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Hampton Randle

VOC Emissions from Sitka Spruce Lumber

Report to

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Report by

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November 18, 2003

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VOC Emissions from Sitka spruce Lumber

I. Results Summary

One charge containing 73.3 board feet of 2x4 Sitka spruce lumber was dried in a small-scale kiln at Oregon State University. The kiln dry- and wet-bulb temperatures were provided by Hampton Lumber. The dry-bulb temperature was ramped to 165°F (74°C) over 15 hours, then to 180°F (82°C) over 9 hours. The wet-bulb temperature was ramped to 150F (43°C) over 15 hours, then held for the rest of the the drying time. The air velocity was 750 feet per minute (2.5 m/s). The kiln was indirectly heated with steam. There was no humidification. Regulating the amount of air entering the kiln controlled venting and the humidity.

A JUM 3-100 total hydrocarbon analyzer was used to measure organic emissions following EPA Method 25A. It has been demonstrated through past studies (Lavery and Milota, 2000, Forest Products Journal, NCASI/Georgia-Pacific SEP project) that this method in this small-scale kiln gives results similar to a large-scale kiln. The data for the test is summarized in the Table 1.

TABLE 1. Summary of results.

Charge	Wood Source	Initial MC	Final MC	VOC[a]	Time
		%	%	lb/mbf	hrs
1	Randle	70.7	16.1	0.24	48.8

[a] To adjust the VOC value to a different final moisture content, add or subtract 0.004 for each percentage point of moisture content difference. The validity of this adjustment is clear in Figure 7.

.25 lb @ propane

II. Lumber Source and Handling

Three charges of lumber were delivered to Oregon State University on September 9, 2003, one to be dried and two as a backups. The wood was wrapped in plastic at the mill to prevent predying and loss of organic compounds.

The wood was wrapped and sealed in plastic in packages of 6 to 12 boards and stored at 0°C charges until the charge could be run on November 10. An analyzer problem prevented the drying from occurring when the wood was received.

III. Kiln Description and Operation

A schematic of the kiln is shown in Figure 1. The kiln box is approximately 4' by 4' by 4'. It is indirectly heated by steam. Four dry-bulb thermocouples and two wet-bulb thermocouples are located on the entering-air side of the load. The dry-bulb

thermocouples are spaced in a grid. The two wet-bulb thermocouples are under a single sock at the center of the entering-air side of the load.

Humidity

A 200 L/min MKS mass flow meter controlled and measured the amount of air entering the kiln. It was factory calibrated and checked using a bubble meter. The amount of air entering the kiln is based on the wet-bulb temperature - if it is above setpoint, the airflow is increased and if it is below setpoint the airflow is decreased. This is analogous to venting for a commercial kiln. A minimum of 5 L/min entered the kiln at all times, more than removed by the analyzer (< 1.8 L/min). Putting air into the kiln at a rate of 100 L/min causes the pressure in the kiln to be 60 to 130 Pa above ambient, depending on location in the kiln (high-pressure or low-pressure side). Thus, any fugitive leakage should be out of the kiln. Two additional flow meters can be manually set to provide additional airflow. The steam spray line is disabled, so no water vapor is added to the kiln atmosphere.

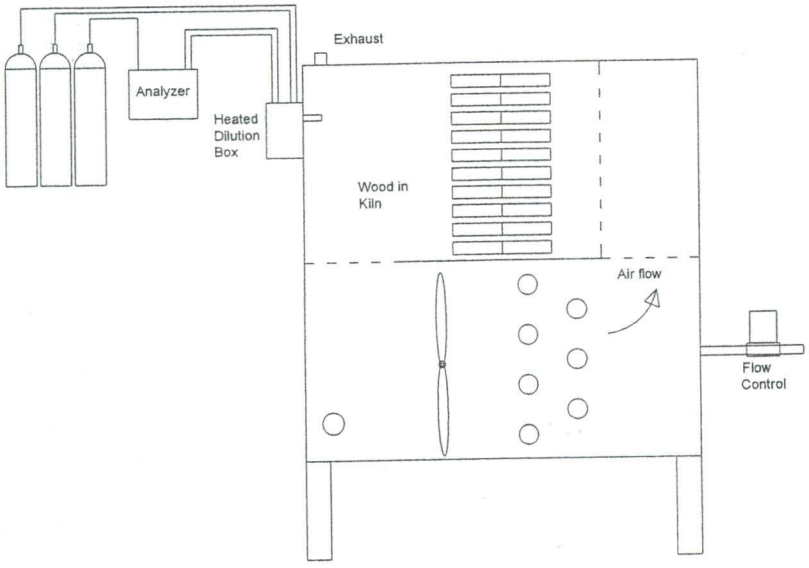


FIGURE 1. Schematic of kiln and sampling system.

Temperature

Temperature in the kiln is controlled by indirect steam heating. When the average of the four dry-bulb thermocouples is below setpoint, the steam pressure in the coil is increased. When it is above setpoint, steam flow to the coil is reduced.

Schedules

The drying schedule supplied by the mill is shown in Table 2. The actual temperatures are presented in Figure 2. The starting temperature was approximately 70°F.

TABLE 2. Drying schedule for charges 1 and 2.

Step time, hours	Ramp time, hours	Dry-bulb, °F	Wet-bulb, °F
15	15	165	150
Until dry	8	180	150

Charge Sequence

The lumber was removed from the freezer and allowed to warm in plastic. The kiln was made ready and 2" were trimmed from each end of each board to give 44" samples. These were then weighed, placed in the kiln, and dried according to the schedule provided. Sampling for hydrocarbon was done as described in section IV. At the end of drying the wood was weighed, oven dried, and reweighed so initial and final moisture contents could be determined by ASTM D4442.

IV. Sampling Systems and Methodologies

Figures 3a and 3b show the hydrocarbon sampling system. The fuel gas was hydrogen. The span gas was EPA Protocol 1527 ppm propane in air, the mid-gas was certified 881 ppm propane. The zero gas was Grade 5 air. Detailed sampling procedures are in Appendix 1 and a summary is presented below.

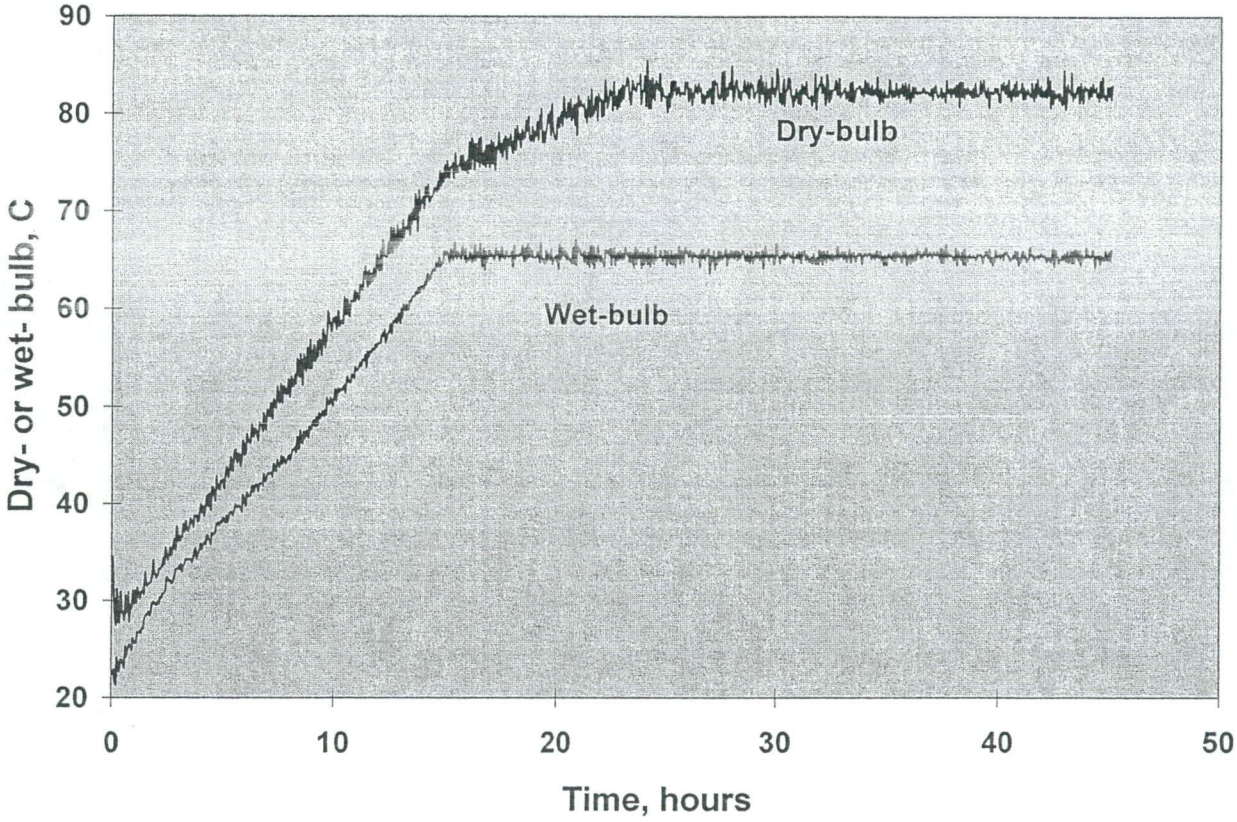


FIGURE 2. Dry- and wet-bulb temperatures during the drying cycles.

