulate testing, using the modified M-5 train would consist of collecting several 2-hour runs at the rear vent stack and main stack. Several 2-hour runs were to be conducted at the main stack of other kilns that were operating in different time modes (2 days, 4 days, etc.). AST planned to conduct cyclonic flow checks and were to "spot check" velocity measurements using a hot-wire anemometer and a propeller (vane) anemometer. AST also planned to evaluate different organic solvents (acetone, methylene chloride, hexane, etc.) during the sample recovery effort. Shell Engineering planned to monitor the air being withdrawn into the upper and lower kiln side air vents.

Royal Oak personnel provided us with a educational tour of the plant operations. They had selected and loaded kiln No. 5 for the emission screening test program. We were shown

the inside configuration of the kiln, how the wood is placed in the kiln, how the kiln door and vent openings are sealed, how the wood was to be fired initially, and how the fire/heat is moved along the kiln perimeter using the upper and lower side air vents. The No. 5 kiln had two top vents and one main stack; one vent is located near the front doors of the kiln (front vent) and the second vent is located near the rear of the kiln (rear vent). Adjacent to the rear vent and at the end of the kiln is the main "back" stack. During the initial kiln startup, the front top vent is to be closed, and the rear top vent and main stack are to remain open. After ~ 2-3 hours the rear top vent will be closed and only the main stack will remain open.

November 25, 1997 (Tuesday 06:00)

Arrived plant and AST setup two M-5 trains at the rear top vent and main stack. The kiln front top vent was closed. The following presents ~ times and results for the No. 5 kiln testing:

07:10 Kiln No. 5 was fired.
07:25 ATS started sampling when emissions started exiting the two stacks..
07:30 The stack tempt was ~ 350° F and the Δp was ~ 0.07 - 0.08 in. H_2O. The sampling rate was ~ 0.04 to 0.2 in. H_2O.
07:40 The rear vent M-5 train's filter started to plug ~ 12-15 minutes into the run.
07:50 The rear vent M-5 filter blew through.
08:00 New filter was installed in the rear vent train and sampling continued.
08:15 Rear vent M-5 filter plugged again. Filter was not replaced a second time as we were notified that the rear vent would be closed at 09:00.
09:00 Rear vent closed; only the main stack is now being sampled.
15:30 Started another two hour particulate run at the main stack.
17:30 Completed particulate run at main stack; no filter plugging was experienced.

The main stack M-5 train's filter did not plug during the two-hour operating time. The rear top vent was closed after ~ 2 hours of kiln startup time and only the main stack remained open during the following testing intervals. Some puffing of smoke was seen coming from several of the upper and lower air vents located along the sides of the kiln during the No. 5 kiln operation. The rear top vent gas tempt ranged from ~ 300°F to 600°F and the velocity ranged from ~ 300 ft/min to 1200 ft/min during the sampling period. The main stack gas tempt ranged from 140°F to 600°F and the velocity ranged from 300 ft/min to 1000 ft/min during the different sampling periods. No cyclonic flow was observed during the sampling periods.

Mr. Seidel made routine velocity measurements at the upper and lower air vents during the sampling of kiln No. 5. Mr. Seidel used a hot wire anemometer to make the measurements.

AST setup a M-5 train at the No. 2 kiln stack which had been in operation for ~ 4 days (96 hours). All the upper and lower air vents were closed. AST reported that the particulate loading

was low as was the moisture content; the gas tempt was ~ 250°F to 300°F during the sampling run.

10:20 Started particulate testing at the No.2 kiln main stack. No filter plugging was experienced.
11:07 Completed No. 2 kiln main stack sampling as operator had to close the main stack early due to process operation.

AST setup a M-5 train at the No. 14 kiln stack which also had been in operation for ~ 3 to 4 days (96 hours). All the upper and lower air vents were closed. AST reported that the particulate loading was low as was the moisture content; the gas tempt was ~ 250°F - 350°F during the 0.5 hour sampling period.

14:24 Started particulate testing at the No.14 kiln main stack. No filter plugging was experienced.
15:00 Completed No. 14 kiln main stack sampling as operator had to close the main stack early due to process operation.

The M-5 trains were removed from the stack and recovered in an adjacent abandoned kiln. AST reported that little water had been collected during the 2 hour run. The stack gas percent moisture had been expected to be ~ 30 to 40 %, however, it was found to be much less (<20%).

The outer surfaces of the probe assembly were heavily coated with varnish-like deposits. AST used methylene chloride with brushing to rinse the probe glass liner, however, the organic solvent was not very effective in removing the varnish/tar catch. AST followed the methylene chloride rinse with acetone which seemed to be more effective in removing the varnish/tar catch. The knockout impinger (1st impg.) contained some particulate and a dark liquid (water). The 2nd impinger, which was precharged with 100 mls water also contained a dark liquid. The 3rd impinger which was precharged with 100 mls water contained a light tint carmel liquid. The in-line thimble filter was coated dark brown with small particulate particles. As mentioned above, the No. 5 kiln rear vent train filter blew through. All of the remaining filters remained intact.

The gaseous plumes containing condensed water, organics and particulate matter were all attached to their associated stack. The moisture vapor usually condensed and separated from the plume ~ 50 to 75 feet downwind. Mr. Seidel reported that several of the plumes from the different kilns would mix making it very difficult to observe the opacity.

V. Conclusions

Routine testing of the rear top vent will require that the modified M-5 filter be replaced ~ every 15 minutes during the initial time (2 - 3 hours) that the vent is opened. AST reported that testing of the main stack did not demonstrate any potential problems (excessive loading) with particulate during the initial start period. However, the main stack filter may have to be replaced routinely (~ 4 to 6 hours) during the sampling run. It was evident during startup, that the rear vent stack

produced higher volumetric flows and particulate until it was closed. The main stack's flue gas is probably diluted more than the rear vent flue gas because of its lower entrance location and the air distribution from the upper and lower intake air vents.

Moisture does not seem to be a problem as was originally anticipated. AST believes the moisture will be fairly constant and in the 15 to 20 percent range during the sampling run.

The rear vent stack and main stack heights should provide sufficient distances to measure the flow velocities. Cyclonic flow was not observed during the screening runs, therefore, it is not believed to be a potential problem at this facility. The vent and stack flow velocities seem to be within the calibration range of the "S" type pitot tube (~400 ft/min to 3000 ft/min). The vent and stack gas temperature ranged from ~ 200°F to 600°F.

Acetone seemed to be more effective in removing the varnish and tars collected in the nozzle and probe components. Toluene may also be a consideration.

The steam plume was attached to the associated stack, therefore the opacity measurement will probably have to be made downwind when the condensed water vapor is no longer visible. The plume less the condensed water vapor is a light color indicating fairly small particle size. Mixing of the plumes from the different kiln presents problems for observing the opacity from the individual kilns.

Fugitive emissions were observed periodically escaping (short puffs) from the kiln sides, upper and lower air vents during the screening run.

VI. Recommendations

According to AST, excessive particulate loading does not seem to be as much a problem as was originally expected. The rear vent train filter will probably have to be replaced frequently during the initial startup period. Rear vent M-5 train modifications that may increase the filter sample run time are: 1) place a particle cutting cyclone with preweighed and precleaned glass wool immediately after the probe exit; 2) add one or two additional impingers with water or toluene (100 - 200 ml) to provide additional scrubbing of the sampled gases; 3) experiment with different filter media that meet the M-5 criteria; and 4) incorporate a batch of preweighed and precleaned glass wool in a dry impinger just prior to the in-line filter. However, most of these modifications create additional work/problems for the analyst.

AST reported that the stack flue gas conditions (temperature, moisture, velocity) should not be as much of a problem as originally believed. The temperature ranged from ~200°F to 600°F. This should not present a problem, other than the tester should consider replacing the Teflon probe ferrules with other materials that will function in >400°F temperatures. The moisture seems to be much lower than initially believed (<20 percent) as well as fairly constant throughout the process time frame. The flow velocity which ranged from ~ 300 ft/min to 1200 ft/min should be

measurable by the "S" type pitot tube.

The lower isokinetic average sampling rate (~0.1 to 0.2 acfm) for the rear vent stack should provide adequate representative data if the M-5 meter and orifice are calibrated at the proposed operating range. Recommend an isokinetic average sampling rate between 0.25 and 0.5 for the main stack. It is important that both train systems be calibrated for the lower operating ranges.

Sample recovery should implement acetone as the primary organic solvent to remove the varnish/tars as was demonstrated during the screening test. See Attachment 1 for recommended sample recovery, sample extraction, and sample analysis procedures.

Attachment 1

PROPOSED SAMPLE RECOVERY, SAMPLE ANALYSIS PROCEDURES

Modified Method 5 Field Recovery Fractions

Fraction	Component
1. Acetone Rinse	Nozzle & Probe Liner Connecting Glassware Empty Impingers In-line Filter Holder
2. Impinger Water	Impinger Contents
3. Methylene Chloride Rinse	Nozzle & Probe Connecting Glassware Empty Impingers In-line Filter Holder
4. Thimble Filter	In-line Filter Holder

Container No. 1

Rinse w/acetone and brush nozzle and probe liner 3X or more.
Rinse w/acetone and brush connecting glassware, 3X.
Rinse w/acetone and brush in-line filter holder, 3X.
Rinse w/acetone emptied impingers, 3X.

Container No. 2

Measure water volume and place in container.

Container No. 3

Rinse w/methylene chloride nozzle and probe liner 2X.
Rinse w/methylene chloride connecting glassware 2X.
Rinse w/methylene chloride in-line filter holder 2X.
Rinse w/methylene chloride emptied impingers 2X.

Container No. 4

Thimble Filter

Sample Preparation & Analysis

Container No. 1

Evaporate acetone to produce dry residue. Desiccate and weigh to a constant weight as per Section 4.3 of Method 5.

Note: If it is desired to separate the acetone fraction into organic and inorganic phases, the contents of Container No.1 may be filtered through a preweighed Whatman 541 filter or the field thimble filter. The acetone organic filtrate is then evaporated, desiccated, and weighed to a constant weight as per Section 4.3 of Method 5. The filterable inorganic matter is desiccated and weighed along with the Whatman 541 or thimble filter to a constant weight as per Section 4.3 of Method 5.

Container No. 2

Measure water contents; pass contents through a preweighed Whatman 541 filter or if desired, analyst may used the field thimble filter to filter the particulate matter from the water. Transfer the water filtrate to a separatory funnel.

Container No.3

Afterwards, flush/rinse the Container No. 2 filterable particulate using the methylene chloride contents of Container No. 3. Continue to flush/rinse (2X) the filterable particulate using ~ 25 mls/each rinse. Collect the methylene chloride filtrate and place in the separatory funnel along with the water filtrate. Using instructions in Section 5.3.2.1 of Method 202, mix the contents and allow phases to fully separate and drain off the organic $MeCl_2$ as directed. Add additional $MeCl_2$ to funnel as directed and collect in tared weighing container. Transfer remaining water fraction to a container for the inorganic weight determination.

Organic Fraction Weight Determination

Evaporate $MeCl_2$ filtrate, desiccate, and weigh to a constant weight as per Section 5.3.2.2 of Method 202.

Inorganic Fraction Weight Determination

Evaporate water, air dry, and weigh to a constant weigh as per instructions in Section 5.3.2.3 of Method 202.

If used, desiccate and weigh the Whatman 541 filter to a constant weight as per Section 4.3 of Method 5.

Container No. 4

Desiccate and weigh the thimble filter to a constant weight as per Section 4.3 of Method 5.

Dec 1997 Test Plan

FAX TRANSMISSION

U.S. EPA
841 CHESTNUT BUILDING (3AT13)
PHILDELPHIA, PA 19107
(215) 566-2324
FAX: (215) 566-2134

To:	Gene Riley, OAQPS	**Date:**	December 18, 1997
Fax #:	(919) 541-1039	**Pages:**	21, including this cover sheet.
From:	Angela McFadden		
Subject:	Revised test plan for testing at Royal Oak.		

