ANALYSIS OF CHEROKEE GROUP CUTTINGS SAMPLES FOR GAS CONTENT -- PRODUCTION MAINTENANCE SERVICES McCLENNING #1 (sec. 32-T.33S.-R.16E.), MONTGOMERY COUNTY, KANSAS

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SUMMARY

Four cuttings samples from the Pennsylvanian Cherokee Group were collected from the Production Maintenance Services McClenning #1 well (NE NE sec. 32-T.33S.-R.16E.) in Montgomery County, KS. Assuming the dark shale that is usually admixed with the coal in the cuttings has approximately 3 scf/ton gas content, the coals calculate to have the following gas contents:

- Weir-Pittsburg coal at 854' to 855' depth (124 scf/ton)
- Rowe coal at 1064' to 1066' depth (--- scf/ton)*
- Neutral/ Rowe coal at 1072' to 1074' depth (82 scf/ton)
- Riverton coal at 1123' to 1126' depth (184 scf/ton)

*no gas-content results were possible due to small amount of coal in the sample, and small amount of sample relative to the size of the desorption container

The most reliable result, which is largely controlled by the amount of coal in the cuttings, is from the Riverton coal sample from 1123' to 1126'. This sample registered 21% coal. The least-constrained results are from the Neutral/Rowe coal sample, which had only 4% coal.

BACKGROUND

Production Maintenance Services McClenning #1 well (NE NE sec. 32-T.33S.-R.16E.) in Montgomery County, KS was selected for cuttings desorption tests in association with an on-going coalbed gas research project at the Kansas Geological Survey. The samples were gathered the day of May 27, 2003 by K. David Newell and Jonathan P. Lange of the Kansas Geological Survey, with well site collection aided by Jurgen J. Hanke and Mike McClenning. Samples were obtained during normal drilling of the well, with no cessation of drilling before zones of interest (i.e., coals in the Cherokee Group) were penetrated. The well was drilled using an air-drilled rotary rig operated by MOKAT Drilling. Lag times for samples to reach the surface (important for assessing lost gas) were taken from a well drilled by the same MOKAT drilling rig in Anderson County, KS. These lag times were determined by periodically noting the time it took for cuttings to reach the surface following resumption of drilling after new pipe was added to the drill string.

Four cuttings samples were collected from the Pennsylvanian (Desmoinesian) Cherokee Group:

- Weir-Pittsburg coal at 854' to 855' depth (1441.7 grams; 9% coal)
- Rowe coal at 1064' to 1066' depth (463.7 grams; <10% coal)
- Neutral/ Rowe coal at 1072' to 1074' depth (1587.2 grams; 4% coal)
- Riverton coal at 1123' to 1126' depth (895.6 grams; 21% coal)

The cuttings samples were caught in a kitchen strainer at the air stream exit by the mud pit. The samples were washed in the kitchen strainer to rid them of drilling mud before they were placed in desorption canisters. A temperature bath for the desorption canisters was on site, with temperatures ranging between 84 and 87 degrees F. The canistered samples were later that day transported to the laboratory at the Kansas Geological Survey and desorption measurements were continued at 85 degrees F ambient temperature. Desorption measurements were periodically made until the canisters produced no more gas upon testing for at least two successive days.

DESORPTION MEASUREMENTS

The equipment and method for measuring desorption gas is that prescribed by McLennan and others (1995). The volumetric displacement apparatus is a set of connected dispensing burettes, one of which measures the gas evolved from the desorption canister. The other burette compensates for the compression that occurs when the desorbed gas displaces the water in the measuring burette. This compensation is performed by adjusting the cylinders so that their water levels are identical, then figuring the amount of gas that evolved by simply reading the difference in water level using the volumetric scale on the side of the burette.

The McA, McB, and McC desorption canisters used in this study were constructed and loaned from Mike McClenning of Production Maintenance Services. On average, these canisters enclosed a volume of approximately 155 cubic inches (2550 cm^3). Canister Brady 27 was constructed at the Kansas Geological Survey and enclosed a volume of approximately 112 cubic inches (1850 cm^3).

The desorbed gas that collected in the desorption canisters was periodically released into the volumetric displacement apparatus and measured as a function of time, temperature and atmospheric pressure.

The time and atmospheric pressure were measured in the field using a portable weather station (model BA928) marketed by Oregon Scientific (Tualatin, OR). The atmospheric pressure was displayed in millibars on this instrument, however, this measurement was not the actual barometric pressure, but rather an altitude-compensated barometric pressure automatically converted to a sea-level-equivalent pressure. In order to translate this measurement to actual atmospheric pressure, a regression correlation was determined over several weeks by comparing readings from the Oregon Scientific instrument to that from a pressure transducer in the Petrophysics Laboratory in the Kansas Geological Survey in Lawrence, Kansas (Figure 1). The regression equation was entered into a spreadsheet and was used to automatically convert the millibar measurement to barometric pressure in psi.

A spreadsheet program written by K.D. Newell (Kansas Geological Survey) was used to convert all gas volumes at standard temperature and pressure. Conversion of gas volumes to standard temperature and pressure was by application of the perfect-gas equation, obtainable from basic college chemistry texts:

$$n = PV/RT$$

where n is moles of gas, T is degrees Kelvin (i.e., absolute temperature), V is in liters, and R is the universal gas constant, which has a numerical value depending on the units in which it is measured (for example, in the metric system R = 0.0820 liter atmosphere per degree mole). The number of moles of gas (i.e., the value n) is constant in a volumetric conversion, therefore the conversion equation, derived from the ideal gas equation, is:

$$(P_{stp}V_{stp})/(RT_{stp}) = (P_{rig}V_{rig})/(RT_{rig})$$

Customarily, standard temperature and pressure for gas volumetric measurements in the oil industry are 60 °F and 14.7 psi (see Dake, 1978, p. 13), therefore P_{stp}, V_{stp}, and T_{stp}, respectively, are pressure, volume and temperature at standard temperature and pressure, where standard temperature is degrees Rankine (°R = 460 + °F). P_{rig}, V_{rig}, and T_{rig}, respectively, are ambient pressure, volume and temperature measurements taken at the rig site or in the desorption laboratory.

The universal gas constant R drops out as this equation is simplified and the determination of V_{stp} becomes:

$$V_{stp} = (T_{stp}/T_{rig})\,(P_{rig}/P_{stp})\,V_{rig}$$

The conversion calculations in the spreadsheet were carried out in the English metric system, as this is the customary measure system used in American coal and oil industry. V is therefore converted to cubic feet; P is psia; T is °R.

The desorbed gas was summed over the time period for which the coal samples evolved all of their gas. In the case of well cuttings from the McClenning #1 well, the maximum time of desorption was 31 days.

Lost gas (i.e., the gas lost from the sample from the time it was drilled, brought to the surface, to the time it was canistered) was determined using the direct method (Kissel and others, 1975; also see McLennan and others, 1995, p. 6.1-6.14) in which the cumulative gas evolved is plotted against the square root of elapsed time. Time zero is assumed to be instant the cuttings sample is cut and circulated off bottom. Characteristically, the cumulative gas evolved from the sample, when plotted against the square root of time, is linear for a short time period after the sample reaches ambient pressure conditions, therefore lost gas is determined by a line projected back to time zero. The period of linearity generally is about an hour for cuttings samples.

Due to the relatively large size of the McA, McB, and McC desorption canisters relative to the size of the cuttings samples, an experimental correction was applied to compensate for the expansion and contraction of the free air space in the desorption canisters due to temperature and pressure changes between successive desorption measurements. For this correction, the free-air-space volume in each canister was calculated by subtracting the volume of the sample from the interior volume of the empty canister. The calculated volume of the sample in the canister was derived from a density measurement on a portion of the sample after decanistering. This sample portion (approximately 50 grams) was selected after running the sample through a sample splitter. The theoretical expansion or contraction of this free gas volume was calculated using the atmospheric pressure and temperature changes between successive desorption measurements. The net change in volume (negative or positive) was converted to standard temperature and pressure, and then added to the volumetric measurement (also converted to standard temperature and pressure) for each desorption measurement.

LITHOLOGIC ANALYSIS

Upon removal from the canisters, the cuttings were washed of drilling mud, and dried in an oven at 150 ˚F for up to 28 days. After drying, the cuttings were weighed and then dry sieved into 5 size fractions: >0.0930", >0.0661", >0.0460", >0.0331", and <0.0331". For large sample sizes, the cuttings were ran through a sample splitter and a lesser portion (approximately 75 grams) were sieved and weighed, and the derived size-fraction ratios were applied to the entire sample.

The size fractions were then inspected and sorted by hand under a dissecting microscope. Three major lithologic categories were differentiated: coal, dark shales (generally Munsell rock colors N3 (dark gray), N2 (grayish black), and N1 (black) on dry surface), and lighter-colored lithologies and/or dark and light-colored carbonates/sandstones. After sorting, and for every size class, each of these three lithologic categories was weighed and the proportion of coal dark shale and light-colored lithologies were determined for the entire cuttings sample based on the weight percentages.