The THC sample was drawn from the kiln directly into a dilution/filter box mounted on the side of the kiln. The box was heated to 125°C. It is assumed that the gas in the kiln is well-mixed and that the composition in the kiln near the exhaust is the same at the composition of the exhaust. The sample line from the box to the analyzer was heated to 133°C. The valve at the back of the analyzer was heated to 145°C.

Leak checks were conducted before and after the charge was dried. Valves are closed and all components from just behind the probe tip to the valve at the back of the analyzer are placed under a 19.5 inHg vacuum. Less than one inHg pressure change during two minutes is acceptable and this was met.

Total flow and sample flow to the analyzer were checked using an NIST-traceable flow meter. This was done at the beginning and end of each sampling interval. The meter was attached to the system near the probe tip within the heated box. The valves were repositioned so that the sample came from the meter rather than the kiln. Readings made with the dilution gas off and on indicated the dilution ratio used to lower the gas moisture

content to the detector. The flow readings were verified by observing the change in the analyzer reading for span gas before and after the dilution gas was turned on. The dilution ratio calculated based on the analyzer readings was within 1 to 2% of that determined by the flow meter. Dilution was used when the gas moisture content in the kiln was greater than 15%.

Calibration of the zero and span of the detector was done at the beginning of each run (about every three hours with one eight-hour interval each night). The calibration gas was introduced by setting the valves so the calibration gas entered the system near the probe tip at ambient pressure. The calibration was checked at the end of each run with no adjustments made to the zero or span during the run. The span drift was always less than two percent of full scale for a run and generally less than one percent. The zero drift was minimal during the two days of sampling.

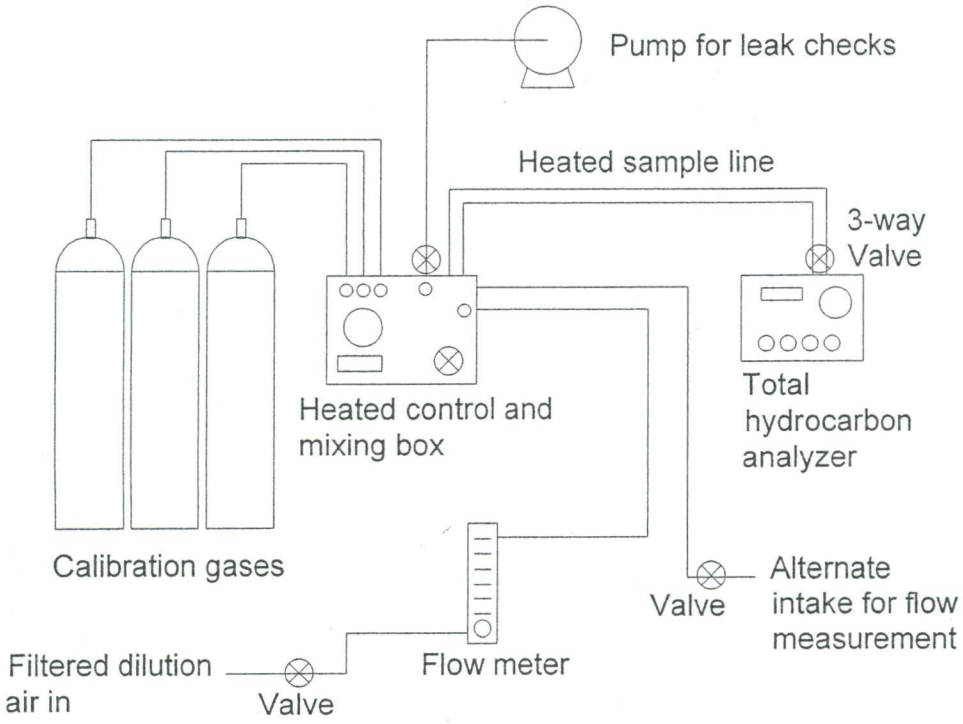


FIGURE 3A. Schematic of heated filter box with air dilution system, heated sample line, and analyzer. Sample enters heated box from back of drawing (box is attached to kiln).

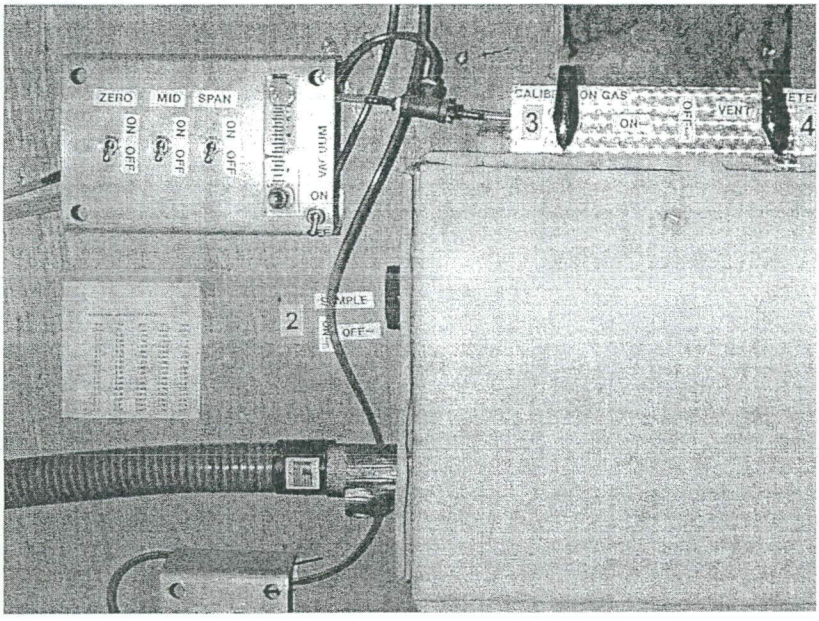


FIGURE 3B. Photo of VOC sampling system showing heated sample box (with white insulation), toggle valves and flow meter for calibration gases (upper left), on/off valve for calibration gas (3 at upper center right), heated sample line to analyzer (green tube, lower left), valve for sample (2 at center), toggle valve to vacuum pump (near calibration gas valves), and vent/flowmeter valve (4 at upper right).

V Data Reduction and Treatment

The "FlowCalc" page in the files "Hampton, Kiln.XLS" in Appendix 2 show the calculations for each 3-minute interval during the charge. Column A is a reading number. Columns B and C are the clock and charge times, respectively. Columns D and E are the average dry- and wet-bulb temperatures. Column F is the vapor pressure at the wet-bulb temperature. The absolute humidity is shown in column G and the molal humidity in column H.

Flow calculations

The volumetric dry gas flow rate in column I (files "Hampton, Kiln.XLS" in Appendix 2) is the flowmeter reading adjusted for the meter calibrations and the molar humidity of the entering gas. This is in standard (at 0°C) liters per minute. In column J this has been converted to a mass flow rate in kg/min and in column K is the same information is expressed as a molal flow rate.

Moisture calculations

The water removal rate in g/min (column L) (files "Hampton, Kiln.XLS" in Appendix 2) is calculated from the humidity and the gas flow rate and the total water (column M) is an integration of column L over time.

The moisture content of the wood at each interval in the event (column N) was determined by reducing the MC of the wood based on the amount of water leaving the kiln during the previous 3-minute interval.