Comments:

Please see the last paragraph of page 13 of the test plan. Also, is the concern regarding methanol analysis (second paragraph, page 14) valid? I would like to suggest to Bob Gossett that they use the best procedures, based on their pre-test study, to analyze the three remaining samples and report their result back to us before they do the full test in February. They suggest further study but I don't think it's necessary. What do you think?

ROYAL OAK ENTERPRISES, INC. - KENBRIDGE, VIRGINIA
MISSOURI-TYPE CHARCOAL KILN #5
PROPOSED EMISSIONS TEST PLAN

December 10, 1997

Prepared for
USEPA Region III
841 Chestnut Building
Philadelphia, PA 19107-4431

Prepared By:

Royal Oak Enterprises, Inc.
Suite 800
900 Ashwood Parkway
Atlanta, GA 30338
(770) 393-1430

Shell Engineering &
Associates, Inc.
2403 W. Ash Street
Columbia, MO 65203
(573) 445-0106

AirSource Technologies, Inc.
11635 W. 83rd Terrace
Lenexa, Kansas 66214
(913) 492-1613

Table of Contents

1.0 Introduction

On August 22, 1997, Royal Oak Enterprises, Inc. received a Section 114 Clean Air Act Information Request letter from USEPA Region III, dated August 14, 1997. The agency is seeking certain information "to determine Royal Oak's compliance status with the Clean Air Act". To obtain this information, the EPA requires that Royal Oak Enterprises, Inc., measure particulate matter emissions from Kiln No. 5, located at the Royal Oak facility in Kenbridge, Virginia. See Appendix C, for detailed correspondence.

Based on the requirements of the Section 114 Information Request letter and Attachment 1, Royal Enterprises, Inc. is proposing the herein test plan. Royal Oak Enterprises, Inc. wishes to provide full cooperation and coordination with EPA efforts. Royal Oak Enterprises, Inc. is interested in the emission results and the safety of all parties at its facility.

The scope of emissions sampling involved testing for the particulate matter and opacity. Emission data shall be evaluated to determine the emissions of one complete batch cycle for particular matter (PM), and opacity with associated kiln operation parameters.

2.0 General Provisions and Time Frames

The general provisions and Time Frames are based on the summarization of the correspondence continued in Appendix C. These items are listed below for clarification and for approval by all parties involved.

2.1 General Provisions

According to correspondence and pre-test conference call;

1. EPA approval of kiln testing protocol proposed by Royal Oak
2. Additional data collection concurrently by EPA or MDNR
3. Raw material and product samples taken by EPA or MDNR
4. Procedure specification and additional testing provision
5. Determination of total emissions by test data

6. Final report containing all field and calculated data
7. Sampling procedures, schedule and report requirements

More specific provisions and clarifications are found in Appendix C, "Correspondence."

2.2 Time Frames

Based on EPA's November 10, 1997 extension letter the following Time Frames must be met.

Time Frames

- Receipt of 114 Information Request Letter ..... August 22, 1997
- Proposed Test Plan Submittal (<30 days plus 7 day extension) .. September 29, 1997
- Completion of Emission Testing (<60 days) ..... October 22, 1997-Extension
- Final Report Submittal (<90 days) ..... November 21, 1997-Extension
- Preliminary Test Plan ..... November 14, 1997
- 7 Days After Approval of Preliminary Test Plan Perform Preliminary Test ..... November 25, 1997
- 15 Days After Preliminary Test Submit Final Proposed Test Plan ..... December 11, 1997
- 30 Days After Approval of Plan Perform Testing .....
- Within 30 Days of Performing Test Submit Report .....

3.0 Facility and Kiln Operation

Royal Oak Enterprises, Inc. operates a charcoal kiln and briquet manufacturing facility located on Route 138, east of Kenbridge, Virginia. The facility contains one briquet manufacturing plant and seventeen (17) metal Missouri-Type Charcoal Kilns. Fourteen (14) kilns are presently used for production while three (3) kilns are in need of repair. The charcoal kilns produce approximately 12,000 tons of charcoal per year. The charcoal is produced by pyrolysis of hardwood slabs. The hardwood logs are a mixed variety. Mixed loads of wood are delivered to the facility by truck. The logs are loaded into the kiln by a front-end loader. Occasionally, the kiln is loaded with brands or slabs to char.

Typical Steps of Kiln Operation

- First Day - Morning - Load kiln, close and seal door and front roof vent stack
- First Day - Noon - Light kiln with kerosene bag (burn phase)
- First Day - 1:00 P.M. - Close back vent stack on roof (burn phase)
- Second Day - Closing intake pipes periodically (burn phase)
- Third Day - Closing intake pipes periodically (burn phase)
- Fourth Day - 2:00 A.M. - Seal kiln close all intakes and rear stack (cooling phase)
- Fifth Day - Morning - Quench and unload kiln (cooling phase)

The normal operating procedure for kiln no. 5 is to light the kiln with the door, upper side vents, and front roof vent stack sealed. The kiln is manually quenched with two 1" fire hoses. The kiln is emptied and the brands and charcoal are manually separated on the yard slab.

Table I
Kiln No. 5 Operation Information

Feed Material	Charcoal Produced	Hours	Configuration
~ 134,000 lbs. of hardwood from truck load Moisture 50-70% green logs ~ 52,300 lbs. of hardwood from yard moisture Moisture 30-40% dry logs	~ 16,000 lbs. on dry basis Moisture 15-18% after quenched spray Prox. analysis 19-20% volatiles 10-15% ash 65-71% fixed carbon BTU Content 8500 BTU/lbs.	60-80 hours burn phase 12-18 hours cooling 4 hours loading 4 hours unloading total days 4-6	2 roof vents stacks 12" diameter front vent stack (not used) 12" diameter back vent stack used only during two hours of start-up 18" diameter rear bottom main stack 16-6" intake pipes rear 4 intake (always closed)

Appendix B contains a diagram of Kiln No. 5's configuration.

4.0 Emissions Testing Schedule

The proposed emission testing schedule contained in Table II is an aggressive schedule to meet the requirements of the EPA's time requirements.

Table II
Time Table - Required and Proposed Dates

Task	Initial Proposed Date	Revised Proposed Dates	Required By
Proposed Test Plan Submittal	September 21, 1997	September 29, 1997	April 20, 1997
Pretest Meeting-Conference Call	November 6, 1997	------	N/A
Preliminary Test Plan Submittal	November 14, 1997	------	November 14, 1997
Preliminary Test	November 24, 25, 1997*	------	November 25, 1997
Revised Test Plan Submittal	December 11, 1997	------	December 11, 1997
Charcoal Kiln No. 5 Emission Test	February 2-6, 1998*	------	30 days after plan approval
Final Report Submittal	March 6, 1998	------	30 days after completion of testing

Comments
*** First day of test dates is for arrival and set up equipment**

5.0 Preliminary Test

Royal Oak and parties conducted a preliminary test to evaluate testing procedures on November 24 & 25, 1997. The parties in attendance were EPA (Research Triangle Park) and Royal Oak representatives including all testing companies. The objectives of the preliminary test was to finalize the charcoal kiln testing program and evaluate any questions on the testing procedures. A complete summary is presented by Shell Engineering & Associates, Inc. in Appendix I. Recommendations from all parties was considered and are incorporated in the following sections.

6.0 Sampling and Analytical Procedures

6.1 Overview

Sampling will be performed in two phases designated "Start-up" and "Burn". During the Start-up phase, testing will be performed from the rear roof vent stack and the back stack on the kiln. During the Burn phase, testing will be performed from the back stack. Except for the bottom intake kiln vents, all other openings shall be sealed or closed. The same parameters will be measured during both phases. The back stack and rear vent stacks are the only exhaust openings which are open and are sampled simultaneously during the start-up phase. The single back stack is the only exhaust opening open during the burn phase.

Testing will be performed continuously during an entire batch cycle excluding the cooling phase, from initial lighting to final extinguishing of the kiln. Sampling will only be halted for short periods during train change-outs and CEM calibrations. Emission rates will be calculated and reported for each 4-hour interval during the burn phase. The start-up phase (estimated to be about 3 hours) will be reported as a separate interval.

The O_2 and CO_2 sampling will be performed alternately every 10-15 minutes on the rear vent stack and the back stack during the start-up phase and only from the back stack during the burn phase. A single MM5 train will be used. Each run will have a duration of approximately four hours.

Full Calibrations will be performed between each run. "Full Calibrations" means calibration according to the requirements of the applicable methods (3A, etc.). Zero and span will be checked hourly.

The second train will be set up while the first one is sampling. At one completion of the run, the next train will be started as quickly as possible.

The O_2 and CO_2 sampling will be performed at a single point at the center of the stack.

The 0.5 cfm sampling rate recommended in Method 5 was based on the need to collect several milligrams of sample during a one-hour run. The emission source being tested here is significantly different than most sources tested with Method 5. The expected total sample catch will be several grams. The extended run time of 4 hours will result in a dry gas volume similar to that collected during a standard one-hour Method 5 test. Attempting to sample at a 0.5 cfm sample rate would create the following problems:

- During a 4-hour run, the high stack moisture levels would result in several liters of condensate, thus requiring impingers to be swapped out during the run, requiring stoppages of sampling for several minutes.

- The resulting huge sample volumes would create analytical problems. The impinger catch would not fit in a liquid-liquid extraction vessel, and would take a very long time to evaporate for gravimetric analysis. It would also add to sample handling and shipping costs.

- The possibility of filter clogging would be increased.

All parties agree after the preliminary testing that a ~0.1 to 0.2 average sampling rate can be used if the M-5 meter and orifice are calibrated at the proposed ranges.

6.2 Start-Up Phase

To sample from the rear roof vent stack, temporary extensions are not needed as determined during the preliminary test. Two M-5 trains shall be operated during the start-up phase with the rear vent stack changing filters when vacuum pressure reaches 10" W.C.

The O_2 and CO_2 sampling will be performed on each of the stacks at 10-15 minute intervals. A single MM5 train will be used.

6.3 Cyclone Flow

Because of the low flow rates, it would an excessive amount of non-sampling time to perform a cyclonic flow traverse. Since cyclonic flow is not likely to be present and is less of a concern

at low flow rates, it would be preferable to minimize sampling delays so that cyclonic flow checks can be performed. Measurements will be made during the pre-test meeting to confirm that cyclonic flow is not a concern on each selected kiln. Cyclonic flow could be quickly rechecked if required at the final test.

6.4 Flow Rate

In the event that the flow rates from the stack rear vent and back stack are too low to be measured with a manometer, pitot readings will be made using an appropriate pressure transducer. During the preliminary testing the velocity pressure was high enough to use a S-type pitot tube, but a calibrated electronic pressure transducer will be available.

6.5 Moisture

Moisture content of the stack gas can change significantly. Changes in moisture from one run to the next could result in unacceptable isokinetics. Therefore, a separate moisture approximation technique will be performed at one-hour intervals. Moisture will be determined using the EPA Method 5 impinger and silica gel weight gain. 4 hr runs require extra port

During the start-up phase, moisture levels will be unknown and cannot be determined beforehand. Sampling will be started immediately upon ignition by assuming a moisture percentage from data obtained during the preliminary test. A moisture measurement will be made as quickly as possible (about 10 minutes) and the sampling rate will be adjusted accordingly. This procedure will need to be repeated any time the train is moved from vent to vent. The following testing knowledge was gained by the prior kiln test and was verified at the preliminary test.

- The tar weight is insignificant compared to the weight of the water.
- Water will be removed by a cooled condenser and measured by a graduated cylinder.
- Water retained by the tars is insignificant.

- The data from this train will only be used to predict the moisture content. Isokinetic calculations will be made using the actual moisture data from the MM5 sampling train.

- The Method 4 approximation method does not require a 15-minute sampling time. The first line of the method reads: "The approximation method described below is presented only as a suggested method..."