DATA PRESENTATION

Data and analyses accompanying this report are presented in the following order: 1) lag time to surface for the well cuttings, 2) data tables for the desorption analyses, 3) lost-gas graphs, 4) "lithologic component sensitivity analyses" showing the interdependence of gas evolved from dark shale versus coal in each sample, 5) a summary component analysis for all samples showing relative reliability of the data from all the samples, and 6) a desorption graph for all the samples.

Graph of Lag-time to Surface for Well Cuttings (Figure 2)
Lag time to surface varied, but there is a general trend of longer lag times for greater depth. The lag times accepted for cuttings were taken to be a visual average of the trend (defined by the scatter of data points on this graph) at the depth at which the samples were taken.

Data Table of the Desorption Analyses (Table 1)
These are the basic data used for lost-gas analysis and determination of total gas desorbed from the cuttings samples. Basic temperature, volume, and barometric measurements are listed at left. Farther to the right, these are converted to standard temperature, pressure and volumes. The volumes are cumulatively summed, and converted to scf/ton based on the total weight of coal and dark shale in the sample. At the right of the table, the time of the measurements are listed and converted to hours (and square root of hours) since the sample was drilled.

Lost-Gas Graphs (Figures 3-6)
Gas lost prior to the canistering of the sample was estimated by extrapolation of the first few data points after the sample was canistered. The linear characteristic of the initial desorption measurements was usually lost within the first hour after canistering, thus data are presented in the lost-gas graphs for only up to one hour after canistering. Lost-gas volumes derived from this analysis are incorporated in the data tables described above.

"Lithologic Component Sensitivity Analyses" (Figures 7-9)
The rapidity of penetration of an air-drilled well makes collection of pure lithologies from relatively thin-bedded strata rather difficult. Mixed lithologies are more the norm rather than the exception. Some of this mixing is due to cavings from strata farther up hole. The mixing may also be due to collection of two or more successively drilled lithologies in the kitchen sieve at the exit line, or differential lifting of relatively less-dense coal compared to other lithologies, all of which are more dense than coal.

The total gas evolved from the sample is due to gas being desorbed from both the coal and dark shale. Both lithologies are capable of generating gas, albeit the coal will be richer in gas than the dark-colored shale. Even though dark-colored shale is less rich in sorbed gas than coal, if a sample has a large proportion of dark, organic-rich shale and only a minor amount of coal, the total volume of gas evolved from the dark-shale component may be considerable.

The total amount of gas evolved from a cuttings sample can be expressed by the following equation:

$$\text{Total gas (cm}^3) = [\text{weight}_{\text{coal}} \text{ (grams) X gas content}_{\text{coal}} \text{ (cm}^3\text{/gram)}] + [\text{weight}_{\text{dark shale}} \text{ (grams) X gas content}_{\text{dark shale}} \text{ (cm}^3\text{/gram)}]$$

A unique solution for *gas* $content_{coal}$ in this equation is not possible because *gas* $content_{dark\ shale}$ is not known exactly. An answer can only be expressed as a linear solution to the above equation. The richer in gas the dark shales are, the poorer in gas the admixed coal has to be, and visa versa. If there is little dark shale in a sample, a relatively well constrained answer for *gas* $content_{coal}$ can be obtained. Conversely, if considerable dark shale is in a sample, the gas content of a coal will be hard to precisely determine.

The lithologic-component-sensitivity-analysis diagram therefore expresses the bivariant nature inherent in the determination of gas content in mixed cuttings. The gas content of dark shales in Kansas can vary greatly. Proprietary desorption analyses of dark shales in cores from southeastern Kansas have registered as much as 50 scf/ton, but can be as low as 2-4 scf/ton. For a general understanding of the lithologic-component-sensitivity-analyses diagrams, the calculated $gas\ content_{coal}$ is given for assumed $gas\ content_{dark\ shale}$ at 30 scf/ton and 50 scf/ton. For most samples gathered in east-central and northeastern Kansas, the resultant $gas\ content_{coal}$ is a negative number for 30 scf/ton and 50 scf/ton $gas\ content_{dark\ shale}$. The only conclusion is that the $gas\ content_{dark\ shale}$ or most samples taken from this region has to be lower than 30-50 scf/ton. Conversely though, to assume that all the gas evolved from a cuttings sample is derived solely from the coal would result in an erroneously high gas content for the coal.

In all the lithologic-component-sensitivity-analysis diagrams, a "break-even" point is noted where the gas content of the coal is equal to that of the dark shale. This "break-even" point corresponds to the minimum gas content assignable to the coal and maximum gas content assignable to the dark shale. It can also be thought of the scf/ton gas content of the cuttings sample minus the weight of any of the lighter-colored lithologies, which are assumed to have no inherent gas content.

Summary Component Analysis for all Samples (Figure 10)

This diagram is a summary of the individual "lithologic component sensitivity analyses" for each sample, all set at a common scale. The steeper the angle of the line for a sample, the more uncertainty is attached to the results (i.e., $gas\ content_{coal}$) for that sample. If the coal content is miniscule (i.e., < approximately 5%), the results are a better reflection of the $gas\ content_{dark\ shale}$.

Desorption Graph (Figure 11)

This is a desorption graph (gas content per weight vs. square root of time) for all the samples. The rate at which gas is evolved from the samples is thus comparable at a common scale. The scf/ton amount for each sample is the minimum scf/ton for the coal (i.e., the gas content based on the total sample weight minus the weight of the light-colored lithologies).

RESULTS and DISCUSSION

The Riverton coal sample registered the greatest gas content at 184.0 scf/ton (assuming the admixed dark shale produce 3 scf/ton). This sample also contained 21% coal, and thus of all the samples, this analysis carries the greatest degree of confidence. Although the Weir-Pittsburg sample only contained 8% coal, most of the sample was composed of very light colored shale (i.e., a lithology that generates little or no gas) and thus reasonable certainty can be attached to results from this sample. The Rowe coal at 1064' to 1066' depth did not have coherent results even in its lost-gas phase (see Figure 4), thus no results could be obtained for gas content in this sample. The size of the sample was likely overwhelmed by the volume of the desorption container and as such, volume changes within the canister due to small changes in temperature and barometric pressure could mask the volume of gas desorbed for the cuttings.

The value of 3 scf/ton for the dark shales used for calculating gas content of the coal is based on the assays of the gas content of dark shale samples in the Cherokee basin and Bourbon arch in eastern Kansas. A very high-gamma ray shale may carry more gas, but present data do not allow reasonable estimation of this gas content. Additional analyses are needed to gain confidence in this assumption.

REFERENCES

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McLennan, J.D., Schafer, P.S., and Pratt, T.J., 1995, A guide to determining coalbed gas content: Gas Research Institute, Chicago, IL, Reference No. GRI-94/0396, 180 p.

FIGURES and TABLES

Correlation of Field Barometer to KGS Petrophysics Lab Barometer

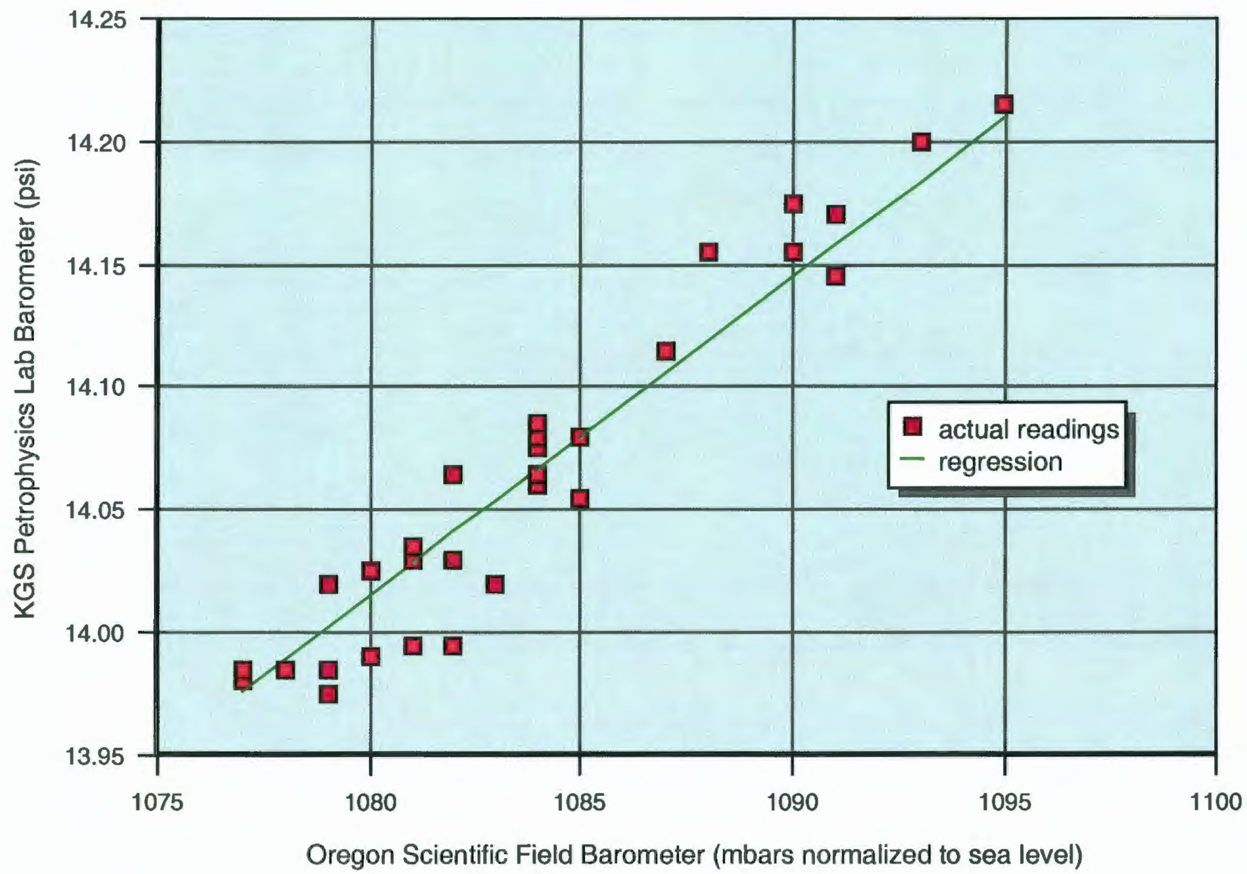

FIGURE 1.