Total hydrocarbon calculations

The original total hydrocarbon analyzer reading is shown in column O (files "Hampton, Kiln.XLS" in Appendix 2). In column P this has been corrected to compensate for the range setting switch on the analyzer and scaling between the analyzer reading and the computer reading. Also in column P, the THA data between sampling runs has been adjusted to the average of the data during the 12-minute periods before and after the down time. The dilution THA (column Q) is the corrected THA reading divided by the dilution ratio (from column Y). In column R we have the opportunity to compensate for the effect of moisture on the JUM detector. This was not done so column R equals column Q. Finally in column S, the hydrocarbon concentration is converted to a dry gas basis concentration.

In column T the hydrocarbon flow rate in g/min as carbon is calculated in a manner analogous to the water flow rate using the dry gas flow rate and the hydrocarbon concentration. Column U is the integral of column T over time, the cumulative hydrocarbon release up to that point in the schedule. Column V is the cumulative unit emissions, that is, column U divided by the oven-dry weight of the wood in the kiln.

Column X indicates the hydrocarbon sampling run and column Y is the dilution ratio during that run. The next two columns, Z and AA, are the cumulative dry gas and water during the kiln cycle. These are used obtain the average gas moisture contents. The corrected wood moisture content, as discussed in section VI, is shown in column AC. The kiln air and analyzer air moisture contents are shown in columns AD and AE.

At the end (bottom) of the FlowCalc spreadsheet are summaries by run of the flow data for the total hydrocarbon run intervals.

The other pages in the files "Hampton, Kiln.XLS" are graphs of the data in the FlowCalc page. Moisture content and board weight data are in the files named "Hampton, Board.XLS."

VI. Sampling Results

The hydrocarbon emissions are summarized graphically here. All emission data is presented in detail in Appendix 2.

Figure 4 shows total hydrocarbon concentration and vent rate versus time. The vent rate is high first 10 hours, and then decreases. The concentration increases to a peak of approximately 70 ppm as the kiln temperature is increased to 180°F over the first 15 hours. The concentration then decreases to a minimum at 25 to 30 hours. A slight increase occurs after this time as venting decreases. This is something we have often observed.

Figure 5 shows the cumulative hydrocarbon emissions and the rate of emissions versus time. The cumulative emissions (in grams) is the emissions up to any point in time in the schedule. One gram of emissions corresponds to 0.03 lb/mbf. The rate of emissions (in grams per minute) is how much is coming out per unit time. The maximum occurs at 15 to 20 hours after the temperature reaches its maximum and the drying rate is still high.

Figure 6 shows the wood moisture content versus time. The measured moisture content is obtained by doing a mass balance on the gas steams, then subtracting the water leaving the kiln from the initial moisture content of the wood. The estimated moisture content should most accurately represent the MC-time relationship because the initial and final moisture contents match the oven-dry test. This initial and final moisture contents were 70.7 and 16.1%, respectively.

Figure 7 shows the cumulative hydrocarbon emissions versus moisture content. The emissions for drying to any moisture content can be read from this graph. If, for example, a mill wanted to dry to 19% instead of 16.1%, the total hydrocarbon emissions could be estimated by adjusting the VOC level by 0.0038 lb/mbf/%MC (Table 3).

TABLE 3. Estimated VOC release at different final moisture contents.

Final Moisture content %	Difference MC %	Difference VOC lb/mbf	VOC release lb/mbf
12	4.1	0.016	0.253
13	3.1	0.012	0.249
14	2.1	0.008	0.245
15	0.1	0.004	0.241
16	0.1	0.000	0.237
16.1	0	0.000	0.237
17	-0.9	-0.003	0.234
18	-1.9	-0.007	0.230

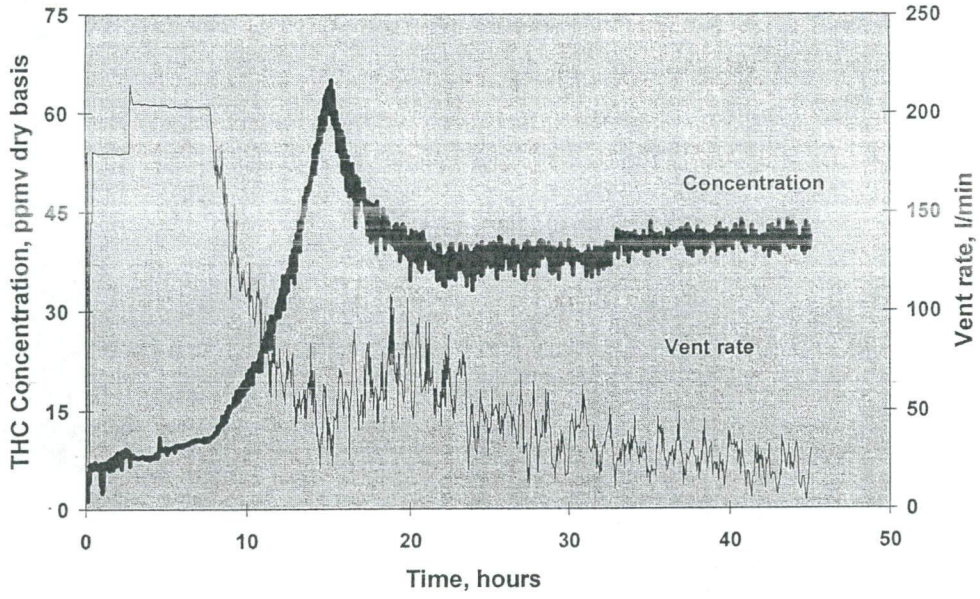


FIGURE 4. Hydrocarbon concentration and vent rate versus time.

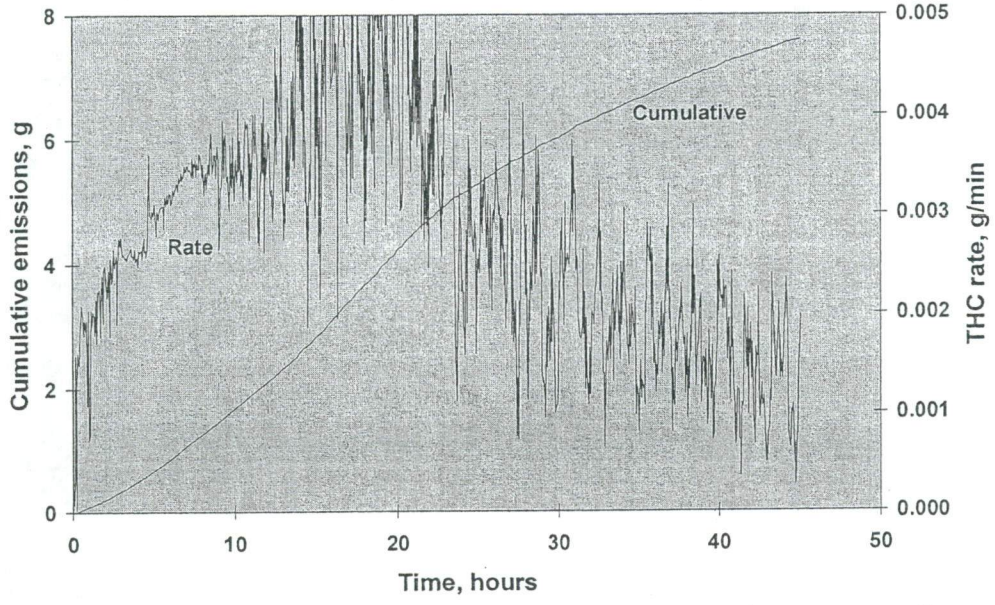


FIGURE 5. Cumulative emissions and rate of emissions versus time.