For this reason, it may not be possible to achieve a 90-110% isokinetic sampling rate during the start-up testing. This is not thought to be a problem for the following reasons:

- An isokinetic error primarily affects large particulate matter, and the emissions from the kilns are primarily small particulate and condensible organics.

- The error from an isokinetic sampling is a function of flow rate. The extremely low flow rate from the kiln vents means that a much wider isokinetic criterion would be acceptable.

An isokinetic rate of 80-120% will be considered acceptable for the start-up phase.

6.6 Particulate

The nature of the emission stream precludes the determination of "filterable" particulate matter. The extremely high level of tars collected throughout the train does not allow the solid particulate matter to be separated from the condensible organic matter. Therefore, particulate emissions will be reported as a total of two fractions:

- Condensible organics
- Inorganic particulate (filterable and condensible combined)

These fractions will be determined as follows:

6.6.1 Condensible Organics

This will be the same fraction measured by the gravimetric analysis of the organic extract.

6.6.2 Inorganic Particulate

After extraction, the aqueous impinger catch will be transferred to an appropriate contained and evaporated to about 50 ml on a steam bath. If necessary to remove solid particulate matter, an additional acetone rinse of the extraction vessel will be performed. This extract will be added to the impinger water before evaporation. After concentration to about 50 ml, the sample will be transferred to a tared 150 ml beaker and evaporated to dryness. The beaker will then be dried in an oven at 105°C for 4 hours, desiccated until cool, and weighted to constant weight. This fraction will contain both water-soluble inorganic compounds and insoluble particulate matter.

A 40 ml aliquot of the impinger water shall be removed prior to extraction and measured for methanol content by GC/FID for each run.

6.7 Details of CEM System

6.7.1 Sampling System

Sampling for oxygen and carbon dioxide will be performed using a sampling and conditioning system designed to meet the criteria of EPA Method 6C. Sampling will be performed at a single point at the center of the stack. Stack gas will be extracted through a stainless steel probe with a sintered filter. A heated teflon sample line will connect the probe to a moisture condenser. The dried gas will be passed through a glass-fiber filter and then through a teflon lined diaphragm pump. The gas will then be pumped to a Horiba ES-150 stack conditioner, which removes any remaining moisture and particulate before delivering the sample the analyzers. Oxygen and carbon dioxide concentrations will be recorded continuously, except during instrument calibrations.

6.7.2 Analytical System

Oxygen and carbon dioxide monoxide will be measured according to EPA Method 3A. Concentrations will be determined using a Horiba CMA-331 triple-component gas analyzer. Oxygen will be measured using a magneto-pneumatic type detector. Carbon dioxide will be measured using non-dispersive infrared detectors.

6.7.3 Calibrations

Complete calibration of the CO_2 and O_2 analyzers will be performed at the beginning of each Modified Method 5 run. Zero and span checks will be performed on 1-hour intervals.

6.8 Details of Modified Method 5 Train

This train will be similar to a Method 5 sampling train, with the filter moved to between the fourth and fifth impingers. This will allow extended run times and permit sampling to be performed continuously throughout the burn cycle.

The particulate train will have the following configuration:

Impinger 1	Mod GBS	Dry (2 L capacity)
Impinger 2	GBS	100 mL DI Water
Impinger 3	GBS	100 mL DI Water
Impinger 4	Mod GBS	100 mL DI Water
Impinger 5	Mod GBS	Silica Gel

A 30 mm x 100 mm glass thimble filter will be placed between impingers 4 and 5.

6.9 QA/QC Procedures

The proposed train configuration worked well for sampling at the stack, but was not successful at the roof vent. This vent had very high concentrations of fine particulate matter that passed

through the impingers and quickly clogged the thimble filter. The resulting high vacuum caused the thimble to burst after an hour. The filter was replaced, but burst again after another 15 minutes. Sampling from the kiln stacks resulted in no elevated vacuums during the runs.

For the final test, several revisions to the train configuration are proposed:

- The second and third impingers will be changed from Greenburg-Smith to Modified impingers because the condensing tars plug the small orifices in the Greenburg-Smith impingers and cause sudden changes in vacuum and flow rate.

- The empty impinger beneath the filter will be removed. This was a remnant of a previously proposed train that used an XAD resin trap at this location and is therefore not necessary in this train. The filter will be placed directly above the silica gel impinger.

- The silica gel impinger will also be loaded with about 100 g of activated charcoal to absorb organic vapors that contaminate the sampling equipment.

- To prevent filter bursting at higher vacuums, the thimble filter will be replaced with a standard 3 or 4 inch filter holder with a Teflon frit. The thimble filter was originally proposed as part of a different method that required soxhlet extraction of the filter. The use of a thimble filter allowed for simple extraction and also eliminated the difficult requirement of cleaning the frit. Since no filter extraction will be performed and no post-filter recovery is necessary, the use of the thimble filter offers no advantage.

6.9.1 Recovery Procedures

The standard Method 202 train recovery procedure was not fully effective in removing all the organic matter from the sampling trains. The methylene chloride rinse did not dissolve all of the condensed organic matter in the train. Hexane was tried as an alternative, but it did not appear to work as well. Toluene was also evaluated and did seem to be somewhat more effective in removing the organic matter. However, it was still not completely effective. Acetone, however, proved to be very effective in removing the remaining organic residue.

The proposed recovery procedure is as follows:

- The probe will be brushed 3 times with methylene chloride into a sample container. It will then be brushed 3 times with acetone into a second container.
- The impingers will be weighed to determine moisture content, and the contents will be transferred to a third sample container. The impingers and connecting glassware will then be rinsed twice with methylene chloride and twice with acetone into the same containers that the probe was rinsed into.
- The final filter will be transferred to a fourth sample container.

6.9.2 Sample Analysis

As anticipated, the Method 202 separatory-funnel extraction procedure did not work well. The sample tended to form an emulsion layer at the water: $MeCl_2$ interface. Gentle swirling and sitting for several minutes would break up most of the emulsion, but some could not be eliminated, probably due to the presence of solid particulate matter at the interface layer. Also, the aqueous layer contained coagulated light tars that would float on the top or stick to the sides of the funnel. These compounds were not highly soluble in $MeCl_2$ and would mostly remain in the aqueous layer after shaking. A single sample was extracted eight times with 50-mL portions of $MeCl_2$ without complete removal of the organic material. Extraction with toluene did not appear to be more effective and resulted in more emulsion formation.

There are several modifications to the standard procedure that may improve performance:

- Filtering of the aqueous phase prior to extraction would remove the solid particulate matter from the sample. This filter could then be weighed as a separate fraction. However, it is likely that a large amount of the condensed organic matter would be retained as well, resulting in a sample fraction that contained both organic and inorganic particulate matter. It would then not be possible to accurately determine organic and inorganic fractions. It may be possible to extract the organic matter by

soxhlet, but this would greatly increase the cost and complexity of the analysis. Due to the nature of the sample, a simple rinsing or the filter with solvent would probably not be effective.

- Extraction by continuous liquid-liquid extractor instead of separatory funnel would likely be more effective in removing the slowly soluble organics. It is also possible that acidification of the sample would improve the extraction. The usual addition of sulfuric acid would not be possible, since residual sulfuric acid in the aqueous phase would remain after evaporation and bias the gravimetric analysis. The use of a sufficiently strong volatile acid would eliminate this problem. Trifluoroacetic acid is the best candidate. If necessary, extended extraction time or additional solvents could be employed, though this would significantly increase the complexity of the analysis. It is possible that an acetone rinse of the extraction vessel would be required to fully remove the solid particulate.

- If the organic/inorganic distinction is not a concern, the analysis could be greatly simplified by combining the aqueous, $MeCl_2$ and acetone fractions and evaporating the composite sample ~~on a hot plate~~. The filter weight would still be determined separately.

- Homogenization of the sample by sonic disruption or shear homogenizer may improve extraction efficiency.

Although it appears that the standard Method 202 extraction method could be used, it is suggested that further research be performed. Due to the small number (3) of remaining samples and the high cost of additional preliminary testing, it is recommended that discussions take place between all interested parties about how to best use these samples. Once a consensus was reached on which method modifications are most likely to be successful, AirSource will evaluate the new procedures with the remaining samples.

6.9.3 Other Concerns

The use of the post-impinger filter causes complications in cold weather. Moisture in the gas stream can condense out and freeze on the filter, causing premature clogging. If testing is the be performed during the winter months, some method of warming the filter may be required. Simply wrapping with heat-tape may be effective, but is might be necessary to construct some kind of oven box above the impingers. If heating of the filter is necessary, an additional impinger or condenser may be required to cool the gas again before entering the silica gel impinger.

The removal of a fraction of the impinger catch for methanol analysis would bias the particulate results, since it would not be possible to homogenize the sample before removal. Since most of the condensed organic material floats on the water layer and is not dispersed in it, assuming an average concentration of solids is the aqueous phase may not be accurate.

7.0 Kiln Parameter Monitoring

The parameter monitoring details are found in Appendix F. One continuous run shall be conducted for the entire length of the start-up and burn phases of the kiln batch process.

7.1 Royal Oak Activities

Royal Oak Enterprises shall conduct the following activities for each kiln test.

- Count and weigh all bundles before start of production batch including black wood, brands and slabs.
- Take six random bore samples of the bundles of slab wood. (See Shell Engineering activities.)
- Identify and quantify the types of slab wood loaded.

- Record operating activities indicating time kiln is lit; when each vent, stack, door and port is opened and closed; burn phase start and end times.

- Record intake vent temperatures and velocities every 15 minutes during test period.

- Take three random samples of each charcoal and brands.

- Separate and weigh charcoal and brands.

7.2 Shell Engineering Activities

Shell Engineering & Associates, Inc. shall perform the following activities:

- Supervise and contract the analysis of the raw material bore and product samples. The samples would be analyzed for moisture, volatile, ash fixed carbon and BTU content.

- Conduct roof vent velocity pressure and temperature monitoring during start-up.

- Train and supervise Royal Oak on the intake vent parameter monitoring.

- Obtain kiln physical characteristics including corner-to-corner GPS coordinates by hand-held field instrument.

- Obtain and record ambient weather conditions including temperature, barometric pressure, relative humidity, wind speed and wind direction monitoring frequency is to be once per hour.

- If required, conduct opacity readings by certified visible observer by Method 9 procedures for at least six minutes per every hour of the testing period except between the hours of 6:00 p.m. and 6:00 a.m.
  Concern: Water droplets; wet attached plume; wide dispersion through trees.

Specific equipment has not yet been purchased for the parameter monitoring. Instrument specification shall be submitted to EPA upon selection.

8.0 Production Sampling and Analysis

As stated in Section 7.0, Shell Engineering & Associates, Inc. will assist Royal Oak Enterprises in the analysis of six slab wood bore samples, three charcoal samples, and three brands samples. The analysis shall be conducted by a certified laboratory retained by Royal Oak Enterprises. The samples shall be analyzed for moisture, volatile matter, ash, fixed carbon, and BTU content. "Fixed Carbon" is the amount of carbon which is not volatile matter, ash or moisture in the proximate analysis for solid fuels. The information gained by these analyses shall characterize the kiln's yield performance and quality of the charcoal products.

9.0 Finalization and Approval of Testing Program

Based on the preliminary testing, Royal Oak has revised this final test program document. The document highlights any changes agreed upon for the pre-test meeting and preliminary test recommendations.

All parties shall review and approve the testing program. Field judgements shall be minimized due to these reviews. All equipment shall be calibrated, certifiable by EPA Methods or NIST certifications. Two complete sets of equipment plus spare components shall be on site during testing. Three

10.0 Testing and Reporting

10.1 Testing Summary

The emission testing shall be conducted in accordance with USEPA methods from 40 CFR Part 60 Appendix A and other procedures pre-approved by the agency. The testing shall collect samples over charcoal batch cycle. The kiln is sealed at the end of the burn phase and enters the cooling phase as the fire is extinguished. No emissions escape the kiln in the cooling phase. Therefore, no testing is to be conducted during the cooling phase. Time gap

filling in between the run periods of less than 30 minutes shall be time weighted as an extension of the previous run. If the non-tested time is greater than 30 minutes the adjustment factor may be applied by an evaluation of the kiln parameters and pre-final report approved by EPA.