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS
lag-time to surface for well cuttings taken from MOKAT rig in Anderson County, KS)

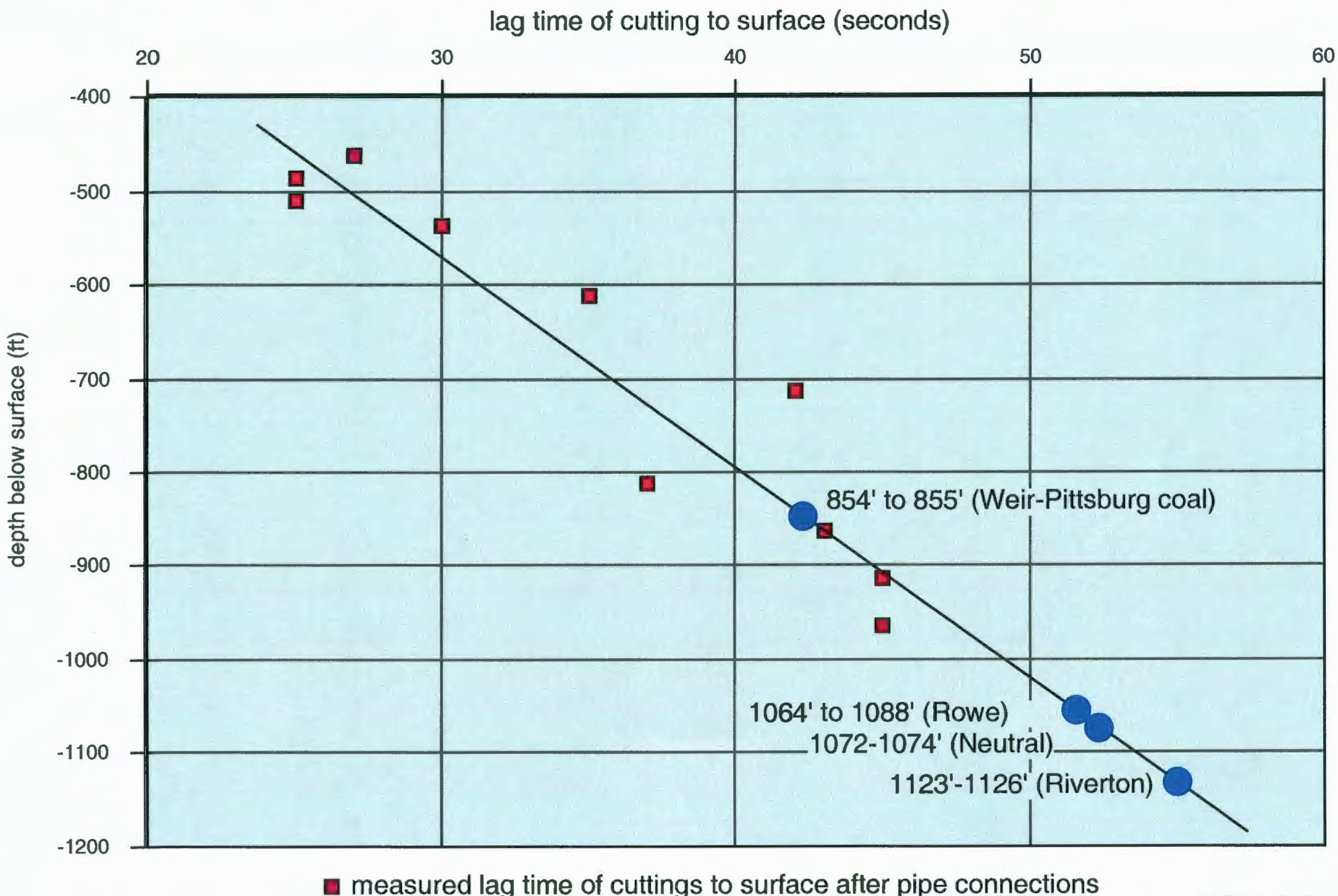

FIGURE 2.

TABLE 1 -- Production Maintenance Service McClenning #1; 920' FNL, 500' FEL, 32-T.33S.-R.18E.

SAMPLE: 854' to 855' (Weir-Pitt coal) in canister McC A

DRY WEIGHT lbs. grams
sample weight: 0.4639 210.421

est. lost gas (cc) = 78

TIME OF: off bottom 5/27/03 11:24; at surface in canister 5/27/03 11:34

5/27/03 11:25 elapsed time (off bottom to canistering) 10.4 minutes; 0.174 hours; 0.4173 SQRT (hrs)

free air space in canister (ccs) 1920.16

RIG MEASUREMENTS; CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 psi); CUMULATIVE VOLUMES