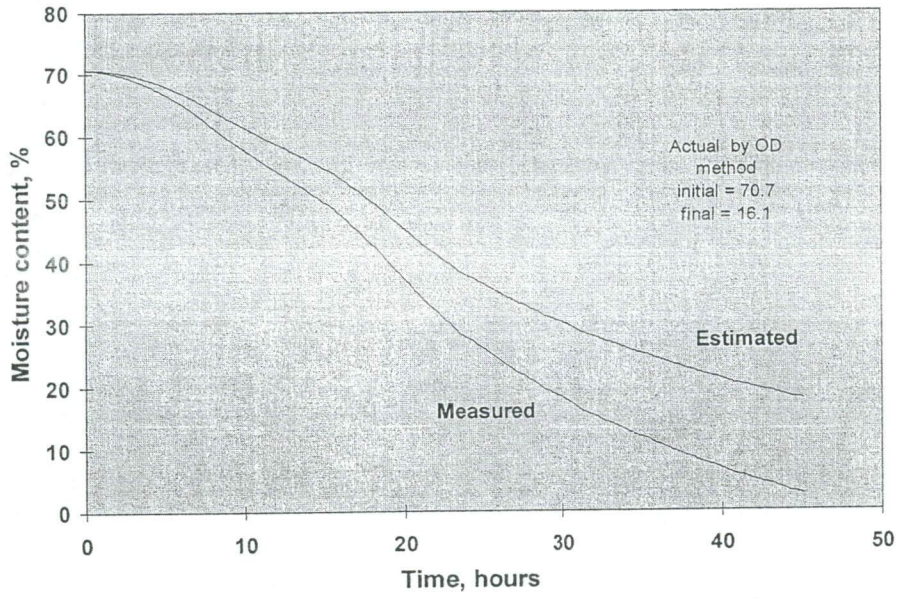


FIGURE 6. Moisture content versus time for the charge.

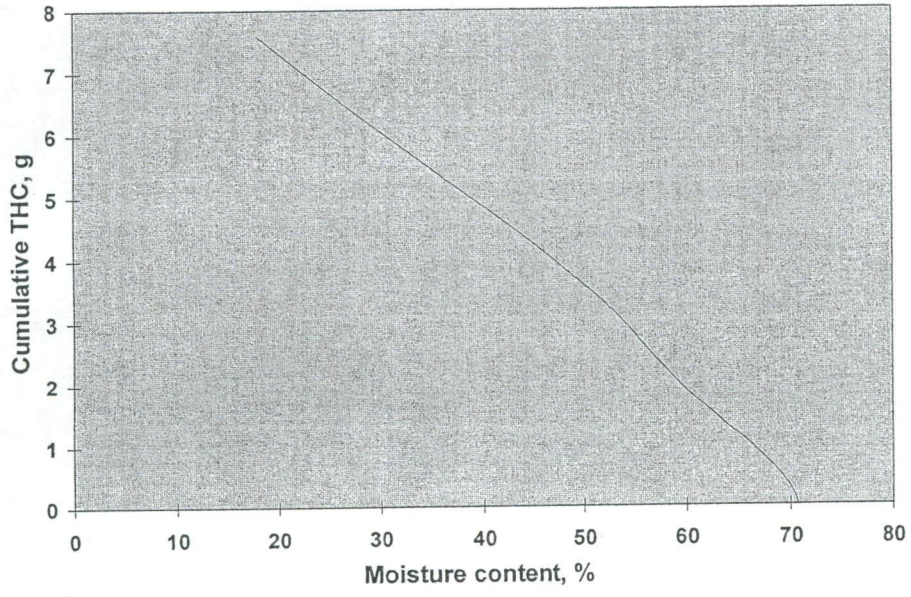


FIGURE 7. Cumulative emissions versus moisture content of the charge. One g is approximately 0.03 lbs.mbf.

Table 4 shows the VOC results by run for the charges. The interval time periods shown in the table include the times between sampling and mass calculations are adjusted to account for these. Sampling occurred for 96% of the total drying time as it took 5 to10 minutes to check and calibrate the analyzer and set up dilution between three-hour sampling periods. Copies of all field sampling sheets, including dilution system and heated component data, in Appendix 3.

TABLE 4. Summary of sample runs for charge.

Sample Run	Time hrs	Dry Flow Rate @68 l/min	Wet Flow Rate @68 l/min	THC wet conc ppmv	THC mass as C lbs/mbf	THC rate as C lb/hr/mbf	Average Wood MC %	Air MC %	Anal. MC %
1	2.75	187.4	192.0	6.6	0.010	0.0036	70.4	2.4	2.4
2	1.75	220.0	229.7	7.5	0.008	0.0047	69.2	4.2	4.2
3	4.50	206.8	222.2	9.9	0.027	0.0060	65.8	6.9	4.0
4	7.95	77.8	93.7	30.8	0.057	0.0072	57.3	17.0	9.8
5	4.55	74.0	97.5	31.0	0.038	0.0082	46.7	24.1	14.0
6	3.30	57.6	75.7	28.1	0.019	0.0058	38.9	24.0	13.9
7	3.75	46.1	60.6	29.1	0.018	0.0048	33.9	24.0	14.2
8	4.30	36.9	48.5	29.0	0.016	0.0038	31.4	23.9	13.9
9	8.25	29.0	38.2	30.7	0.027	0.0032	23.6	24.0	13.9
10	3.15	22.9	30.1	30.6	0.008	0.0025	23.1	23.9	14.1
11	4.55	16.7	21.9	31.4	0.009	0.0019	17.2	24.0	13.9
Sum	48.82				**0.237**				
Ave.		88.6	100.9	24.1		0.0047		18.0	10.8

VII Quality Assurance

Leak checks

Leak checks were performed on the VOC system before and after drying.

Calibration

Data for the calibration gases are given in Appendix 4. The mid gas was not named because the analyzer was within tolerance without naming. The calibration sheet for the flow meter is also included is also included in Appendix 4 as is the thermocouple calibration check.

VIII Discussion

There were no anomalies during the charges or unexpected problems that would affect the data.

Appendix 1. Detailed Sampling Procedures

INSTRUCTIONS FOR CHECKS OF EMISSIONS KILN

Purpose: Ensure kiln is operating correctly

Clock time: Record from computer

Run time: Record from computer. Check the box if the computer screen being refreshed and time is advancing.

Box temperature: Read from metal electrical box under desk, left controller. The top and bottom numbers should be similar on the box should be similar, about 126 C..

Valve temperature: Read from metal electrical box under desk, right controller. The top and bottom numbers should be similar on the box should be similar, about 154 C..

Dry-bulb temperature: Read from computer screen. Compare to graph to be sure it's correct. If it's not within a degree or two of the chart, check again in a few minutes. During startup (the first 3 or so hours), it may not be able to track. If it's too high, the heat valve should be closed, too low and the heat valve should be open. If it does not appear to be working correctly, call Mike or Mark.

Wet-bulb temperature: Read from computer screen. Compare to graph to be sure it's correct.

If it is too low, it means that the kiln atmosphere is too dry. Check the flow meters. If Flow1 is about 10 L/min (its lower limit), make sure that Flow2 and Flow3 are turned off

I*f it's too high,* then either the kiln atmosphere is too humid or the sock is not being wetted. If Flow 1 is near 200 L/min (its upper limit) add venting by opening Flow2 and/or Flow 3. The maximum for Flow2 is 50 L/min, if it reads over this value for several readings, reduce it to about 45 L/min. Don't change Flow3 often, rather set it and leave it for several hours if possible. Keep the Flow 3 reading constant by small adjustments. As Flow1 decreases or Flow2 turned down, there is more pressure behind Flow3 and the flow increased. Check for water in the wet-bulb reservoir (push the float down and make sure it's getting water).

Check both Wet-bulb1 and Wet-bulb2 and make sure they are reading about the same. If they differ by more than 2 C, call Mike or Mark.

If both wet-bulbs are reading the same as the dry-bulb, check the wet-bulb water.
If these procedures do not correct the wet-bulb temperature within 30 minutes, call Mike or Mark.

Line temperature: Read from gray box on wall above analyzer. It should read about 275°F.

Analyzer temperature: Push the temperature button on the analyzer. It should be in the 160 to 190°C range. When the lab is hot, it will read lower. Analyzer should usually be on range setting 3. All lights on the front of the analyzer should be green. The pressure should read about 200. Does the reading make sense - is it the same before and after an analyzer check; does increasing dilution cause a lower reading?

Chiller temperature: Read the chiller temperature. It should be about -1°C.

Flow 1: Read from computer. The value of Flow1 changes depending on the wet-bulb. If Flow 1 is 10 L/min and the wet-bulb is too low, there's probably nothing we can do. If it's 200 L/min and the wet-bulb is too high, Flow2 and/or Flow3 can be opened. Flow2 and Flow3 should be adjusted so that Flow1 stays below 175 to 200 L/min.

Dilution flow: Read dilution flow meter. It should read the same setting as the red flag. Do not adjust. If significantly different, investigate.