AirSource Technologies is proposing two crews composed of three persons. Shell Engineering is proposing to send two engineers, one on site at all times. The sampling shall be conducted by personnel in (12) twelve hour shifts.

10.1.1 Proposed Test Facilities and Dates

As presented in 3.2 and 4.0, the metal Kiln No. 5 emission test is proposed for the Royal Oak Enterprises, Inc., Kenbridge Virginia facility on February 2-6, 1998.

10.1.2 Proposed Testing Laboratories

AirSource Technologies is continuing to evaluate the laboratory repeatability and reliability concern for the particulate analyses.

10.2 Reporting

The final report shall include the entire scope of data collected ranging from the production samples to the final emission calculations for each pollutant. The report shall be in the format as outlined in the 114 Information Request Letter Attachment 1.

The emission results shall be reported in units of pounds per hour, pounds per batch cycle, pounds per ton of charcoal produced, etc. The results will be reported in different ways that may be useful. All the data will be consistently reported on each of the relevant bases.

The final report is proposed to be submitted in triplicate within 30 days after the completion of the testing.

ROYAL OAK ENTERPRISES, INC.
KENBRIDGE, VIRGINIA
MISSOURI-TYPE CHARCOAL KILN #5
EMISSIONS TEST SUMMARY REPORT

March 16, 1998

Prepared for
USEPA Region III
841 Chestnut Building
Philadelphia, PA 19107-4431

Facility Information
Royal Oak Enterprises, Inc.
Highway 137 & 137
P.O. Box 403
Kenbridge, VA
Ph. (804) 676-8238
Facilty ID : 51-111-0010

Prepared By:

Royal Oak Enterprises, Inc.
Suite 800
900 Ashwood Parkway
Atlanta, GA 30338
(770) 393-1430

Shell Engineering &
Associates, Inc.
2403 W. Ash Street
Columbia, MO 65203
(573) 445-0106

AirSource Technologies, Inc.
11635 W. 83rd Terrace
Lenexa, Kansas 66214
(913) 492-1613

Table of Contents

1.0 Introduction

This introduction provides the background information for the emissions testing conducted at Royal Oak Enterprises, Inc. located at the following address:

Royal Oak Enterprises, Inc.
Highway 137 & 137
P.O. Box 403
Kenbridge, VA
Ph. (804) 676-8238
Facilty ID : 51-111-0010
Contact: Paul McAllister

1.1 Emissions Testing Purpose

On August 22, 1997, Royal Oak Enterprises, Inc. received a Section 114 Clean Air Act Information Request letter from USEPA Region III, dated August 14, 1997. The agency is seeking certain information "to determine Royal Oak's compliance status with the Clean Air Act". To obtain this information, the EPA requires that Royal Oak Enterprises, Inc., measure particulate matter emissions from Kiln No. 5, located at the Royal Oak facility in Kenbridge, Virginia. See Appendix C, for detailed correspondence. See Appendix A for a facility layout diagrams.

Based on the requirements of the Section 114 Information Request letter; its Attachment 1; and the Proposed Emissions Test Plan (January 30, 1998), Royal Enterprises, Inc. has completed the herein emissions testing. Royal Oak Enterprises, Inc. has provided full cooperation and coordination with EPA efforts. Royal Oak Enterprises, Inc. is interested in the emission results.

The scope of emissions sampling involved testing for the particulate matter and opacity. Emission data was evaluated to determine the emissions of one complete batch cycle for particular matter (PM) by USEPA Methods 5 & 202 , and opacity by USEPA Method 9 with associated kiln operation parameters for Kiln #5.

1.2 General Information

The testing was conducted on February 12-16, 1998, after months preparation. The preparation included several corespondence letters; three protocol revisions; a preliminary test; and a two pretest teleconferences. The following parties were present at the emissions test besides plant manager, Paul McAllister and his staff:

Angela McFadden USEPA Region III 841 Chestnut Building Philadelphia, PA 19107-4431 (215) 566-2324	C.E. (Gene) Riley USEPA OAQPS Emission Measurement Ctr Mail Drop 19 Research Triangle Park, NC 27711 (215) 566-2324	Gene Brooks Virginia DEQ Air Regional Office 7705-03 Timberlake Road Lynchburg, VA 24502 (804) 582-5120
Bob Gossett Royal Oak Enterprises, Inc. Suite 800 900 Ashwood Parkway Atlanta, GA 30338 (770) 393-1430	David Seidel Shell Engineering & Associates, Inc. 2403 W. Ash Street Columbia, MO 65203 (573) 445-0106	Daniel Soderberg AirSource Technologies, Inc. 11635 W. 83rd Terrace Lenexa, Kansas 66214 (913) 492-1613

The other AirSource team members were Pete Liebl (Project Manager/CEM Specialist), Kevin Eudaly (console technician), Lisa Wallace, Finnegan Schall, and Robert Phillips. The other Shell Engineering team members were Padmaja Guntaka (opacty reader), Gayle Vandelicht (opacity reader), and John Pulliam (night technician). AirSource laboratory support was provided by Dr. George W. Scheil of G.W. Specialties. Shell Engineering used Galbraith Laboratories of Knoxville, TN for the wood analysis.

Appendix H contains corespondence for the preparation for this test between the above parties.

2.0 Facility and Kiln No. 5 Operation

2.1 General Description and Process Operation

Royal Oak Enterprises, Inc. operates a charcoal kiln and briquet manufacturing facility located on Route 138, east of Kenbridge, Virginia. The facility contains one briquet manufacturing plant and seventeen (17) metal Missouri-Type Charcoal Kilns. Fourteen (14) kilns are presently used for production while three (3) kilns are in need of repair. The charcoal kilns produce approximately 12,000 tons of charcoal per year. The charcoal is produced by pyrolysis of hardwood and softwood logs. The logs are a mixed variety. Mixed loads of wood are delivered to the facility by truck and open air yard dryed. The logs are loaded into the kiln by a front-end loader. Occasionally, the kiln is loaded with brands or slabs to char.

Typical Steps of Kiln Operation

- First Day - Morning - Load kiln, close and seal door and front roof vent stack
- First Day - Noon - Light kiln with kerosene bag (burn phase)
- First Day - 1:00 P.M. - Close back vent stack on roof (burn phase)
- Second Day - Closing intake pipes periodically (burn phase)
- Third Day - Closing intake pipes periodically (burn phase)
- Fourth Day - 2:00 A.M. - Seal kiln close all intakes and rear stack (cooling phase)
- Fifth Day - Morning - Quench and unload kiln (cooling phase)

The normal operating procedure for kiln no. 5 is to light the kiln with the door, upper side vents, and front roof vent stack sealed. The kiln is manually quenched with two 1" fire hoses. The kiln is emptied and the brands and charcoal are manually separated on the yard slab.

Table I
Kiln No. 5 Operation Information

Feed Material	Charcoal Produced	Hours	Configuration
~ 134,000 lbs. of hardwood from truck load Moisture 50-70% green logs ~ 52,300 lbs. of hardwood from yard moisture Moisture 30-40% dry logs	~ 16,000 lbs. on dry basis Moisture 15-18% after quenched spray Prox. analysis 19-20% volatiles 10-15% ash 65-71% fixed carbon BTU Content 8500 BTU/lbs	60-80 hours burn phase 12-18 hours cooling 4 hours loading 4 hours unloading total days 4-6	2 roof vents stacks 12" diameter front vent stack (not used) 12" diameter back vent stack used only during two hours of start-up 18" diameter rear bottom main stack 4-6" & 11 8" intake pipes and at under cut door slot.

Appendices A & F contains diagrams of Kiln No. 5's configuration.

2.2 Operation During Emissions Testing

2.2.1 Test Period

The kiln was lit on both sides of the kiln through intake ports 2 and 14 into the fire box area (stacked brands) by keosene soaked bags.

Kiln #5 was loaded with 57.33 tons of wood logs which included 2.03 tons of brands for the fire box section. The yard wood contained between 27.5 to 34.1 percent moisture. The brands contained between 1.0 to 18.0 percent moisture. The kiln produces 7.85 tons of charcoal and 11.84 tons of brands. The moisture in the charcoal and brands prior to wetting down contained 1.0 percent moisture and 6.1 to 11.7 percent after wetting down to quench remaining smoldering.

Table II
Emissions Test Events

Event	Time	Activities	Comments
Arrival Day 2-11-98	11:00	Mr. Seidel arrived at 11:00. Supervised sampling platform and electricity setup.	
Arrival Day 2-11-98	15:30	AST van arrived at 15:30. Proceded with equipment unpacking.	
Setup Day 2-12-98	9:00	Other AST team members arrival. Continued setup of equipment.	Ran moisture train on Kiln #2 for procedure verification.
Setup Night 2-12-98	21:00-23:00	AST ran two exiperimental runs to verify trains on Kiln #2	Filters clogg in 15-20 minutes.
Test Date 2-13-98 Day One	8:00	Other SEA team members arrive. Test delayed over filter concern and until dual filter train developed.	Mr. Riley made arrangements for more filters to be tared and AST member returned from retriving filters in Durham NC.
Day One 2-13-98	18:00	Lighting of Kiln	Four trains available (Two for each source stack.)
2-14-98	0:00	Night kiln operator closes off door undercut opening DR2. Killing fire box combustion.	Not the correct time to close. (Paul M.)
2-14-98	9:00	Kiln has slowed down due to fire box burnout.	
2-14-98	10:00	Paul McAllister attempts to stoke the fire by blowing air into one intake port at a time. Suggested by Mr. Riley.	Leaf blow appears to have some effect but not enough to boost combustion.
2-14-98	13:00	Decision made to reopen rear vent stack without sampling if 70 % sampled time criteria is met.	All parties agree that the kiln is not hot enough and vent opening is needed.
2-14-98	18:10	Rear vent stack reopened for 62 minutes only. Sampling continued on the back main stack with no decrease in stack flow.	No sampling train setup due to hot surface danger at perpend. port access way.
2-14-98	19:12	Rear vent stack closed.	Kiln is restoked and hot again. Carbonization continued.
2-15-98	14:00	Kiln is carbonizing and filters clogging faster. Filter changes are done simultanously with *other train sampling.*	
2-15-98	23:45	Kiln intake ports are all closed and burn phase is ended by capping the back main stack.	End of sampling.
2-16-98	10:00	Equiment breakdown and samples are prepared for transportation.	
2-16-98	15:00	Kiln is opened and water hoses quench smolding logs and charcoal is wetted down. Product weighed at scales.	Dry and wet product samples are taken by Mr. Seidel.
2-16-98	20:00	Testing teams depart from the facility.	

Table III is a table which shows the kiln monitoring and metoerological information collected during the test.