measured cc	measured T (F)	measured P	cubic ft (@rig)	ABSOLUTE T (F) (@rig)	psia (@rig)	cubic ft (@STP)	cc (@STP)	air-space adjusted vol. (cc)	air-space adjusted vol. (cubic ft@STP)	air-space adjusted vol. (cc @STP)	air-space-adjusted cum. vol. (cubic ft@STP)	air-space-adjusted cum. vol. (cc@STP)	SCF/TON with lost gas	TIME OF MEASURE (date)	TIME OF MEASURE (time)	TIME SINCE off bottom	TIME SINCE in canister	SQRT hrs. (since off bottom)	
	87	1097	0	547	14.239														
8	87	1097	0.00028	547	14.239	0.00026	7.37	8.00	0.00026	7.37	0.00026	7.37	**13.00**	5/27/03	11:36	0:11:57	0:01:30	0.4462809	
4	87	1097	0.00014	547	14.239	0.00013	3.68	4.00	0.00013	3.88	0.00039	11.05	**13.56**	5/27/03	11:37	0:12:57	0:02:30	0.4845787	
7	87	1097	0.00025	547	14.239	0.000228	8.45	7.00	0.00023	6.45	0.000618	17.50	**14.54**	5/27/03	11:42	0:18:27	0:08:00	0.5545268	
5	87	1097	0.00018	547	14.239	0.000163	4.60	5.00	0.00016	4.80	0.00078	22.10	**15.24**	5/27/03	11:44	0:19:42	0:09:15	0.5730038	
8	87	1097	0.00021	547	14.239	0.000195	5.52	6.00	0.0002	5.52	0.000976	27.82	**16.08**	5/27/03	11:45	0:21:27	0:11:00	0.597913	
2	87	1097	7.1E-05	547	14.239	6.5E-05	1.84	2.00	8.5E-05	1.84	0.001041	29.47	**16.36**	5/27/03	11:47	0:22:57	0:12:30	0.8184658	
3	87	1097	0.00011	547	14.239	9.76E-05	2.76	3.00	9.8E-05	2.76	0.001138	32.23	**16.78**	5/27/03	11:48	0:24:27	0:14:00	0.6383573	
4	87	1097	0.00014	547	14.239	0.00013	3.68	4.00	0.00013	3.88	0.001268	35.91	**17.34**	5/27/03	11:49	0:25:27	0:15:00	0.6512808	
7	87	1097	0.00025	547	14.239	0.000228	6.45	7.00	0.00023	6.45	0.001496	42.36	**18.32**	5/27/03	11:52	0:27:57	0:17:30	0.6825198	
15	87	1097	0.00053	547	14.239	0.000488	13.81	15.00	0.00049	13.81	0.001984	58.17	**20.43**	5/27/03	11:55	0:31:27	0:21:00	0.7239936	
19	87	1097	0.00067	547	14.239	0.000618	17.50	19.00	0.00062	17.50	0.002801	73.66	**23.09**	5/27/03	12:06	0:41:42	0:31:15	0.6336666	
8	87	1097	0.00028	547	14.239	0.00026	7.37	8.00	0.00026	7.37	0.002882	81.03	**24.21**	5/27/03	12:10	0:48:12	0:35:45	0.8774964	
13	87	1097	0.00046	547	14.239	0.000423	11.97	13.00	0.00042	11.97	0.003284	93.00	**26.04**	5/27/03	12:17	0:52:42	0:42:15	0.9371944	
12	87	1097	0.00042	547	14.239	0.00039	11.05	12.00	0.00039	11.05	0.003675	104.05	**27.72**	5/27/03	12:24	0:59:57	0:49:30	0.9995832	
20	87	1097	0.00071	547	14.239	0.00085	18.42	20.00	0.00065	18.42	0.004325	122.47	**30.52**	5/27/03	12:35	1:10:57	1:00:30	1.0874282	
15	88	1096	0.00053	548	14.226	0.000486	13.77	9.73	0.00032	8.94	0.004841	131.41	**31.86**	5/27/03	12:46	1:22:27	1:12:00	1.1722486	
19	88	1096	0.00087	548	14.226	0.000618	17.45	19.00	0.00082	17.45	0.005257	148.85	**34.54**	5/27/03	12:58	1:34:12	1:23:45	1.2529964	
5	88	1096	0.00018	548	14.226	0.000182	4.59	5.00	0.00016	4.59	0.005419	153.44	**35.24**	5/27/03	13:13	1:48:57	1:38:30	1.3475286	
5	88	1096	0.00018	548	14.226	0.000162	4.59	5.00	0.00016	4.59	0.005581	158.04	**35.94**	5/27/03	13:31	2:06:42	1:58:15	1.4531575	
15	88	1098	0.00053	548	14.226	0.000486	13.77	15.00	0.00049	13.77	0.006067	171.81	**38.03**	5/27/03	13:51	2:26:42	2:18:15	1.5636496	
18	88	1096	0.00064	548	14.228	0.000584	18.53	18.00	0.00058	16.53	0.006651	188.34	**40.55**	5/27/03	14:46	3:21:42	3:11:15	1.8334848	
15	87	1095	0.00053	547	14.213	0.000487	13.79	18.75	0.00054	15.40	0.007195	203.74	**42.90**	5/27/03	15:34	4:09:42	3:59:15	2.0400163	estimate
27	88	1095	0.00095	546	14.213	0.000878	24.86	30.51	0.00099	28.09	0.008187	231.83	**47.17**	5/27/03	18:41	5:18:42	5:06:15	2.2974624	
11	85	1095	0.00039	545	14.213	0.000358	10.15	14.52	0.00047	13.39	0.00888	245.22	**49.21**	5/27/03	17:24	5:59:42	5:49:15	2.4484689	
1	85	1095	3.5E-05	545	14.213	3.28E-05	0.92	1.00	3.3E-05	0.92	0.008893	246.15	**49.35**	5/27/03	17:32	6:07:42	5:57:15	2.4755471	estimate
-8	84	1094	-0.00028	544	14.200	-0.000261	-7.39	-6.23	-0.0002	-5.75	0.008489	240.39	**48.48**	5/27/03	18:32	7:07:42	6:57:15	2.6698939	
-3	84	1094	-0.00011	544	14.200	-9.78E-05	-2.77	-3.00	-9.8E-05	-2.77	0.008392	237.82	**48.05**	5/27/03	19:13	7:48:42	7:38:15	2.7949359	
-20	84	1093	-0.00071	544	14.187	-0.000652	-18.45	-21.76	-0.00071	-20.07	0.007683	217.55	**45.00**	5/27/03	20:14	8:49:42	8:39:15	2.9712511	
80	85	1092	0.00283	545	14.174	0.002599	73.60	74.71	0.00243	68.73	0.01011	286.28	**55.46**	5/28/03	10:52	23:27:42	23:17:15	4.8437245	
68	85	1087	0.0024	545	14.109	0.002199	62.27	59.17	0.00191	54.18	0.012024	340.47	**63.71**	5/29/03	11:48	48:21:42	48:11:15	6.9542553	
80	85	1083	0.00212	545	14.057	0.001933	54.74	52.91	0.0017	48.27	0.013728	388.74	**71.06**	5/30/03	18:17	78:52:42	78:42:15	8.768029	
-5	85	1085	-0.00018	545	14.083	-0.000161	-4.57	-1.48	-4.7E-05	-1.34	0.013881	387.40	**70.86**	5/31/03	18:48	101:21:42	101:11:15	10.067853	
-2	85	1082	-7.1E-05	545	14.044	-8.44E-05	-1.82	-7.32	-0.00024	-6.68	0.013445	380.73	**69.84**	8/1/03	14:27	123:02:42	122:52:15	11.092565	
37	91	1081	0.00131	551	14.031	0.001177	33.33	14.08	0.00045	12.87	0.013893	393.40	**71.77**	6/3/03	13:48	170:23:42	170:13:15	13.053544	
-22	84	1081	-0.00078	544	14.031	-0.000709	-20.07	2.39	7.7E-05	2.18	0.01397	395.58	**72.10**	6/4/03	18:59	199:34:42	199:24:15	14.12722	
0	85	1082	0	545	14.044	0	0.00	-1.75	-5.8E-05	-1.80	0.013913	393.98	**71.86**	8/5/03	14:28	219:03:42	218:53:15	14.800732	
19	93	1077	0.00067	553	13.979	0.0006	18.99	-18.23	-0.00058	-18.30	0.013338	377.88	**69.38**	8/8/03	14:20	242:55:42	242:45:15	15.588158	
-14	85	1078	-0.00049	545	13.992	-0.000449	-12.71	15.53	0.0005	14.11	0.013838	391.79	**71.53**	6/7/03	19:56	272:31:42	272:21:15	18.508432	
-8	85	1075	-0.00028	545	13.953	-0.000258	-7.25	-13.36	-0.00043	-12.10	0.013409	379.69	**69.68**	8/11/03	17:32	386:07:42	385:57:15	19.13448	
-3	85	1075	-0.00011	545	13.953	-9.59E-05	-2.72	-3.00	-9.6E-05	-2.72	0.013313	376.97	**69.27**	6/12/03	22:12	394:47:42	394:37:15	19.889449	
-8	85	1078	-0.00028	545	13.992	-0.000257	-7.27	-2.66	-8.5E-05	-2.41	0.013228	374.56	**68.90**	8/13/03	15:13	411:48:42	411:38:15	20.293143	

DECANISTERED 6/13/2003; air-dried 24 days

SAMPLE: 1064' to 1066' (Rowe coal) in canister McC B

DRY WEIGHT lbs. grams
sample weight: 1.0223 483.7

est. lost gas (cc) = 0

TIME OF: off bottom 5/27/03 17:55; in canister 5/27/03 18:05

5/27/03 17:56 elapsed time (off bottom to canistering) 9.9 minutes; 0.164 hours

free air space in canister (ccs)
2388.00

TIME SINCE
TIME OF MEASURE off bottom in canister

0.4055 SQRT (hrs)
SQRT hrs. (since off bottom)

RIG MEASUREMENTS | CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 psi) | CUMULATIVE VOLUMES