F/M Flow: Read from rotometer. This should be about 400 to 500 cc/min.

Line vacuum: Read from the vacuum gauge. This should be about 20"Hg.

INSTRUCTIONS - FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER
PRE-SAMPLE PROCEDURE

BACKGROUND INFORMATION

Get the dry- and wet-bulb temperatures from the kiln schedule or off the computer. Use the highest expected values for the run.

Read absolute humidity off the psychrometric chart.
Calculate

Percent moisture = 100 / [1 + 1 / 1.61*AbHum]
Target Dilution Ratio (TDR) = 15 / Percent Moisture

Event = the name of the drying cycle.
Run = the number of the 3-hour interval.
Operator, that's you.
Date and time are now, as you start the data collection process.

AMBIENT DATA

Call 9-754-0081 and get temperature and altimeter setting.
Local pressure in Pascals = (Altimeter - 0.23) x 3.3867
Read the laboratory temperature from the thermometer.

ANALYZER CALIBRATION

Set valves so that 1, 2 = off; 3=on; 4=vent. This allows gas to flow out of the vents from the calibration tanks and shuts off all other sources. Only calibration gas should go through the detector.

Open the zero gas tank valve
- zero toggle switch up (on), others down (off)
- set flow to 3.5 L/min using regulator on tank
- wait for a stable reading (about 30 to 60 seconds)
- use the zero dial (pot) on THA to get a zero reading
- read the analyzer
- read computer
- note pot setting
- close valve on zero gas tank

Open span gas tank valve
- span toggle switch up (on), others down (off)
- set flow to 3.5 L/min using regulator on tank
- set analyzer to range 4
- wait for a stable reading (about 30 to 60 seconds)
- use the span dial (pot) on THA to get a reading of 1527 ppm
- read the analyzer, record, for example, 1.53 as 1530
- read computer (should read about 153 due to range 4 setting)
- note pot setting

Open mid gas tank valve
- mid toggle switch up (on), others down (off)
- set flow to 3.5 L/min using regulator on tank
- set analyzer to range 3
- wait for a stable reading (about 30 to 60 seconds)
- read analyzer (do not adjust pot settings), record, for example, 8.50 as 850
- read computer (should about 850 with analyzer on range 3)
- check for within tolerance
- turn off mid gas
- all toggle switches off

SET DILUTION FLOW BEFORE RUN

Set valves so that 1, 2, 3 = off; 4=meter. This allows gas to flow only from the meter to the detector.

Use the Gilibrator to take 5 readings of the total flow rate (TFR). This is the total flow drawn by the analyzer and should be about 2.6 L/min

Make sure the average does not include any "bad" readings
Record the average, L/min = cc/min / 1000
Write the Event, Run, and "Pre-TFR" on the Gilibrator printout.

Calculate the next two values -

Target dilution flow rate (TDFR) is the TFR x (1 - DR)
Target sample flow rate (TSFR) is the TFR x DR
Check that the sum of these is the Total Flow Rate

Set dilution flow

Set red pointer to desired dilution flow (on meter with valve 1)
Slowly open lower valve on dilution flow meter (1=on; 2, 3=off; 4=meter)
Use upper valve on dilution flow meter to adjust flow
Do not adjust this meter after this point
Read the meter that you just set and record the value

Use the Gilobrator to take 5 readings of the sample flow rate (SFR). This is the flow through the analyzer after dilution is set. It will vary, depending on the dilution setting.

Make sure the average does not include any "bad" readings
Record the average, L/min = cc/min / 1000
Write "Pre-SFR" on the Gilobrator printout.

CHECK DILUTION FLOW BEFORE RUN

Set valves so that 1, 3 = on; 2=off; 4=vent. This allows gas to flow out of the vent from the calibration tank and shuts off all other sources. Calibration gas and dilution air will go through the detector.

Open span gas tank valve

span toggle switch up (on), others down (off)
set flow to 3.5 L/min using regulator on tank
wait for a stable reading (about 30 to 60 seconds)
if reading is >9.99, switch to range 4
record
set analyzer to range 3
turn off all calibration gas tank valves
all toggle switches off

Calculate the dilution ratio based on gas flow by dividing the Sample Flow Rate by the Total Flow Rate.

Calculate the dilution ratio based on span gas by dividing the Diluted span by the undiluted span.

If the Dilution ratios do not agree within 5% - DO NOT PROCEED****. Use
$100*(DR_{Span} - DR_{Flow})/DR_{Flow}$ to calculate the % difference.

**** check calculations, check that values for ppm and flows make sense, remeasure everything. If it still does not agree, call Mike or Mark

START RUN

Set valve so that 1, 2, 5 = on; 3, 4=off; all calibration tank valves off
Record the start time. Use the computer clock for all times or set your watch to the computer time.
Make sure analyzer is on appropriate range, usually range 3, to keep THC reading on computer between 60 and 750.

Monitor system, as needed. Record system condition at least hourly.
End time should be no more than 3 hours from start time.

POST-SAMPLE PROCEDURE

AT END OF RUN

Record your name as the operator.
Event = the drying cycle. Run = the 3-hour interval.
Operator, that's you. Date and time are now, as you start the data collection process.

AMBIENT DATA

Call 9-754-0081 and get temperature and altimeter
Local pressure = (Altimeter - 0.23) x 3.3867
Read the laboratory temperature from the thermometer.

Fill out appropriate information on Pre-sample side of data sheet for next run. This will save time in between runs.

END TIME

Record computer time.
DO NOT adjust dilution gas yet.

CHECK DILUTION FLOW AFTER RUN

Set valves so that 1, 3 = on; 2=off; 4=vent. This allows gas to flow out of the vent from the calibration tank and shuts off all other sources. Calibration gas and dilution air will go through the detector.

Open span gas tank valve
span toggle switch up (on), others down (off)
set flow to 3.5 L/min using regulator on tank
wait for a stable reading (about 30 -60 seconds)
record
all toggle switches off

Sample flow rate. Set valves so that 1=on; 2, 3 = off; 4=meter. This allows gas to flow only from the meter and the dilution to the detector.

Use the Gilibrator to take 5 readings of the sample flow rate (SFR). This is the flow through the analyzer with dilution on.
Make sure the average does not include any "bad" readings
Record the average, L/min = cc/min / 1000
Write "Post-SFR" on the Gilibrator printout.

Read dilution flow meter
To calculate the L/min, divide scfh by 2.12
Turn off dilution flow meter using valve 1

Total flow rate. Set valves so that 1, 2, 3 = off; 4=meter. This allows gas to flow only from the meter to the detector.

Use the Gilibrator to take 5 readings of the total flow rate (TFR). This is the total flow drawn by the analyzer and should be about 2.6 L/min
Make sure the average does not include any "bad" readings
Record the average, L/min = cc/min / 1000
Write "Post-TFR" on the Gilibrator printout.

CHECK CALIBRATION OF ANALYZER

Set valves so that 1, 2 = off; 3=on; 4=vent. This allows gas to flow out of the vents from the calibration tanks and shuts off all other sources. Only calibration gas should go through the detector.

Span gas tank valve should be open
span toggle switch up (on), others down (off)

set flow to 3.5 L/min using regulator on tank
set analyzer to range 4
wait for a stable reading (about 30 -60 seconds)
read analyzer (do not adjust pot settings), record, for example, 1.50 as 1500
read computer (should read about 152 due to range 4 setting)
note pot setting
check for within tolerance - between 1483 and 1573

Open mid gas tank valve
mid toggle switch up (on), others down (off)
set flow to 3.5 L/min using regulator on tank
set analyzer to range 3
wait for a stable reading (about 30 -60 seconds)
read analyzer (do not adjust pot settings), record, for example, 8.50 as 850
read computer (should read same as analyzer)
check for within tolerance

Open the zero gas tank valve
zero toggle switch up (on), others down (off)
set flow to 3.5 L/min using regulator on tank
wait for a stable reading (about 30 -60 seconds)
read analyzer (do not adjust pot settings)
read computer
note pot setting

Calculate the dilution ratio based on gas flow by dividing the Sample Flow Rate by the Total Flow Rate.

Calculate the dilution ratio based on gas flow by dividing the Sample Flow Rate by the Total Flow Rate.

Calculate % difference as 100 * {Absolute Value (DR_{Span}-DR_{Flow})} / DR_{Flow}

Record the time now as the end time for check.