Table III
Emissions Testing Period

Date	Time	Hr	Front Vent	Rear Vent	Back Stack	Intake Ports	Wind Speed	Wind Dir	Amb. Temp	RH
2-13	18:00	1	x	o	o	oooooooooooooooo	1.2	156	45	59
2-13	19:00	2	x	o	o	oooooooooooooooo	1.1	155	44	64
2-13	20:00	3	x	x	o	xoooooooooooooooo	1.0	123	43	69
2-13	21:00	4	x	x	o	xoooooooooooooooo	1.0	47	42	72
2-13	22:00	5	x	x	o	xoooooooooooooooo	2.5	193	42	71
2-13	23:00	6	x	x	o	xoooooooooooooooo	4.4	34	41	70
2-14	0:00	7	x	x	o	xooooooooooooooox	5.4	32	41	62
2-14	1:00	8	x	x	o	xooooooooooooooox	6.8	28	39	56
2-14	2:00	9	x	x	o	xooooooooooooooox	7.3	29	38	54
2-14	3:00	10	x	x	o	xooooooooooooooox	6.2	27	37	56
2-14	4:00	11	x	x	o	xooooooooooooooox	6.5	27	36	57
2-14	5:00	12	x	x	o	xooooooooooooooox	6.0	26	36	59
2-14	6:00	13	x	x	o	xooooooooooooooox	5.3	21	36	59
2-14	7:00	14	x	x	o	xooooxxxxooooooox	3.5	359	36	62
2-14	8:00	15	x	x	o	xooooxxxxooooooox	3.6	354	37	61
2-14	9:00	16	x	x	o	xooooxxxxooooooox	5.4	10	38	56
2-14	10:00	17	x	x	o	xooooxxxxooooooox	6.9	22	39	56
2-14	11:00	18	x	x	o	xooooxxxxooooooox	6.2	7	41	57
2-14	12:00	19	x	x	o	xooooxxxxooooooox	6.4	335	43	54
2-14	13:00	20	x	x	o	xooooxxxxooooooox	6.6	244	43	51
2-14	14:00	21	x	x	o	oooooxxxxooooooox	5.4	349	43	51
2-14	15:00	22	x	x	o	oooooxxxxooooooox	5.0	356	43	50
2-14	16:00	23	x	o	o	xooooxxxxooooooox	4.8	3	44	48
2-14	17:00	24	x	x	o	xooooooooooooooo x	3.1	15	42	53
2-14	18:00	25	x	x	o	xooooooooooooooox	1.9	28	39	64

2-14	19:00	26	x	x	o	xooooooooooooooox	3.1	42	36	65
2-14	20:00	27	x	x	o	xooooooooooooooox	2.4	34	35	70
2-14	21:00	28	x	x	o	xooooooooooooooox	2.4	14	34	76
2-14	22:00	29	x	x	o	xooooooooooooooox	3.0	30	32	78
2-14	23:00	30	x	x	o	xooooooooooooooox	2.0	14	32	82
2-15	0:00	31	x	x	o	xooooooooooooooox	1.3	299	31	86
2-15	1:00	32	x	x	o	xooooooooooooooox	1.5	214	31	90
2-15	2:00	33	x	x	o	xooooooooooooooox	2.0	227	29	89
2-15	3:00	34	x	x	o	xooooooooooooooox	1.7	153	29	90
2-15	4:00	35	x	x	o	xooooooooooooooox	1.8	12	28	86
2-15	5:00	36	x	x	o	xooooooooooooooox	2.3	16	27	86
2-15	6:00	37	x	x	o	xooooooooooooxoox	2.1	15	28	82
2-15	7:00	38	x	x	o	xooooooooooooxoox	2.3	23	27	79
2-15	8:00	39	x	x	o	xooooooooooooxoxx	3.2	15	33	66
2-15	9:00	40	x	x	o	xxooooooooooooxxxx	4.0	54	36	56
2-15	10:00	41	x	x	o	xxooooooooooooxxxx	5.4	74	39	45
2-15	11:00	42	x	x	o	xxooooooooooxxxxx	4.1	71	42	42
2-15	12:00	43	x	x	o	xxooooooooooxxxxx	4.2	194	44	40
2-15	13:00	44	x	x	o	xxoooooxxoooooxxxx	4.2	283	46	38
2-15	14:00	45	x	x	o	xxooooooooooxxxxx	3.7	31	47	36
2-15	15:00	46	x	x	o	xxoooooxxoooooxxxx	3.2	95	48	35
2-15	16:00	47	x	x	o	xxoooooxxxxooxxxxx	4.2	95	48	35
2-15	17:00	48	x	x	o	xxooxxoxxxxoxxxxx	2.7	118	45	44
2-15	18:00	49	x	x	o	xxoxoxxxxxoxxxxxx	1.2	96	40	54
2-15	19:00	50	x	x	o	xxxooooxxxooxxxxx	1.2	72	37	60
2-15	20:00	51	x	x	o	xoooooxxxooooxxxxx	1.4	93	36	61
2-15	21:00	52	x	x	o	xxooxxxooxxxxxxxx	4.0	88	35	56
2-15	22:00	53	x	x	o	xxxxxxxxxxxxxxxxx	3.7	86	33	60
2-15	23:00	54	x	x	o	xxxxxxxxxxxxxxxxx	2.7	79	32	59
2-16	0:00	x	x	x	x	xxxxxxxxxxxxxxxxx	-	-	-	-

Key: x = closed and o = open. Intake ports are in order as shown on diagram in Appendix F.

2.2.2 Weather Conditions

Prior to the test date, the weather was cool and rainy. The wood logs were exposed to the elements which resulted in high surface moisture in the logs. On February 11, the AirSource Technologies' van and equipment trailer arrived at 3:30 PM. The weather was in the upper 40s with periodic heavy rainfall. The weather during the test varied from 27 degrees with snow flurries to rain in the 30 degrees range to sunny in the upper 40's. Mostly the time was cloudy in the 30s. The Barametric pressure was 29.41 evening of the 13th and rose to 29.91 by the end of the test at midnight on the 15th.

2.2.3 Production

Kiln #5 was loaded with 57.33 tons of wood logs which included 2.03 tons of brands for the fire box section. The yard wood contained between 27.5 to 34.1 percent moisture. The brands contained between 1.0 to 18.0 percent moisture. The kiln produces 7.85 tons of charcoal and 11.84 tons of brands. The moisture in the charcoal and brands prior to wetting down contained 1.0 percent moisture and 6.1 to 11.7 percent after wetting down to quench remaining smoldering.

3.0 Summary of Test Results

The emission testing results are presented in Table IV in English units and Table IV in Metric units. The results are listed by hourly time intervals from the corresponding runs.

Table IV
Summary of Emissions Test Results (English)

Hour	Time	Run ID	Actual Emissions Lb/Hr	Allowable PWR Lb/Hr	Actual Opacity Readings	Allowable Opacity
1	18:00	V-1 + S-2	7.83	4.29		
2	19:00	V-2 + S-2	7.89	4.29		
3	20:00	V-2 + S-2	7.89	4.29		
4	21:00	S-1	3.47	4.29		
5	22:00	S-1	3.47	4.29		
6	23:00	S-1	3.47	4.29		
7	0:00	S-1	3.47	4.29		
8	1:00	S-1	3.47	4.29		
9	2:00	S-1	3.47	4.29		
10	3:00	S-3	3.05	4.29		
11	4:00	S-3	3.05	4.29		
12	5:00	S-3	3.05	4.29		
13	6:00	S-3	3.05	4.29		
14	7:00	S-4	5.91	4.29	14.4	20.0
15	8:00	S-4	5.91	4.29	15.1	20.0
16	9:00	S-4	5.91	4.29	20.4	20.0
17	10:00	S-4	5.91	4.29	24.5	20.0
18	11:00	S-4	5.91	4.29	29.7	20.0
19	12:00	S-4	5.91	4.29	44.1	20.0
20	13:00	S-5	14.00	4.29	38.3	20.0
21	14:00	S-5	14.00	4.29	41.4	20.0
22	15:00	S-5	14.00	4.29	30.8	20.0
23	16:00	S-5	14.00	4.29	38.5	20.0
24	17:00	S-5	14.00	4.29	33.5	20.0
25	18:00	S-6	15.34	4.29	22.4	20.0
26	19:00	S-6	9.51	4.29		
27	20:00	S-6	9.51	4.29		

28	21:00	S-6	9.51	4.29		
29	22:00	S-6	9.51	4.29		
30	23:00	S-7, S-8	41.58	4.29		
31	0:00	S-7, S-8	41.58	4.29		
32	1:00	S-7, S-8	41.58	4.29		
33	2:00	S-7, S-8	41.58	4.29		
34	3:00	S-7, S-8	41.58	4.29		
35	4:00	S-7, S-8	41.58	4.29		
36	5:00	S-7, S-8	41.58	4.29		
37	6:00	S-7	45.21	4.29		
38	7:00	S-7, S-9	49.53	4.29	23.7	20.0
39	8:00	S-7, S-9	49.53	4.29	36.1	20.0
40	9:00	S-9, S-10	64.97	4.29	45.7	20.0
41	10:00	S-9, S-10	64.97	4.29	47.7	20.0
42	11:00	S-9, S-10	64.97	4.29	49.8	20.0
43	12:00	S-9, S-10	64.97	4.29	47.5	20.0
44	13:00	S-9, S-10	64.97	4.29	46.0	20.0
45	14:00	S-9, S-10	64.97	4.29	39.3	20.0
46	15:00	S-9, S-10	64.97	4.29	46.6	20.0
47	16:00	S-9, S-10	64.97	4.29	64.5	20.0
48	17:00	S-11	88.92	4.29	55.8	20.0
49	18:00	S-11, S-12	76.26	4.29	55.3	20.0
50	19:00	S-11, S-12	76.26	4.29		
51	20:00	S-11, S-12	76.26	4.29		
52	21:00	S-11, S-12	76.26	4.29		20
53	22:00	S-11, S-12	76.26	4.29		20
54	23:00	S-12, S-13	57.26	4.29		20

Comments
Total pounds emitted over 54 hours = 1689
*** Opacity readings were difficult to read due to downwash and heavy moisture. Most reading were after the condensate plume against a treeline background.**

Table V
Summary of Emissions Test Results (Metric)

Hour	Time	Run ID	Actual Emissions g/Hr	Allowable PWR g/Hr	Actual Opacity Readings	Allowable Opacity
1	18:00	V-1 + S-2	3551	1946		
2	19:00	V-2 + S-2	3578	1946		
3	20:00	V-2 + S-2	3578	1946		
4	21:00	S-1	1574	1946		
5	22:00	S-1	1574	1946		
6	23:00	S-1	1574	1946		
7	0:00	S-1	1574	1946		
8	1:00	S-1	1574	1946		
9	2:00	S-1	1574	1946		
10	3:00	S-3	1383	1946		
11	4:00	S-3	1383	1946		
12	5:00	S-3	1383	1946		
13	6:00	S-3	1383	1946		
14	7:00	S-4	2680	1946	14.4	20.0
15	8:00	S-4	2680	1946	15.1	20.0
16	9:00	S-4	2680	1946	20.4	20.0
17	10:00	S-4	2680	1946	24.5	20.0
18	11:00	S-4	2680	1946	29.7	20.0
19	12:00	S-4	2680	1946	44.1	20.0
20	13:00	S-5	6350	1946	38.3	20.0
21	14:00	S-5	6350	1946	41.4	20.0
22	15:00	S-5	6350	1946	30.8	20.0
23	16:00	S-5	6350	1946	38.5	20.0
24	17:00	S-5	6350	1946	33.5	20.0
25	18:00	S-6	6957	1946	22.4	20.0
26	19:00	S-6	4313	1946		
27	20:00	S-6	4313	1946		

28	21:00	S-6	4313	1946		
29	22:00	S-6	4313	1946		
30	23:00	S-7, S-8	18858	1946		
31	0:00	S-7, S-8	18858	1946		
32	1:00	S-7, S-8	18858	1946		
33	2:00	S-7, S-8	18858	1946		
34	3:00	S-7, S-8	18858	1946		
35	4:00	S-7, S-8	18858	1946		
36	5:00	S-7, S-8	18858	1946		
37	6:00	S-7	20505	1946		
38	7:00	S-7, S-9	22464	1946	23.7	20.0
39	8:00	S-7, S-9	22464	1946	36.1	20.0
40	9:00	S-9, S-10	29466	1946	45.7	20.0
41	10:00	S-9, S-10	29466	1946	47.7	20.0
42	11:00	S-9, S-10	29466	1946	49.8	20.0
43	12:00	S-9, S-10	29466	1946	47.5	20.0
44	13:00	S-9, S-10	29466	1946	46.0	20.0
45	14:00	S-9, S-10	29466	1946	39.3	20.0
46	15:00	S-9, S-10	29466	1946	46.6	20.0
47	16:00	S-9, S-10	29466	1946	64.5	20.0
48	17:00	S-11	40329	1946	55.8	20.0
49	18:00	S-11, S-12	34587	1946	55.3	20.0
50	19:00	S-11, S-12	34587	1946		
51	20:00	S-11, S-12	34587	1946		
52	21:00	S-11, S-12	34587	1946		20
53	22:00	S-11, S-12	34587	1946		20
54	23:00	S-12, S-13	25970	1946		20

Comments

Total grams emitted over 54 hours = 766,030

*** Opacity readings were difficult to read due to downwash and heavy moisture. Most reading were after the condensate plume against a treeline background.**

The reopening of the rear vent stack was estimated at 5.83 lbs/hr (2,630 g/hr). The total amount of particulate emissions during two entire batch processes was 1,689 lbs over the 54 hour startup and burn phase. Of the 1,689 lbs, 23.25 lbs came from the rear vent stack. Based on 7.85 tons of charcoal produced at 8.8% moisture, the emission factor is 215.16 lbs/ton of charcoal produced.