measured cc	measured T (F)	measured P	cubic ft (@rig)	ABSOLUTE T (F) (@rig)	psia (@rig)	cubic ft (@STP)	cc (@STP)	air-space adjusted vol. (cc)	air-space adjusted vol. (cubic ft@STP)	air-space adjusted vol. (cc @STP)	air-space-adjusted cum. vol. (cubic ft@STP)	air-space-adjusted cum. vol. (cc@STP)	SCF/TON with lost gas	TIME OF MEASURE		TIME SINCE off bottom	in canister	SQRT hrs. (since off bottom)
	85	1095	0	545	14.213													
4	85	1095	0.00014	545	14.213	0.00013	3.69	4.00	0.00013	3.89	0.00013	3.89	0.25	5/27/03	18:06	0:11:22	0:01:30	0.4352522
1	85	1095	3.5E-05	545	14.213	3.28E-05	0.92	1.00	3.3E-05	0.92	0.000163	4.81	0.32	5/27/03	18:09	0:14:07	0:04:15	0.4850544
5	85	1095	0.00018	545	14.213	0.000183	4.61	5.00	0.00018	4.61	0.000328	9.22	0.64	5/27/03	18:19	0:23:52	0:14:00	0.6306963
-1	85	1095	-3.5E-05	545	14.213	-3.26E-05	-0.92	-1.00	-3.3E-05	-0.92	0.000293	8.30	0.57	5/27/03	18:23	0:28:22	0:18:30	0.6875884
-1	85	1095	-3.5E-05	545	14.213	-3.28E-05	-0.92	-1.00	-3.3E-05	-0.92	0.000261	7.38	0.51	5/27/03	18:26	0:33:07	0:23:15	0.7429296
-7	84	1094	-0.00025	544	14.200	-0.000228	-6.48	-4.82	-0.00016	-4.45	0.000104	2.93	0.20	5/27/03	18:43	0:48:37	0:38:45	0.9001543
12	84	1094	0.00042	544	14.200	0.000391	11.08	12.00	0.00039	11.08	0.000495	14.01	0.97	5/27/03	19:13	1:17:52	1:08:00	1.1392005
-16	84	1094	-0.00057	544	14.200	-0.000522	-14.77	-16.00	-0.00052	-14.77	-2.7E-05	-0.76	-0.05	5/27/03	20:10	2:15:37	2:05:45	1.503422
85	85	1092	0.0023	545	14.174	0.002112	59.80	58.31	0.00183	51.80	0.001803	51.04	3.53	5/28/03	10:53	16:57:52	16:48:00	4.1187916
40	85	1087	0.00141	545	14.109	0.001294	36.83	29.12	0.00094	26.66	0.002744	77.71	5.37	5/29/03	11:45	41:49:52	41:40:00	6.4676975
35	85	1083	0.00124	545	14.057	0.001128	31.93	26.26	0.00085	23.98	0.00359	101.87	7.02	5/30/03	18:18	70:22:52	70:13:00	8.3893451
-15	85	1083	-0.00053	545	14.057	-0.000483	-13.69	-15.00	-0.00048	-13.89	0.003107	87.98	6.08	5/31/03	18:45	94:49:52	94:40:00	9.7381267
-7	85	1062	-0.00025	545	14.044	-0.000225	-8.38	-9.19	-0.0003	-8.37	0.002811	79.81	5.50	6/1/03	14:42	116:48:52	118:37:00	10.808531
9	91	1081	0.00032	551	14.031	0.000288	8.11	-19.28	-0.00081	-17.35	0.002199	82.26	4.30	6/3/03	13:49	163:53:52	163:44:00	12.802257
-42	84	1081	-0.00148	544	14.031	-0.001353	-38.32	-11.94	-0.00038	-10.90	0.001814	51.36	3.55	6/4/03	18:58	193:02:52	192:53:00	13.894183
0	84	1082	0	544	14.044	0	0.00	2.19	7.1E-05	2.00	0.001884	53.38	3.69	6/5/03	14:59	213:03:52	212:54:00	14.598727
37	93	1077	0.00131	553	13.979	0.001168	33.09	-13.31	-0.00042	-11.90	0.001464	41.48	2.86	6/6/03	14:25	238:29:52	238:20:00	15.378484
-29	85	1078	-0.00102	545	13.992	-0.00093	-28.34	7.39	0.00024	8.71	0.001701	48.17	3.33	6/7/03	19:53	285:57:52	285:48:00	18.308416
-20	85	1075	-0.00071	545	13.953	-0.00064	-18.11	-26.60	-0.00085	-24.09	0.00085	24.08	1.66	6/11/03	17:30	359:34:52	359:25:00	18.962624
-10	65	1075	-0.00035	545	13.953	-0.00032	-9.08	-10.00	-0.00032	-9.06	0.00053	15.02	1.04	6/12/03	22:07	386:11:52	388:02:00	19.702735

DECANISTERED 6/13/03; air-dried 24 days

SAMPLE: **1072' to 1074' (Neutral/Rowe coal) in canister Brady 27**

DRY WEIGHT lbs. grams
sample weight: 3.0794 1398.79

est. lost gas (cc) =
35

TIME OF: 5/27/03 18:08 elapsed time (off bottom to canistering)
off bottom in canister 2.9 minutes
5/27/03 18:05 5/27/03 18:08 0.046 hours
0.2192 SQRT (hrs)

free air space in canister (ccs)
1214.39

TIME SINCE
TIME OF MEASURE off bottom in canister SQRT hrs. (since off bottom)

RIG MEASUREMENTS | CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 psi) | CUMULATIVE VOLUMES

measured cc	measured T (F)	measured P	cubic ft (@rig)	ABSOLUTE T (F) (@rig)	psia (@rig)	cubic ft (@STP)	cc (@STP)	air-space adjusted vol. (cc)	air-space adjusted vol. (cubic ft@STP)	air-space adjusted vol. (cc @STP)	air-space-adjusted cum. vol. (cubic ft@STP)	air-space-adjusted cum. vol. (cc@STP)	SCF/TON with lost gas	TIME OF MEASURE		TIME SINCE off bottom	in canister	SQRT hrs. (since off bottom)
	85	1095	0	545	14.213	0	0.00											
17	85	1095	0.0006	545	14.213	0.000554	15.68	17.00	0.00055	15.88	0.000554	15.88	1.16	5/27/03	18:10	0:05:38	0:02:45	0.3084129
8	85	1095	0.00021	545	14.213	0.000195	5.53	8.00	0.0002	5.53	0.000749	21.22	1.29	5/27/03	18:12	0:07:23	0:04:30	0.3507928
5	85	1095	0.00018	545	14.213	0.000163	4.81	5.00	0.00018	4.61	0.000912	25.83	1.40	5/27/03	18:14	0:08:53	0:08:00	0.3847799
8	85	1095	0.00021	545	14.213	0.000195	5.53	6.00	0.0002	5.53	0.001108	31.36	1.52	5/27/03	18:15	0:10:23	0:07:30	0.4159995
8	85	1095	0.00021	545	14.213	0.000195	5.53	6.00	0.0002	5.53	0.001303	38.90	1.65	5/27/03	18:17	0:12:23	0:09:30	0.4543004
7	85	1094	0.00025	545	14.200	0.000228	6.45	5.89	0.00019	5.43	0.001495	42.33	1.77	5/27/03	18:20	0:14:53	0:12:00	0.4980518
4	85	1094	0.00014	545	14.200	0.00013	3.89	4.00	0.00013	3.69	0.001825	46.01	1.86	5/27/03	18:21	0:16:38	0:13:45	0.526519
6	85	1094	0.00021	545	14.200	0.000195	5.53	6.00	0.0002	5.53	0.00182	51.54	1.99	5/27/03	18:24	0:19:38	0:18:45	0.5720334
4	85	1094	0.00014	545	14.200	0.00013	3.69	4.00	0.00013	3.69	0.00195	55.23	2.07	5/27/03	18:27	0:22:23	0:19:30	0.6107827
6	85	1094	0.00021	545	14.200	0.000195	5.53	6.00	0.0002	5.53	0.002146	60.78	2.20	5/27/03	18:31	0:25:53	0:23:00	0.856802
3	84	1094	0.00011	544	14.200	9.78E-05	2.77	5.23	0.00017	4.83	0.002316	65.59	2.31	5/27/03	18:33	0:28:08	0:25:15	0.6847546
11	84	1094	0.00039	544	14.200	0.000359	10.16	11.00	0.00036	10.18	0.002675	75.75	2.54	5/27/03	18:42	0:37:23	0:34:30	0.7893387
6	84	1094	0.00021	544	14.200	0.000196	5.54	6.00	0.0002	5.54	0.002871	81.29	2.67	5/27/03	18:49	0:43:53	0:41:00	0.8552128
7	84	1094	0.00025	544	14.200	0.000226	8.48	7.00	0.00023	6.48	0.003099	87.75	2.82	5/27/03	18:58	0:50:53	0:48:00	0.9208993
11	84	1094	0.00039	544	14.200	0.000359	10.18	11.00	0.00038	10.16	0.003458	97.91	3.05	5/27/03	19:12	1:07:08	1:04:15	1.0577754
29	84	1094	0.00102	544	14.200	0.000948	26.78	29.00	0.00095	26.78	0.004403	124.88	3.66	5/27/03	20:02	1:58:53	1:54:00	1.3957276
21	80	1087	0.00074	540	14.109	0.000685	19.41	22.17	0.00072	20.49	0.005127	145.17	4.13	5/27/03	23:22	5:18:53	5:14:00	2.2981273
20	85	1092	0.00071	545	14.174	0.00065	18.40	14.37	0.00047	13.22	0.005593	158.39	4.44	5/28/03	10:51	16:45:53	18:43:00	4.0944746