Tear off the four sets of Gilibrator readings (Pre-TFR, Pre-SFR, Post-SFR, Post-TFR) and staple to paper with other records.

Start Pre-Sample procedure for next run.

Appendix 3. Samples of field data sheets.

Charge: Hampton 1
Date: ~~8 Sep 03~~ 11-10-03

Board		Weights			
		Initial Wt.	Final Wt.	Oven	
		kg	kg	kg	
1-	1	2.165	1.470	1.290	
1-	2	2.405	1.690	1.465	
1-	3	2.290	1.485	1.280	
1-	4	2.285	1.595	1.360	
1-	5	2.225	1.575	1.335	
1-	6	2.100	1.445	1.245	
1-	7	2.300	1.475	1.270	
1-	8	2.250	1.430	1.230	
1-	9	2.230	1.515	1.325	
1-	10	2.290	1.380	1.195	
1-	11	2.265	1.650	1.400	
1-	12	2.195	1.470	1.295	
1-	13	2.285	1.585	1.370	pitch
1-	14	2.070	1.415	1.220	
1-	15	2.120	1.485	1.280	
1-	16	2.290	1.570	1.335	
1-	17	2.420	1.705	1.475	
1-	18	2.310	1.630	1.385	
1-	19	2.225	1.460	1.265	
1-	20	2.275	1.400	1.205	
1-	21	2.410	1.640	1.410	
1-	22	2.290	1.530	1.330	
1-	23	2.110	1.485	1.315	
1-	24	2.065	1.410	1.235	
1-	25	2.395	1.605	1.355	
1-	26	2.410	1.440	1.190	
1-	27	2.230	1.615	1.385	
1-	28	2.295	1.645	1.390	
1-	29	2.345	1.655	1.420	
1-	30	2.160	1.385	1.230	
Sums:		0.000	0.000	0.000	
Averages:					

Charge:	1
Hampton Affiliates	
Page:	1

	Date		Time
Start:	11-10-03		12:30
End:	11-12-03		1:35

Clock time	Run time	✓	Run	Temperatures									Flows				Line Vac.
				Box	Valve	Dry-bulb	✓	Wet-bulb	✓	Line	Anlz	Chiller	Flow 1	✓	Dilution	F/M	
	hrs		#	°C	°C	°C		°C		°F	°C	°C	L/min		SCFM	ml/min	inHg
12:33	0		1	125	145	21		18		272	180	—	—		—	—	
3:15	2:45		1	125	145	35		32		272	192	—	183		1.5	—	
9:30	9		3/4	125	145	57	✓	48	✓	272	192	—	182		1.5	—	
11-11-03 5:25	16:53	✓	4	125	145	74		66		272	192	—	50		1.5		
5:43	17:11		5	124	145	78	✓	66	✓	272	192	—	126		1.5	—	
7:41	19:08		5	125	145	78		64		272	193		90		1.5		
8:25	19:52		5	125	145	80		65		272	192		60		1.5		
9:54	21:22		5	125	145	81		65		272	193		3		1.5		
13:18	24:46		-	125	145	83		66		272	192		54		1.5		
14:54	26:22		7	125	145	83		66		272	192		53		1.5		
15:15	28:42		8	125	145	82		65		272	192		8		1.5		
21:15	32:42		8	125	145	83		66		271	192		40		1.5		
11-12-03 5:36	47:06		9	125	145	83		66		272	193		85		1.5		
5:55	41:23	✓	10	125	145	82		66		272	193		38		1.5		
8:46	44:14		10	125	145	82		65		272	180		73		1.5		

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 70 - 165

Wet-bulb temperature: 70 - 150

Absolute humidity: —

Percent moisture: —

Target Dilution Ratio (TDR): 1.0

Event (kiln charge): Hampton 1

Run (sample): 1

Operator: MRM

Date: Nov 10

Time now : 12:25

AMBIENT DATA

Altimeter setting: 30.19 inHg

Laboratory temperature: 21 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	NA	does not apply	395
span	1.52 (1527)	NA	does not apply	381
mid	8.76	NA	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1.725 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) 1 L/min [TFR x (1 - DR)]

sample flow rate (TSFR) — L/min [TFR x DR]

Set and read dilution meter: — scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): — L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	—			

START TIME: 12:32 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 3 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 3:15 p Run (sample): 1

AMBIENT DATA

Airport pressure: _____ inHg Laboratory temperature: 71 °C

END TIME: 3:15

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	150	160

Sample flow rate (SFR) : _____ L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: _____ scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): _____ L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): _____ [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	150	160	1481 to 1573	381
mid	867	921	804 to 957	none
zero	0	0	-45 to +45	395

Dilution ratio (DR_{Span}): 1 [$Span_{Diluted}$ / Span]

Dilution ratio difference: — % [100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}]

End time for check: 3:20

Comments: Leak check 19.5" → 19.5" over 3 MIN
Are run ↑

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: <165F

Wet-bulb temperature: <150F

Absolute humidity: \

Percent moisture: \

Target Dilution Ratio (TDR): 1

Event (kiln charge): Hampton 1

Run (sample): 2

Operator: MRM

Date: 11-10-03

Time now : _____

AMBIENT DATA

Altimeter setting: _____ inHg

Laboratory temperature: _____ °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	0	does not apply	395
span	152 (1527)	163	does not apply	385
mid	880	936	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1726 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: _____ scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): _____ L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	—	—	—	—

START TIME: 15:24 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 4:59 Run (sample): 2

AMBIENT DATA

Airport pressure: 30.20 inHg Laboratory temperature: _____ °C

END TIME: 5:00

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	152	161

Sample flow rate (SFR) : _____ L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: _____ scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): _____ L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): _____ [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	1.52	161	1481 to 1573	
mid	8.77	9.33	804 to 957	none
zero	0.01		-45 to +45	

Dilution ratio (DR_{Span}): _____ [$Span_{Diluted}$ / Span]

Dilution ratio difference: _____ % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: 5:10

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: < 82 C

Wet-bulb temperature: < 65C

Absolute humidity: < 0.2

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 4

Operator: MRM

Date: Nov 10 03

Time now : 9:30p (21:30)

AMBIENT DATA

Altimeter setting: 30.20 inHg

Laboratory temperature: 21 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	0	does not apply	395
span	152 (1527)	~~1513~~ 162	does not apply	385
mid	880	933	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1.725 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 0.997 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	883	0.58	0.58	0

START TIME: 9:40 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM

Event (kiln charge): Hampton 1

Time now: 5:38

Run (sample): 4

AMBIENT DATA

Airport pressure: 30.25 inHg

Laboratory temperature: 22 °C

END TIME: 5:28

CHECK DILUTION FLOW AFTER RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	884	940

Sample flow rate (SFR) : 1,008 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh 0.71 L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1.716 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0.57 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION

[1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	~~884~~ 1,52	1628	1481 to 1573	386
mid	880	934	804 to 957	none
zero	0	1	-45 to +45	395

Dilution ratio (DR_{Span}): 0.58 [$Span_{Diluted}$ / Span]

Dilution ratio difference: 1.7 % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: 5:36

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: <165 F

Wet-bulb temperature: <150 F

Absolute humidity: 0.2

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 3

Operator: MRM

Date: Nov 10, 03

Time now : 5:00

AMBIENT DATA

Altimeter setting: 30.20 inHg

Laboratory temperature: 21 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	0	does not apply	395
span	152 (1527)	161	does not apply	385
mid	0.00	933	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1,730 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) 0.69 L/min [TFR x (1 - DR)]

0.6 sample flow rate (TSFR) 1,038 L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 988 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}$/Span]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	863	0.57	0.57	

START TIME: 5:07 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 9:30 Run (sample): 3

AMBIENT DATA

Airport pressure: 30.20 inHg Laboratory temperature: _____ °C

END TIME: 9:31

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	887	942

Sample flow rate (SFR) : 987 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1737 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 057 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	152	162	1481 to 1573	385
mid	880	933	804 to 957	none
zero	0	0	-45 to +45	395

Dilution ratio (DR_{Span}): 0.58 [$Span_{Diluted}$ / Span]

Dilution ratio difference: <2 % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: 937p