4.0 Sampling and Analytical Procedures

The particulate emissions sampling and analytical procedures were performed in accordance with USEPA Methods and are details in the AirSource Technologies' Report entitled, "Source Emissions Report, Prepared for Shell Engineering & Associates, Inc., regarding testing of Charcoal Kiln #5 at Royal Oak Enterprises, Inc. - Kenbridge, Virginia. The body of this report is found in Appendix B.

The opacity readings were done by certified opacity readers using EPA Method 9. Appendix C contains their certifications.

5.0 Conclusion

The conclusion is based upon the emission testing data in this report and the following assumptions:

1. Opacity readings were difficult but not impossible to read against a treeline background. The Method 9 attached and dettached plum procedures were followed because of high moisture content.

2. The reopening of the rear vent stack on February 14, 1998 at 6:10 p.m. which had less than 15% opacity observed was estimated at 5.83 lbs/hr.

The particulate emissions ranged from 3.05 lbs/hr (1,383 g/hr) to 88.92 lbs/hr (40,329 g/hr) with corresponding opacity reading ranging from 14% to 64%.

SOURCE EMISSIONS REPORT

Prepared for

Shell Engineering and Associates, Inc.

Regarding testing of

Charcoal Kiln #5

at

Royal Oak Enterprises
Kenbridge, Virginia
Facility ID No. 51-111-0011

Performed on February 12 - 16, 1998

By

AIRSOURCE TECHNOLOGIES, INC.
11635 W. 83rd Terrace
Lenexa, Kansas, 66214
(913) 492-1613

Project No. 2258

PREFACE

This report was prepared by AirSource Technologies, Inc., and contains the results of testing that was conducted at the Royal Oak Enterprises, Inc., charcoal manufacturing facility in Kenbridge, Virginia, on February 12 - 16, 1998. To the best of our knowledge the data contained in this report is accurate and complete. Any questions concerning this report should be directed to Mr. Daniel Soderberg, Project Manager or Mr. George Cobb, President.

Mr. Daniel Soderberg
Project Manager

Dr. George Scheil
Quality Assurance Manager

Approved By:

Mr. George Cobb
President

March 16, 1998

TABLE OF CONTENTS

APPENDICES

SECTION 1 - INTRODUCTION

1.1 CLIENT INFORMATION

Testing was performed at the request of Shell Engineering and Associates, Inc., 2403 W. Ash St., Columbia, MO, 65203.

1.2 TEST SITE INFORMATION

1.2.1 Description of Facility

Testing was performed at the Royal Oak Enterprises charcoal production facility in Kenbridge, Virginia.

1.2.2 Location of Facility

The tested facility is located at Highway 137, Kenbridge, VA 23944.

1.2.3 Owner/Operator of Facility

The tested facility is owned and operated by Royal Oak Enterprises, Inc., Suite 800, 900 Ashwood Parkway, Atlanta, GA 30338

1.2.4 Contact Persons

The contact person at Shell Engineering was Mr. David Seidel, . The contact person for Royal Oak was Mr. Paul McAllister, Plant Manager.

1.3 PURPOSE OF TESTING

Testing was performed to determine the facility's compliance with Virginia's process weight regulation and to provide requested data to USEPA Region III.

1.4 TESTING ORGANIZATION

1.4.1 Company

Testing was performed by AirSource Technologies, Inc., 11635 W. 83rd Terrace, Lenexa, KS, 66214.

1.4.2 Personnel

AirSource personnel who conducted the tests were:

Mr. Daniel Soderberg, Project Manager,
Mr. Pete Liebl, CEM Project Manager,
Mr. Kevin EuDaly, Environmental Scientist
Mr. Finnegan Schall, Environmental Scientist
Mr. Robert Phillips, Environmental Scientist and
Ms. Lisa Wallace, Environmental Scientist.

1.5 REGULATORY REPRESENTATIVES

Testing was observed by Ms. Angela McFadden, Environmental Engineer, USEPA Region III. Mr. Gene Riley of the USEPA Emission Measurement Center was also in attendance.

1.6 SUMMARY OF TESTING PERFORMED

Testing was performed to measure emissions during an entire production run (batch). The tested kiln had two emission points. A 16" diameter roof vent was open during the initial "start-up" phase only. The 19" rear stack was open during the entire batch cycle. Testing was performed simultaneously on both sources during the start-up phase, and on the rear stack only for the remainder of the production cycle.

A modified EPA Method 5/202 sampling train was used to measure filterable and condensible particulate emissions. These fractions have been reported separately, but due to the nature of the samples, complete separation of filterable and condensible particulate could not be achieved. The "filterable results" contain some contribution from condensible organic matter.

Oxygen and carbon dioxide measurements were made continuously according to EPA Method 3A.

SECTION 2 - SUMMARY OF RESULTS

2.1 RUN IDENTIFICATION

A total of 15 runs were performed during the test. Two runs were performed on the vent stack, and were designated V1 and V2. Thirteen runs were performed on the rear stack, and were designated as S1 through S13. Run S2 was the first run, while run S1 was the second run. Runs S3, S4, S5 and S6 were performed sequentially. Runs S7 through S12 were not performed sequentially, but were interleaved as necessary to minimize down-time during filter changes. The times associated with each run are summarized in Table 2-1.

Table 2-1
Run Times

Train ID	Date	Run start/stop times		
V-1	13-Feb	18:15 - 19:15		
V-2	13-Feb	19:20 - 21:25		
S-1	13-Feb	22:20 - 02:50		
S-2	13-Feb	18:17 - 21:39		
S-3	14-Feb	03:05 - 07:10		
S-4	14-Feb	07:40 - 12:03		
S-5	14-Feb	12:33 - 16:34		
S-6	14-Feb	18:10 - 22:40		
S-7	14-Feb	22:46 - 23:46	00:56 - 01:41	02:53 - 03:45
		05:45 - 06:25	07:40 - 08:20	
S-8	14-Feb	23:54 - 00:54	01:46 - 02:46	03:45 - 05:45
S-9	15-Feb	06:50 - 07:40	08:25 - 09:15	10:02 - 10:17
		11:08 - 11:33	12:40 - 13:35	14:42 - 15:22
S-10	15-Feb	09:23 - 09:58	10:26 - 10:55	11:35 - 12:35
		13:40 -14:35	15:25 - 15:50	16:05 - 16:45
S-11	15-Feb	16:49 - 17:04	17:24 -17:39	19:22 - 19:37
		20:12 - 20:27	21:40 -22:40	
S-12	15-Feb	17:50 - 19:10	19:42 - 20:12	20:40 - 21:40
S-13	15-Feb	23:03 - 23:43		

2.2 CONDENSIBLE AND FILTERABLE PARTICULATE MATTER

The results of the particulate emission testing are summarized in Tables 2-2 and 2-3.

Table 2-2
Summary of Results (American Units)

Parameter	Unit	V1	V2	S2	S1	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Moisture	%	9.06	26.90	8.70	15.79	15.23	17.46	23.62	25.34	33.90	28.27	33.86	35.74	45.44	42.49	56.81
Stack Temperature	° F	149	384	77	131	136	153	173	214	243	239	308	335	421	435	322
O2	%V	17.4	10.4	16.1	15.1	16.4	16.1	14.9	14.0	11.4	12.0	8.7	8.7	3.5	3.4	4.8
CO2	%V	3.0	9.9	4.7	5.6	4.4	4.7	6.0	6.9	10.1	9.1	12.7	12.7	17.9	17.5	18.0
Stack Velocity	ft/min	633	1,054	288	697	755	779	902	985	1,118	1,174	1,219	1,208	1,052	1,070	706
Volumetric Flow Rate	acfm	870	1,449	583	1,409	1,526	1,575	1,823	1,991	2,261	2,372	2,464	2,441	2,127	2,163	1,428
Corrected Flow, Wet	scfm	741	890	563	1,237	1,331	1,339	1,504	1,544	1,687	1,780	1,689	1,618	1,270	1,271	963
Corrected Flow, Dry	dscfm	674	651	514	1,041	1,128	1,105	1,149	1,153	1,115	1,277	1,117	1,040	693	731	416
Filterable Particulate	gr/acf	0.194	0.216	0.244	0.124	0.109	0.158	0.302	0.191	0.319	0.274	0.450	0.592	0.647	0.427	0.273
	gr/dscf	0.250	0.482	0.277	0.168	0.148	0.226	0.480	0.330	0.647	0.510	0.992	1.390	1.986	1.263	0.935
	lb/hr	1.45	2.69	1.22	1.50	1.43	2.14	4.73	3.26	6.19	5.58	9.50	12.39	11.80	7.91	3.34
Condensible Particulate	gr/acf	0.580	0.253	0.168	0.163	0.124	0.280	0.593	0.366	2.013	1.592	2.098	3.044	4.229	3.002	3.888
	gr/dscf	0.749	0.562	0.191	0.220	0.168	0.398	0.941	0.632	4.082	2.957	4.629	7.143	12.983	8.883	13.344
	lb/hr	4.32	3.14	0.84	1.97	1.62	3.78	9.27	6.25	39.02	32.37	44.33	63.70	77.13	55.68	47.59
Total Particulate	gr/acf	0.774	0.469	0.413	0.287	0.233	0.438	0.896	0.557	2.332	1.866	2.548	3.636	4.876	3.429	4.160
	gr/dscf	0.999	1.044	0.468	0.389	0.316	0.624	1.421	0.962	4.729	3.467	5.622	8.533	14.969	10.145	14.280
	lb/hr	5.77	5.83	2.06	3.47	3.05	5.91	14.00	9.51	45.21	37.95	53.84	76.09	88.92	63.59	50.93
Isokineticity	%	82.8	121.4	99.3	101.5	95.9	95.3	97.0	100.1	101.7	93.6	96.7	99.2	101.4	100.0	107.5

Table 2-3
Summary of Results (Metric Units)