18	85	1087	0.00064	545	14.109	0.000582	16.48	12.41	0.0004	11.37	0.005995	189.78	4.70	5/29/03	11:47	41:41:53	41:39:00	8.4574032	estimate
10	85	1083	0.00035	545	14.057	0.000322	9.12	5.51	0.00016	5.03	0.006173	174.79	4.61	5/30/03	16:16	70:10:53	70:08:00	8.3774333	
-3	85	1082	-0.00011	545	14.044	-9.88E-05	-2.73	-4.12	-0.00013	-3.78	0.00804	171.03	4.73	5/31/03	16:47	94:41:53	94:39:00	9.7312928	
2	85	1082	7.1E-05	545	14.044	8.44E-05	1.82	2.00	6.4E-05	1.82	0.006104	172.85	4.77	6/1/03	14:42	118:36:53	116:34:00	10.79883	
38	91	1081	0.00134	551	14.031	0.001209	34.23	23.49	0.00075	21.18	0.006852	194.02	5.25	8/3/03	13:50	183:44:53	163:42:00	12.796408	
-16	84	1081	-0.00057	544	14.031	-0.000518	-14.80	-0.57	-1.8E-05	-0.52	0.006833	193.49	5.24	6/4/03	18:57	192:51:53	192:49:00	13.887574	
4	84	1082	0.00014	544	14.044	0.000129	3.65	5.12	0.00017	4.68	0.008998	198.17	5.35	6/5/03	14:59	212:53:53	212:51:00	14.591027	
23	93	1077	0.00081	553	13.979	0.000726	20.57	-2.82	-6.9E-05	-2.52	0.006909	195.65	5.29	6/6/03	14:20	236:14:53	238:12:00	15.370363	
-9	85	1078	-0.00032	545	13.992	-0.000289	-8.17	9.68	0.00031	8.79	0.00722	204.44	5.49	8/7/03	19:52	265:48:53	265:44:00	16.302803	
13	85	1075	0.00046	545	13.953	0.000416	11.77	9.81	0.00031	8.70	0.007527	213.14	5.69	6/11/03	17:30	359:24:53	359:22:00	18.958238	
2	65	1075	7.1E-05	545	13.953	6.4E-05	1.81	2.00	8.4E-05	1.81	0.007591	214.95	5.73	6/12/03	22:12	388:06:53	388:04:00	19.700627	
-1	85	1078	-3.5E-05	545	13.992	-3.21E-05	-0.91	2.38	7.8E-05	2.16	0.007667	217.11	5.78	6/13/03	15:14	405:08:53	405:06:00	20.12829	
2	88	1083	7.1E-05	548	14.057	6.41E-05	1.61	0.95	3.1E-05	0.86	0.007898	217.98	5.80	6/14/03	14:46	428:40:53	428:38:00	20.704822	
-13	85	1085	-0.00046	545	14.063	-0.00042	-11.88	-4.13	-0.00013	-3.77	0.007565	214.21	5.72	6/15/03	14:36	452:30:53	452:28:00	21.272393	
11	89	1087	0.00039	549	14.109	0.000353	10.00	4.34	0.00014	3.94	0.007704	218.15	5.81	6/16/03	13:31	475:25:53	475:23:00	21.804389	
-12	80	1085	-0.00042	540	14.083	-0.000391	-11.07	5.71	0.00019	5.26	0.00789	223.42	5.93	6/17/03	13:38	499:30:53	499:28:00	22.349826	
40	95	1081	0.00141	555	14.031	0.001283	35.77	1.85	5.2E-05	1.47	0.007942	224.89	5.96	6/18/03	13:55	523:49:53	523:47:00	22.887383	
-11	85	1082	-0.00039	545	14.044	-0.000354	-10.03	11.98	0.00039	10.92	0.008326	235.81	6.21	6/21/03	10:38	592:32:53	592:30:00	24.34231	
-6	85	1079	-0.00021	545	14.005	-0.000193	-5.45	-9.38	-0.0003	-8.52	0.008027	227.29	6.02	6/23/03	11:15	641:09:53	841:07:00	25.321231	
48	100	1078	0.00162	580	13.992	0.001436	40.86	11.42	0.00036	10.09	0.008383	237.38	6.25	6/25/03	18:30	694:24:53	694:22:00	28.35175	
-50	75	1082	-0.00177	535	14.044	-0.00164	-46.43	8.50	0.00028	7.90	0.006662	245.28	6.43	6/27/03	15:23	741:17:53	741:15:00	27.228789	

DECANISTERED 7/2/03, air-dried 21 days

SAMPLE: 1123' to 1126' (Riverton coal) in canister McC C

DRY WEIGHT lbs. grams

sample weight: 1.7415 789.953

est. lost gas (cc) = 71

TIME OF: off bottom 5/27/03 19:09; in canister 5/27/03 19:15

5/27/03 19:10 elapsed time (off bottom to canistering) 5.9 minutes

0.098 hours

0.3136 SQRT (hrs)

free air space in canister (ccs) 2137.54

RIG MEASUREMENTS measured cc	measured T (F)	measured P	CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 psi) cubic ft (@rig)	ABSOLUTE T (F) (@rig)	psia (@rig)	cubic ft (@STP)	cc (@STP)	air-space adjusted vol. (cc)	air-space adjusted vol. (cubic ft@STP)	air-space adjusted vol. (cc @STP)	CUMULATIVE VOLUMES air-space-adjusted cum. vol. (cubic ft@STP)	air-space-adjusted cum. vol. (cc@STP)	SCF/TON with lost gas	TIME OF MEASURE		TIME SINCE off bottom	in canister	SQRT hrs. (since off bottom)	
	75	1076	0	535	13.986	0	0.00												
16	75	1076	0.00057	535	13.968	0.000522	14.77	16.00	0.00052	14.77	0.000522	14.77	3.48	5/27/03	19:16	0:07:39	0:01:45	0.3570714	
9	75	1078	0.00032	535	13.966	0.000293	8.31	9.00	0.00029	8.31	0.000815	23.09	3.82	5/27/03	19:18	0:09:24	0:03:30	0.3958114	
9	75	1076	0.00032	535	13.966	0.000293	8.31	9.00	0.00029	8.31	0.001109	31.40	4.15	5/27/03	19:20	0:11:24	0:05:30	0.4358899	
12	75	1076	0.00042	535	13.986	0.000391	11.08	12.00	0.00039	11.08	0.0015	42.48	4.60	5/27/03	19:23	0:14:09	0:08:15	0.4856267	
11	75	1076	0.00039	535	13.966	0.000359	10.18	11.00	0.00038	10.16	0.001859	52.64	5.01	5/27/03	19:28	0:18:54	0:11:00	0.5307228	
11	75	1076	0.00039	535	13.986	0.000359	10.16	11.00	0.00036	10.16	0.002218	82.79	5.43	5/27/03	19:29	0:20:09	0:14:15	0.5795113	
13	75	1078	0.00046	535	13.988	0.000424	12.00	13.00	0.00042	12.00	0.002641	74.80	5.91	5/27/03	19:33	0:24:24	0:18:30	0.6377042	
13	75	1078	0.00046	535	13.966	0.000424	12.00	13.00	0.00042	12.00	0.003065	88.80	6.40	5/27/03	19:38	0:29:09	0:23:15	0.6970175	
7	75	1076	0.00025	535	13.968	0.000228	6.46	7.00	0.00023	8.48	0.003294	93.27	6.66	5/27/03	19:41	0:32:24	0:28:30	0.7348469	
9	75	1078	0.00032	535	13.966	0.000293	8.31	9.00	0.00029	8.31	0.003587	101.58	7.00	5/27/03	19:46	0:36:54	0:31:00	0.7842194	
10	75	1076	0.00035	535	13.966	0.000328	9.23	10.00	0.00033	9.23	0.003913	110.81	7.37	5/27/03	19:51	0:41:54	0:36:00	0.8356634	
8	75	1076	0.00028	535	13.966	0.000261	7.39	8.00	0.00026	7.39	0.004174	118.20	7.67	5/27/03	19:55	0:48:39	0:40:45	0.8817596	
9	75	1076	0.00032	535	13.966	0.000293	8.31	9.00	0.00029	8.31	0.004468	126.51	8.01	5/27/03	20:01	0:52:24	0:46:30	0.9345231	
10	75	1075	0.00035	535	13.953	0.000326	9.23	8.01	0.00028	7.39	0.004729	133.90	8.31	5/27/03	20:09	0:59:54	0:54:00	0.9991663	
180	80	1087	0.00636	540	14.109	0.005875	166.38	183.84	0.008	189.91	0.010729	303.81	15.20	5/27/03	23:23	4:13:54	4:08:00	2.0571015	
250	85	1092	0.00883	545	14.174	0.008122	229.99	240.09	0.0078	220.87	0.018529	524.68	24.16	5/28/03	10:50	15:40:54	15:35:00	3.9800084	estimate
155	85	1087	0.00547	545	14.109	0.005013	141.94	145.17	0.00469	132.94	0.023224	857.82	29.55	5/29/03	11:48	40:38:54	40:33:00	6.3758045	
110	85	1083	0.00388	545	14.057	0.003544	100.36	102.11	0.00329	93.18	0.026514	750.78	33.33	5/30/03	16:15	69:05:54	89:00:00	6.3125407	
30	85	1082	0.00108	545	14.044	0.000966	27.35	28.02	0.0009	25.55	0.027418	778.33	34.36	5/31/03	18:48	93:38:54	93:33:00	9.6772069	
26	85	1082	0.00092	545	14.044	0.000837	23.70	26.00	0.00084	23.70	0.028253	600.03	35.33	6/1/03	14:39	115:29:54	115:24:00	10.747015	
98	91	1081	0.00346	551	14.031	0.003117	88.26	72.47	0.00231	65.28	0.030558	865.31	37.97	8/3/03	13:54	162:44:54	162:39:00	12.757288	
-16	84	1081	-0.00057	544	14.031	-0.000516	-14.60	11.16	0.00036	10.18	0.030918	875.48	38.39	6/4/03	18:55	191:45:54	191:40:00	13.847924	
30	84	1082	0.00106	544	14.044	0.000968	27.40	31.98	0.00103	29.20	0.031949	904.69	39.57	8/5/03	14:59	211:49:54	211:44:00	14.554438	
68	93	1077	0.0024	553	13.979	0.002147	60.81	22.55	0.00071	20.18	0.032861	924.85	40.39	8/8/03	14:21	235:11:54	235:08:00	15.338177	estimate
-26	85	1078	-0.00092	545	13.992	-0.000834	-23.81	6.88	0.00022	8.25	0.032881	931.09	40.64	6/7/03	19:51	264:41:54	284:38:00	18.289552	
25	85	1075	0.00088	545	13.953	0.0008	22.84	19.03	0.00081	17.24	0.03349	948.33	41.34	8/11/03	17:28	358:18:54	358:13:00	18.92921	
17	85	1075	0.0006	545	13.953	0.000544	15.40	17.00	0.00054	15.40	0.034034	963.73	41.96	6/12/03	22:10	387:00:54	386:55:00	19.672897	
-2	85	1078	-7.1E-05	545	13.992	-8.41E-05	-1.82	3.95	0.00013	3.59	0.034161	987.31	42.11	6/13/03	15:15	404:05:54	404:00:00	20.102197	