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82c

Wet-bulb temperature: 65 c

Absolute humidity: 0.2

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 5

Operator: MRM

Date: 11-11-03

Time now : 5:30

AMBIENT DATA

Altimeter setting: 30.25 inHg

Laboratory temperature: 22 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	0	does not apply	395
span	1530 (1527)	165	does not apply	389
mid	881	932	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1,745 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 1,002 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	888	0,57	0,58	1,7%

START TIME: 5:40a **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 9:50 Run (sample): 5

AMBIENT DATA

Airport pressure: 30,34 inHg Laboratory temperature: 21 °C

END TIME: 9:57

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	882	933

Sample flow rate (SFR) : 1,001 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1,730 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0.58 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	1510	1630	1481 to 1573	396
mid	875	931	804 to 957	none
zero	0	1	-45 to +45	395

Dilution ratio (DR_{Span}): 0.58 [$Span_{Diluted}$ / Span]

Dilution ratio difference: 0 % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: 10:02

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82

Wet-bulb temperature: 65

Absolute humidity: 0.2

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 6

Operator: MRM

Date: 11-11-03

Time now : 9:50

AMBIENT DATA

Altimeter setting: 30.34 inHg

Laboratory temperature: 21 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	0	does not apply	392
span	1520 (1527)	1647	does not apply	395
mid	881	935	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1,731 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 1,004 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	903	0.580	0.59	2

START TIME: 10:07 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 1:15 Run (sample): 6

AMBIENT DATA

Airport pressure: 30.25 inHg Laboratory temperature: 21 °C

END TIME: 1:20

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	899	944

Sample flow rate (SFR) : 1010 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): ~~1737~~ L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0.581 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	153	166	1481 to 1573	
mid	883	936	804 to 957	none
zero	0	1	-45 to +45	

Dilution ratio (DR_{Span}): 0.587 [$Span_{Diluted}$ / Span]

Dilution ratio difference: ~~0.591~~ 0 % [100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}]

End time for check: 1:25

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82

Wet-bulb temperature: 65

Absolute humidity: 0.2*

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 7

Operator: MRM

Date: 11-11-03

Time now: 1:15

AMBIENT DATA

Altimeter setting: 30.25 inHg

Laboratory temperature: 21 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	1	does not apply	392
span	1530 (1527)	166	does not apply	392
mid	883	936	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1,740 L/min (no dilution) [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: _____ scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 1008 L/min (dilution) [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	887	0.58	0.58	0

START TIME: 1:24 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 5:07 Run (sample): 7

AMBIENT DATA

Airport pressure: 30.24 inHg Laboratory temperature: 71 °C

END TIME: 5:07

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	881	941

Sample flow rate (SFR) : 1.004 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1.738 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0.58 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	1530	1620	1481 to 1573	395
mid	884	940	804 to 957	none
zero	0	1	-45 to +45	395

Dilution ratio (DR_{Span}): 0.58 [$Span_{Diluted}$ / Span]

Dilution ratio difference: 0 % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: 5:10

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82

Wet-bulb temperature: 65

Absolute humidity: 0.2

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 8

Operator: MRM

Date: 11-11-03

Time now : 5:05

AMBIENT DATA

Altimeter setting: 30.24 inHg

Laboratory temperature: 71 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	NO (0)		does not apply	
span	CHANGES FROM POST (1527)		does not apply	
mid			804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1739 L/min [1, 2, 3 = off; 4=meter]

Target

dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 997 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$			0.57	

START TIME: 5:13 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 9:15 pm Run (sample): 8

AMBIENT DATA

Airport pressure: 30.43 inHg Laboratory temperature: 20 °C

END TIME: 9:20pm

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	934	977

Sample flow rate (SFR) : 1,026 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1,5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1751 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0,59 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
~~span~~	~~1,590~~ 1,530	~~1708~~ 1641	1481 to 1573	
mid	883	938	804 to 957	none
zero	~~0~~	1	-45 to +45	

Dilution ratio (DR_{Span}): 0,61 [$Span_{Diluted}$ / Span]

Dilution ratio difference: _____ % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: _____

Comments:

FHA Temp = 183°C, but it was 192°C earlier. Then it came back to 192
this was probably after stop key

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82

Wet-bulb temperature: 65

Absolute humidity: 0.16

Percent moisture: 24

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 9

Operator: MRM

Date: 11-11-03

Time now : 9:15p

AMBIENT DATA

Altimeter setting: 30.43 inHg

Laboratory temperature: 26 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	No Run & Change Post (0)		does not apply	395
span	(1527)		does not apply	398
mid			804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1.746 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 1.013 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	903	0.59	0.58	2

START TIME: 9:30 pm **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM

Event (kiln charge): Hampton 1

Time now: 5:36

Run (sample): 9

AMBIENT DATA

Airport pressure: 30.42 inHg

Laboratory temperature: 19 °C

END TIME: 5:36

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	901	955

Sample flow rate (SFR): 1023 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1754 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): ~~1084~~ 0.583 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	1540	1647	1481 to 1573	395
mid	889	948	804 to 957	none
zero	0	1	-45 to +45	395

Dilution ratio (DR_{Span}): 0.585 [$Span_{Diluted}$ / Span]

Dilution ratio difference: 0.3 % [$100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}$]

End time for check: 5:44

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82

Wet-bulb temperature: 65

Absolute humidity: 0.17

Percent moisture: 25

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 10

Operator: MRM

Date: 11-12-03

Time now : 5:42

AMBIENT DATA

Altimeter setting: 30.42 inHg

Laboratory temperature: 19 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	1	does not apply	392
span	1520 (1527)	1638	does not apply	390
mid	883	937	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1.748 L/min [1, 2, 3 = off; 4=meter]

Target
dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]

sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 9.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 0.999 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	892	0.586	0.572	1

START TIME: 5:47 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM Event (kiln charge): Hampton 1

Time now: 8:47 Run (sample): 10

AMBIENT DATA

Airport pressure: 30.39 inHg Laboratory temperature: 28 °C

8:48 **END TIME:** 8:48

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	890	946

Sample flow rate (SFR): 1,019 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 1.5 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1,749 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0.58 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	1500	1611	1481 to 1573	392
mid	871	924	804 to 957	none
zero	0	1	-45 to +45	392

Dilution ratio (DR_{Span}): 059 [$Span_{Diluted}$ / Span]

Dilution ratio difference: 1.7 % [100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}]

End time for check: 8:54

Comments:

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - PRE

BACKGROUND INFORMATION

Dry-bulb temperature: 82

Wet-bulb temperature: 65

Absolute humidity: 0.16

Percent moisture: 24

Target Dilution Ratio (TDR): 0.6

Event (kiln charge): Hampton 1

Run (sample): 11

Operator: MRM

Date: 11-12-03

Time now : 847

AMBIENT DATA

Altimeter setting: 30.39 inHg

Laboratory temperature: 20 °C

ANALYZER CALIBRATION

[1, 2 = off; 3=on; 4=vent]

	Analyzer, ppm	Computer	Within range	Pot settings
zero	0 (0)	1	does not apply	392
span	152 (1527)	1636	does not apply	392
mid	870	921	804 - 957	none

SET DILUTION FLOW BEFORE RUN

Total flow rate (TFR): 1,752 L/min [1, 2, 3 = off; 4=meter]

Target
- dilution flow rate (TDFR) _____ L/min [TFR x (1 - DR)]
- sample flow rate (TSFR) _____ L/min [TFR x DR]

Set and read dilution meter: 1.5 scfh [scfh = L/min * 2.12]

Sample flow rate (SFR): 1,029 L/min [1 = on; 2, 3 = off; 4=meter]

CHECK DILUTION FLOW BEFORE RUN

[1, 3=on; 2=off; 4=vent]

	Analyzer	DR_{Span} [$Span_{Diluted}/Span$]	DR_{Flow} [SFR / TFR]	Difference, % $100*(DR_{Span} - DR_{Flow})/DR_{Flow}$
$Span_{Diluted}$	910	0.59	0.59	

START TIME: 9:00 **[1, 2, 5 = on; 3, 4 = off; tank valves off]**

ANALYZER RANGE: 2 **[60 < computer reading < 750]**

FIELD DATA SHEET FOR TOTAL HYDROCARBON ANALYZER - POST

Operator: MRM

Event (kiln charge): Hampton 1

Time now: 1[illegible]

Run (sample): 2 11

AMBIENT DATA

Airport pressure: 30.34 inHg

Laboratory temperature: 20 °C

12:00 **END TIME:** 1:23

CHECK DILUTION FLOW AFTER RUN [1, 3=on; 2=off; 4=vent]