Parameter	Unit	V1	V2	S2	S1	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Moisture	%	9.06	26.90	8.70	15.79	15.23	17.46	23.62	25.34	33.90	28.27	33.86	35.74	45.44	42.49	56.81
Stack Temperature	° C	65	196	25	55	58	67	78	101	117	115	153	168	216	224	161
O2	%V	17.4	10.4	16.1	15.1	16.4	16.1	14.9	14.0	11.4	12.0	8.7	8.7	3.5	3.4	4.8
CO2	%V	3.0	9.9	4.7	5.6	4.4	4.7	6.0	6.9	10.1	9.1	12.7	12.7	17.9	17.5	18.0
Stack Velocity	m/min	192.9	321.3	87.9	212.6	230.2	237.5	274.9	300.2	340.9	357.7	371.6	368.1	320.8	326.2	215.3
Volumetric Flow Rate	acm/min	24.6	41.0	16.5	39.9	43.2	44.6	51.6	56.4	64.0	67.2	69.8	69.1	60.2	61.3	40.4
Corrected Flow, Wet	scm/min	21.0	25.2	15.9	35.0	37.7	37.9	42.6	43.7	47.8	50.4	47.8	45.8	36.0	36.0	27.3
Corrected Flow, Dry	dscm/min	19.1	18.4	14.6	29.5	31.9	31.3	32.5	32.6	31.6	36.2	31.6	29.5	19.6	20.7	11.8
Filterable Particulate	mg/acm	444	495	559	285	250	362	692	437	730	628	1029	1355	1480	977	624
	mg/dscm	573	1,103	634	385	338	516	1,098	755	1,481	1,166	2,271	3,181	4,545	2,890	2,141
	g/hr	655	1,219	554	682	648	970	2,143	1,480	2,805	2,530	4,310	5,620	5,350	3,589	1,513
Condensible Particulate	mg/acm	1,327	578	386	373	284	640	1,358	838	4,608	3,643	4,802	6,966	9,679	6,870	8,898
	mg/dscm	1,713	1,287	437	504	384	912	2,154	1,447	9,342	6,768	10,595	16,348	29,714	20,330	30,541
	g/hr	1,961	1,423	382	892	736	1,712	4,204	2,834	17,697	14,680	20,105	28,888	34,977	25,249	21,582
Total Particulate	mg/acm	1,771	1,073	945	657	534	1,003	2,050	1,275	5,338	4,270	5,832	8,321	11,159	7,847	9,522
	mg/dscm	2,286	2,390	1,072	890	722	1,428	3,252	2,202	10,823	7,934	12,866	19,529	34,259	23,220	32,682
	g/hr	2,617	2,642	936	1,574	1,385	2,682	6,347	4,313	20,503	17,210	24,414	34,508	40,327	28,839	23,095
Isokineticity	%	82.8	121.4	99.3	101.5	95.9	95.3	97.0	100.1	101.7	93.6	96.7	99.2	101.4	100.0	107.5

2.3 PROCESS OPERATING CONDITIONS

Processes data is presented in the Final Report prepared by Shell Engineering.

2.4 POTENTIAL ERRORS IN TESTING

The sample rate during run V2 was outside the target isokinetic range of 80-110%. The isokinetic percent for this run was 121.4%. This was the result of a rapid increase in moisture content during the last third of the run, due to a significant increase in stack temperature. The bias in the results from this would have been minimal for the following reasons:

- The anisokinetic error would not have affected the condensible fraction, which represented over half of the collected mass.
- Of the filterable fraction, 97% of this mass was collected on the final filters. Only extremely small particles (sub-micron) could have passed through the impinger train. These fine particles would also have been too small to be significantly affected by isokinetic error, which primarily affects larger particles.
- Error from anisokinetic sampling is a function of the inertia of the particles and is therefore a function of the square of the velocity. Because of the very low stack velocity, the actual bias from the isokinetic error would have been many times less than it would have been if the stack flow rate was in the usual range for Method 5 sampling.
- The isokinetic rate during the previous Vent run was at the lower end of the range (82.8%). The errors from these two runs would cancel out to some degree.

SECTION 3 - FACILITY DESCRIPTION AND OPERATION

Detailed facility and process information is provided in the Final Report prepared by Shell Engineering and Associates, Inc.

SECTION 4 - SAMPLING AND ANALYTICAL PROCEDURES

4.1 DESCRIPTION OF SAMPLING LOCATIONS

Diagrams of the Roof Vent and Rear Stack sampling locations are shown in Figures 4-1 and 4-2, respectively.

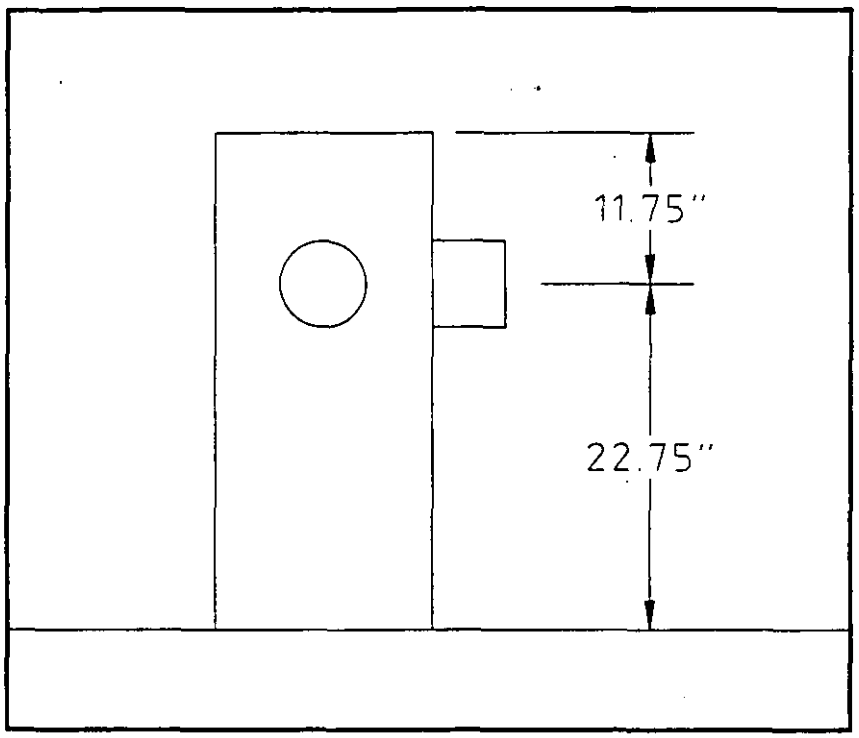

Figure 4-1
Rear Vent Stack Sampling Location

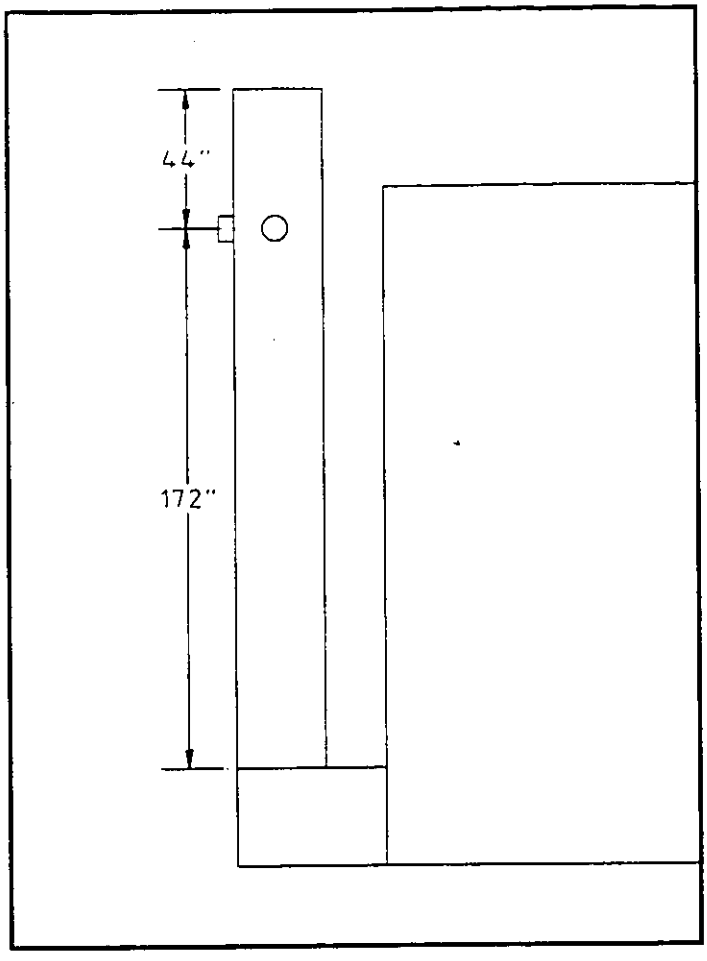

Figure 4-2
Rear Stack Sampling Location

4.2 TRAVERSE POINT LAYOUTS

Diagrams of the vent and stack traverse point layout are shown in Figures 4-3 and 4-4. Actual point locations can be found in Appendix B.

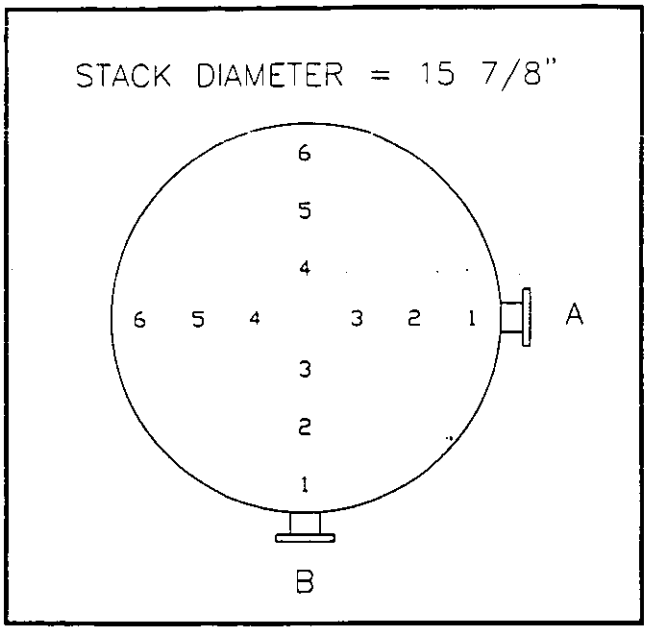

Figure 4-3
Roof Vent Stack Diagram

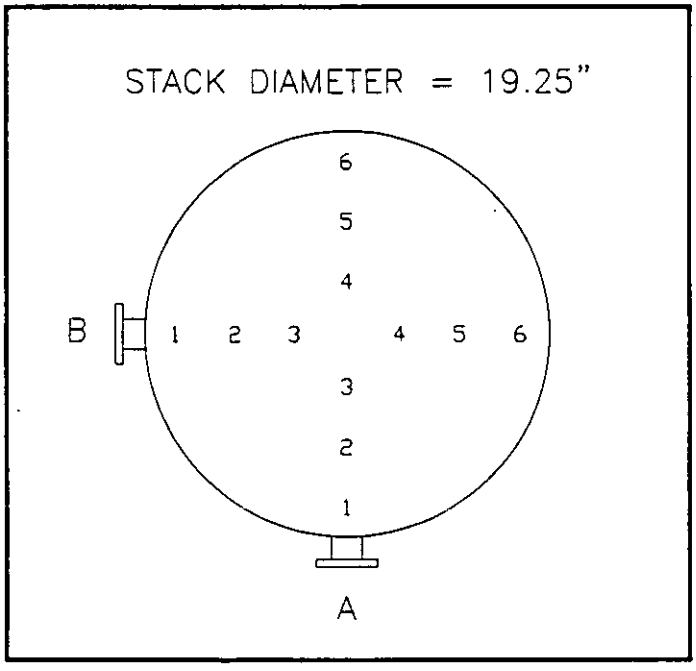

Figure 4-4
Rear Stack Diagram

4.3 SAMPLING PROCEDURES

4.3.1 Traverse Point Layout

Traverse point layouts were determined according to EPA Method 1 (40 CFR, Part 60, Appendix A). A 12-point layout was used for the roof vent stack because the anticipated short run time would not have allowed for all the points to be sampled by the end of the run if a 24-point traverse was used. When it was determined that the vent stack run time would be longer than anticipated, each point was sampled twice.

4.3.2 Stack Flowrate

Stack flowrates were determined according to EPA Method 2 (40 CFR, Part 60, Appendix A). An electronic pressure transducer was placed in parallel to the oil manometer to allow more precise readings when the flowrate was very low.

4.3.3 Molecular Weight

Molecular weight was determined by continuous emissions monitor according to EPA Method 3A. During start-up, separate analyzers were used on the the vent and stack. Instrument calibrations were performed at approximately 12-hour intervals. A bias check was performed at approximately 4-hour intervals.