7	88	1083	0.00025	548	14.057	0.000224	8.35	5.18	0.00017	4.88	0.034326	971.99	42.30	6/14/03	14:27	427:17:54	427:12:00	20.871196	estimate
-10	85	1085	-0.00035	545	14.083	-0.000323	-9.14	5.82	0.00018	5.14	0.034507	977.13	42.51	6/15/03	14:37	451:27:54	451:22:00	21.247706	
21	89	1087	0.00074	549	14.109	0.000874	19.09	9.27	0.0003	8.43	0.034805	985.56	42.85	6/16/03	13:30	474:20:54	474:15:00	21.779539	
-14	80	1085	-0.00049	540	14.083	-0.000458	-12.92	17.17	0.00056	15.84	0.035364	1001.40	43.49	6/17/03	13:35	498:25:54	498:20:00	22.325583	
62	95	1081	0.00219	555	14.031	0.001958	55.45	-5.51	-0.00017	-4.92	0.03519	996.47	43.29	6/18/03	13:55	522:45:54	522:40:00	22.864055	
-7	85	1082	-0.00025	545	14.044	-0.000225	-8.38	33.45	0.00108	30.49	0.038287	1028.97	44.53	6/21/03	10:38	591:28:54	591:23:00	24.320396	
-3	85	1079	-0.00011	545	14.005	-9.63E-05	-2.73	-8.94	-0.00029	-8.13	0.03598	1018.84	44.20	6/23/03	11:14	640:04:54	639:59:00	25.299835	
73	100	1078	0.00258	560	13.992	0.002279	84.52	12.13	0.00038	10.72	0.038359	1029.56	44.63	6/25/03	16:30	693:20:54	693:15:00	26.331508	
-55	75	1082	-0.00194	535	14.044	-0.001804	-51.07	47.98	0.00157	44.55	0.037932	1074.11	46.44	6/27/03	15:23	740:13:54	740:08:00	27.207199	

DECANISTERED 7/2/03, air-dried 21 days

854' to 855' (Weir-Pittsburg coal) in canister McC A

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

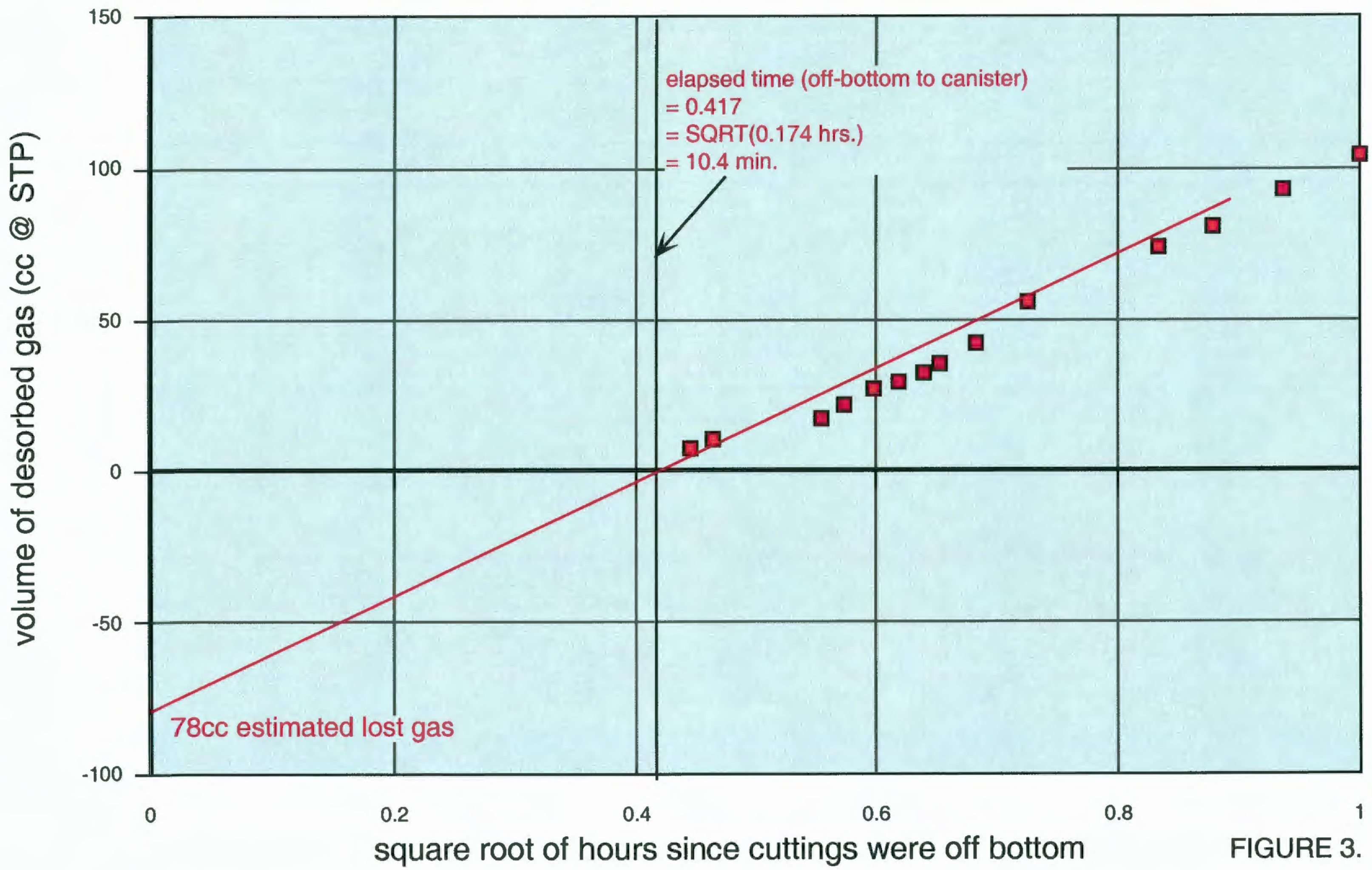

FIGURE 3.

1064' to 1066' (Rowe coal) in canister McC B

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

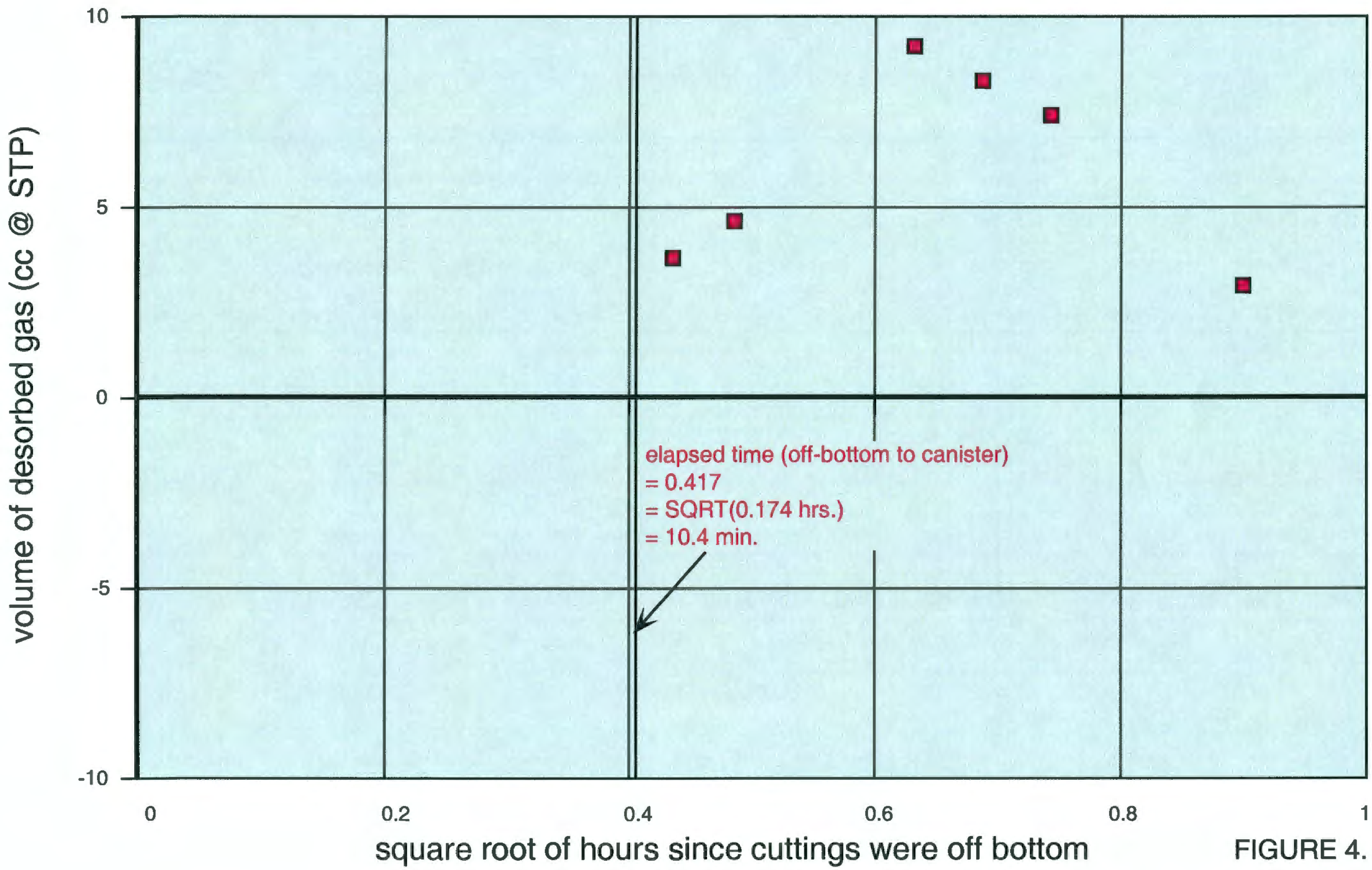

FIGURE 4.