	Analyzer	Computer
$Span_{Diluted}$	885	950

Sample flow rate (SFR) : 1005 L/min [1= on, 2, 3 = off, 4=meter]

Read dilution meter: 15 scfh _____ L/min [L/min = scfh*0.472]

Total flow rate (TFR): 1733 L/min [1, 2, 3 = off; 4=meter]
(attach print out with all four sets of data)

Dilution ratio (DR_{Flow}): 0.580 [SFR / TFR]

CHECK OF ANALYZER CALIBRATION [1, 2=off; 3=on, 4=vent]

	Analyzer	Computer	Within range	Pot settings
span	1510	0	1481 to 1573	390
mid	874	"	804 to 957	none
zero	0	"	-45 to +45	392

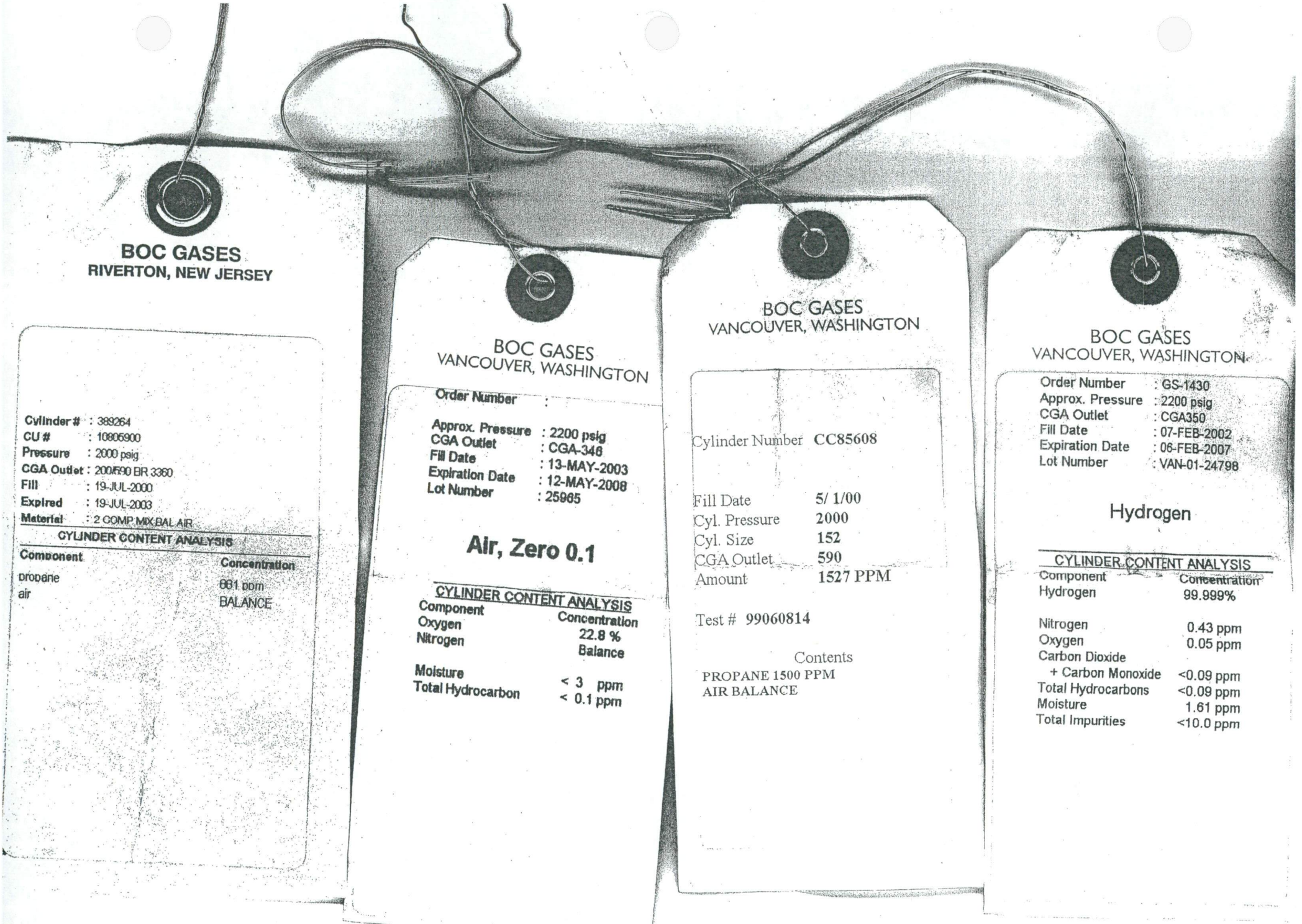
Dilution ratio (DR_{Span}): 0.586 [$Span_{Diluted}$ / Span]

Dilution ratio difference: 1 % [100*(Abs(DR_{Span} - DR_{Flow}))/DR_{Flow}]

End time for check: 1:31

Comments: Leak check POST 19.5" @ 1:33:07
19" @ [illegible] @ 1:42pm

Appendix 4. Calibration Data



BOC GASES
RIVERTON, NEW JERSEY

Cylinder #	: 389264
CU #	: 10805900
Pressure	: 2000 psig
CGA Outlet	: 200/590 BR 3360
Fill	: 19-JUL-2000
Expired	: 19-JUL-2003
Material	: 2 COMP MIX BAL AIR

CYLINDER CONTENT ANALYSIS

Component	Concentration
propane	661 ppm
air	BALANCE

BOC GASES
VANCOUVER, WASHINGTON

Order Number :

Approx. Pressure	: 2200 psig
CGA Outlet	: CGA-346
Fill Date	: 13-MAY-2003
Expiration Date	: 12-MAY-2008
Lot Number	: 25965

Air, Zero 0.1

CYLINDER CONTENT ANALYSIS

Component	Concentration
Oxygen	22.8 %
Nitrogen	Balance
Moisture	< 3 ppm
Total Hydrocarbon	< 0.1 ppm

BOC GASES
VANCOUVER, WASHINGTON

Cylinder Number	CC85608
Fill Date	5/ 1/00
Cyl. Pressure	2000
Cyl. Size	152
CGA Outlet	590
Amount	1527 PPM

Test # 99060814

Contents
PROPANE 1500 PPM
AIR BALANCE

BOC GASES
VANCOUVER, WASHINGTON

Order Number	: GS-1430
Approx. Pressure	: 2200 psig
CGA Outlet	: CGA350
Fill Date	: 07-FEB-2002
Expiration Date	: 06-FEB-2007
Lot Number	: VAN-01-24798

Hydrogen

CYLINDER CONTENT ANALYSIS

Component	Concentration
Hydrogen	99.999%
Nitrogen	0.43 ppm
Oxygen	0.05 ppm
Carbon Dioxide + Carbon Monoxide	<0.09 ppm
Total Hydrocarbons	<0.09 ppm
Moisture	1.61 ppm
Total Impurities	<10.0 ppm

TC Calibration	
6/10/2002	
Omega Calibrator C	PC Readout C
30.0	30.0
50.0	50.1
70.0	70.1
90.0	90.1
110.0	110.0

MKS INSTRUMENTS

Flow
Calibration Record Sheet
(200 SLM)

ERA #: 128989W

Customer: OREGON STATE UNIVERSITY

MKS Transfer Standard Type: 1559A-200L-SV

Serial Number: WS 136

MKS Primary Standard Type: A-200-1

Serial Number: 14952-1-1

Standard Flow Rate (SLM)	UUT Flow Rate (SLM)	UUT Error (SLM)	Percent of full scale Error
0.00	0.000	0.000	0.000%
50.000	50.880	0.880	0.440%
100.000	99.880	-0.120	-0.060%
150.000	150.040	0.040	0.020%
200.000	200.000	0.000	0.000%

UUT Model: 1559A-200L-SV

UUT Process Gas: N2

Process Gas used: N2

Date of Calibration: 05/10/00

UUT Serial #: 000317785

UUT Range: 200 SLM

Calibrated by: DP

Verified by:

Notes:

1. All units must be operated on regulated heat (Power on) for a minimum of of one hour before any adjustment is made.
2. Flowmeters and/or Controllers are Calibrated at atmospheric pressure.
3. This Calibration is referenced to 0 Degrees Centigrade and 760 Torr.