Since the CEM run times did not correspond to the Method 5/202 run times, O_2 and CO_2 concentrations for each run were determined by time-weighting the corresponding CEM runs.

During Run 5, the CEM system was off-line for about 3 hours while the conditioning system was cleaned. During this time, an integrated stack gas sample was collected in a Tedlar bag and was analyzed when the CEM system was operational.

The following analyzers were used:

California Analytical 100F Oxygen analyzer
California Analytical 3300A Carbon dioxide analyzer
California Analytical 200F Combination oxygen/carbon dioxide analyzer

The stack gas was conditioned by passing it through a cooled condenser to remove moisture and tars. Sample was then passed through a series to midget impingers charged with water to further remove organic vapors. Finally, gas was filtered through silica gel and a glass fiber filter before being delivered to the analyzers.

4.3.4 Particulate Matter

Testing for filterable and condensible particulate was performed using a modified EPA Method 5/202 sampling train. Impinger weights were measured to the nearest 0.1 g prior to sampling. The train configuration was as follows:

Impinger	Type	Charge
1	Modified GBS	100 ml H_2O
2	Modified GBS	100 ml H_2O
3	Modified GBS	100 ml H_2O
4	GBS	100 ml H_2O
5	Knockout	Dry
6	Modified GBS	Silica Gel

A heated probe was connected directly to the first impinger. A glass-fiber filter was placed between impinger 5 and the silical gel impinger. A diagram of the sampling train is shown in Figure 4-11.

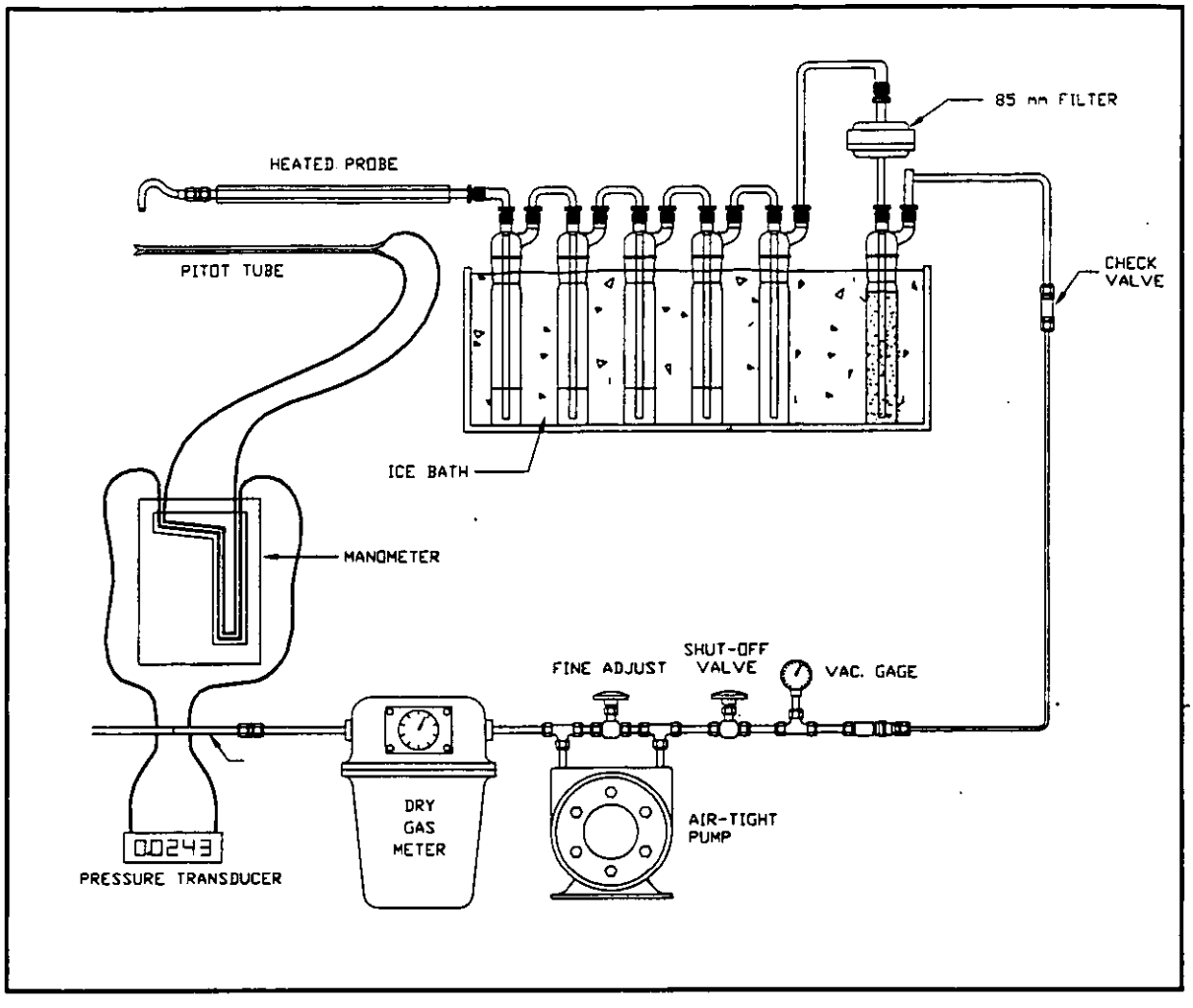

Figure 4-5
Modified Method 5/202 Sampling Train

The train was operated at a nominal sampling rate of 0.2 cfm. The target run time was 4 hours, but some of the runs had shorter run times because of filter plugging.

Due to the high concentrations of filterable particulate matter, the filters clogged rapidly during the last half of the test. Some of the trains were modified so that two filter holders could be operated in parallel, thus extending the run time between filter changes.

Trains were leak-checked before and after each run, and any time a filter replacement was necessary.

The meter box consoles were Nutech Model 2010 sampling consoles. Probes and umbilicals were manufactured by Apex instruments.

4.4 TRAIN RECOVERY PROCEDURES

Each train recovery generated the following samples:

Container #1 - Impinger Catch
Container #2 – Acetone Rinse
Container #3 – Methylene Chloride Rinse
Container #4 – Final Filter
Container #5 – Pre-Extraction Filter

The recovery procedure was as follows:

The impingers were weighed to determine moisture content.

The contents of impingers 1-5 were filtered into Container #1 using a pressurized Teflon filter column with a 47 mm Whatman 541 paper filter.

The nozzle and probe liner were brushed 3 times with acetone, which was filtered into Container #2 using the same filter column and filter that was used to filter the impinger contents.

The impingers and connecting glassware were rinsed 3 times with acetone and filtered into Container #2

The final filter was removed from the filter holder and placed in Container #4.

The front of the filter holder was rinsed 3 times with acetone and filtered into Container #2

A final rinse of 50 ml acetone was passed through the filter column into Container #2. Additional acetone was used if a large amount of organic matter was still visible in the rinse. It was not possible to completely extract all organic material in this manner.

The nozzle and probe liner were then brushed 2 times with methylene chloride and filtered through the same column and filter into Container #3.

The impingers, connecting glassware, and filter front were rinsed 2 times with methylene chloride and filtered into Container #3.

The filter from the filter column was removed and transferred to Container #5

If the filter column filter became clogged, it was replaced with a new filter. Before replacement, each filter was rinsed with 50 mL acetone into Container #2 to remove organic matter.

Samples were stored at room temperature until analysis.

4.5 SAMPLE EXTRACTION PROCEDURES

Samples were extracted according to the flowchart shown in Figure 4-6.

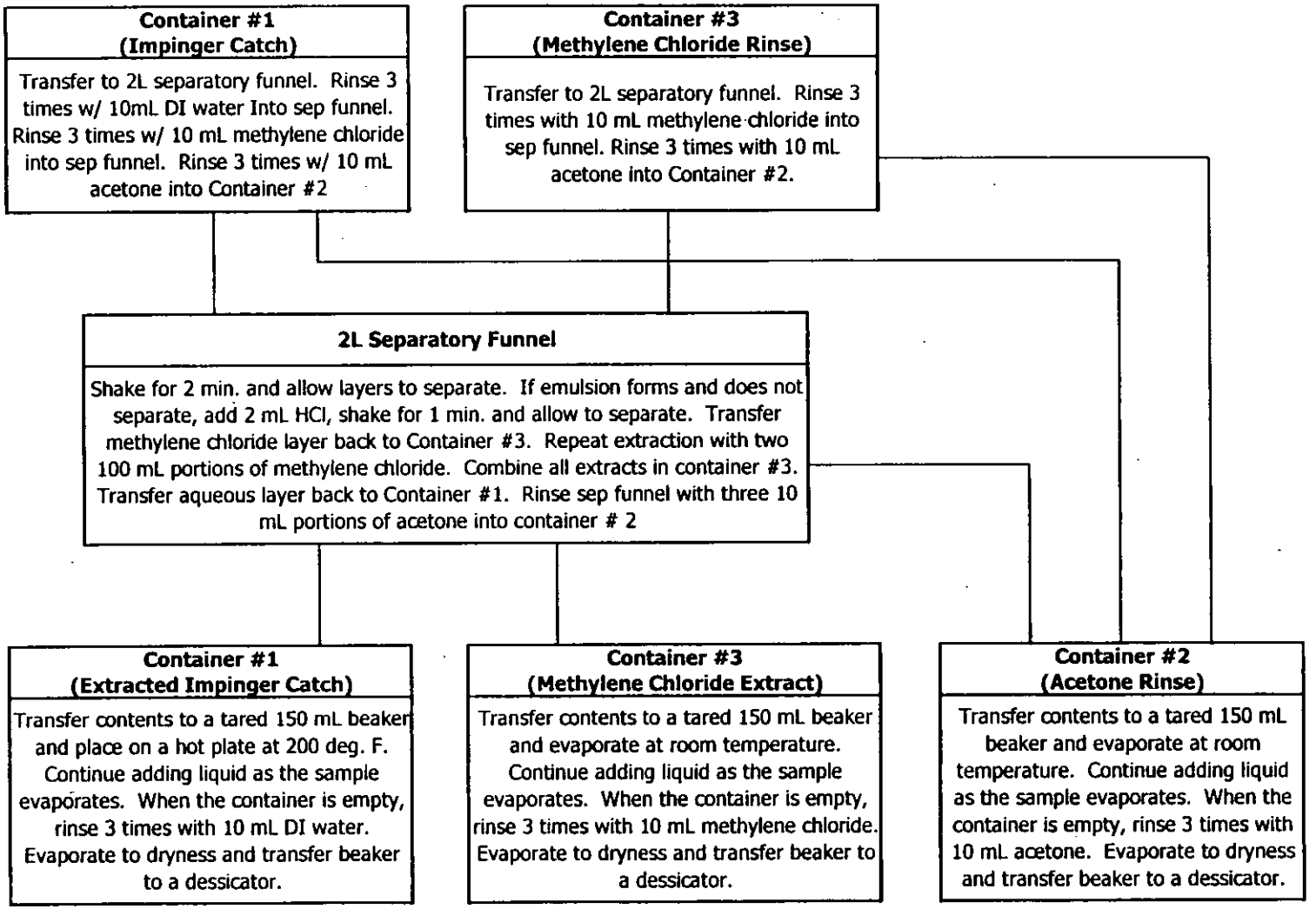

Figure 4-6
Sample Extraction Procedure

4.6 ANALYTICAL PROCEDURES

4.6.1 Gravimetric Analysis

AirSource Technologies, Inc. performed gravimetric analysis of the samples. Evaporated samples were placed in a dessicator for 24 hours before weighing, and were then weighed at intervals of at least 6 hours. Because many of the fractions contained volatile organic compounds, they would continue to loose weight and never reach a constant weight. Weights were considered constant if the change between consecutive weighings was less than 1% of the total weight gain or if the change was less than 0.5 mg. The average of the final two weighings was used as the final weight.

A few of the samples continued to gain weight. This was most likely the result of oxidizable compounds in the sample. In these cases, the earliest weight was used as the final weight.