1072' to 1074' (Neutral/Rowe coal) in canister Brady 27

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

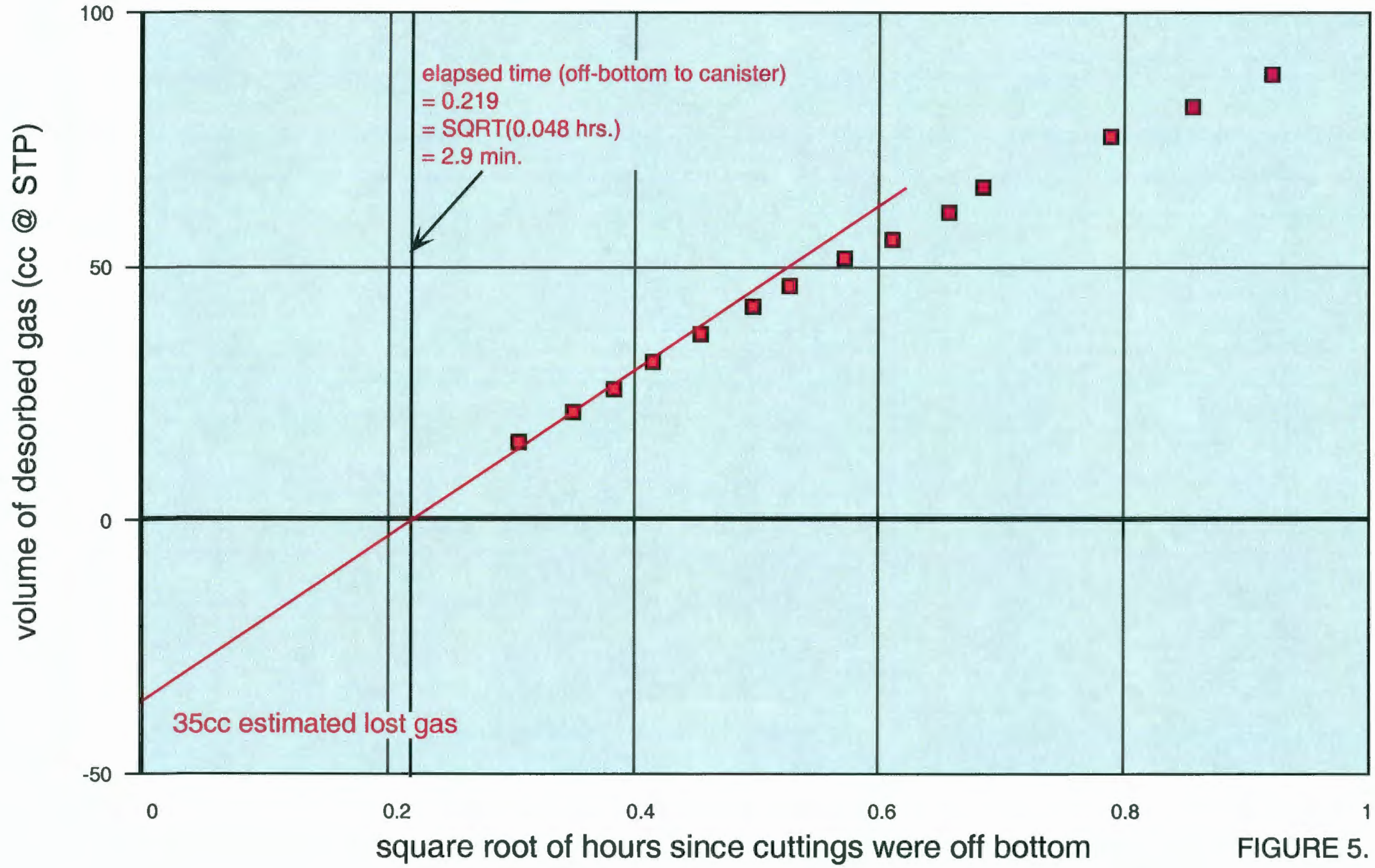

FIGURE 5.

1123' to 1126' (Riverton coal) in canister McC C

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

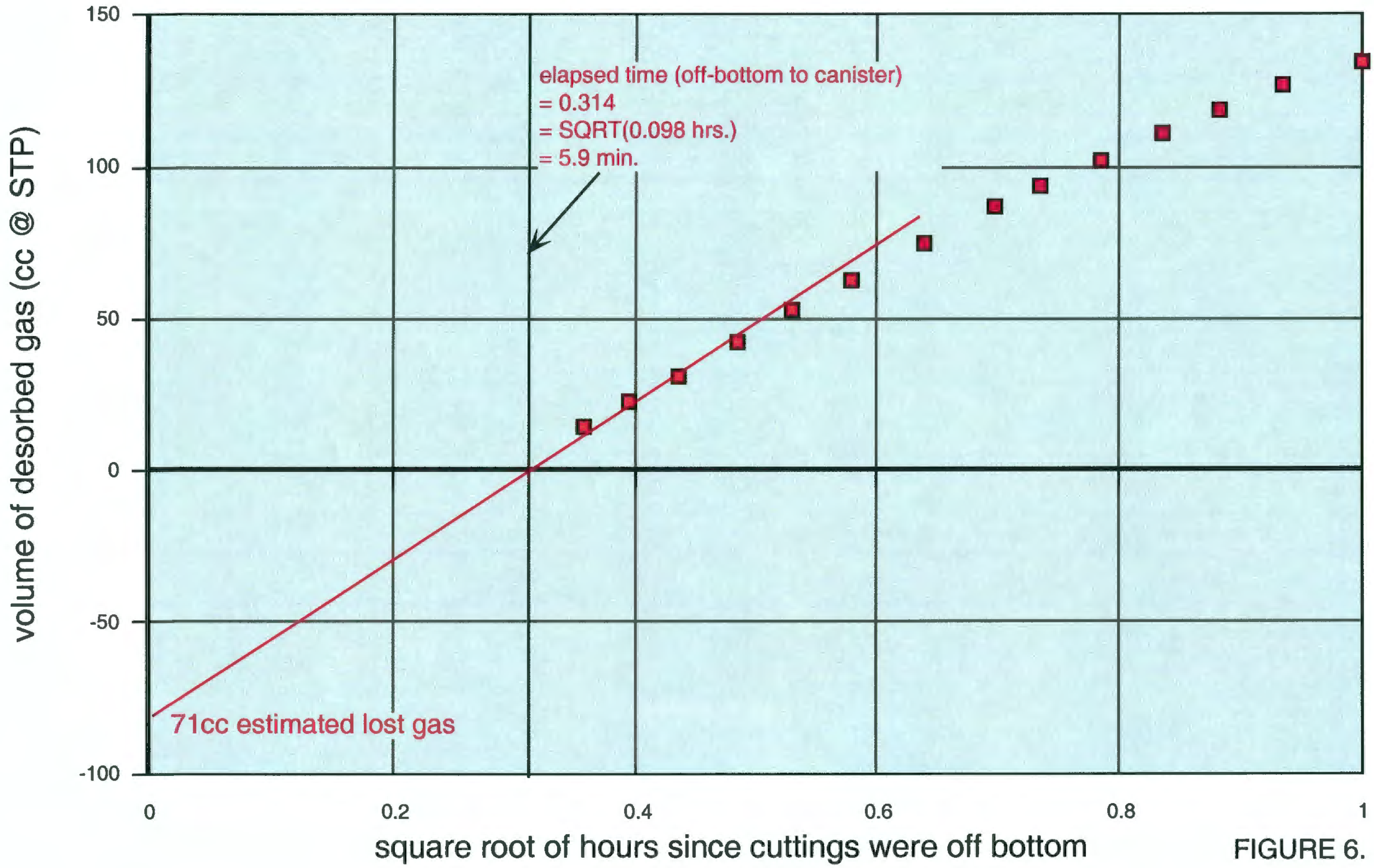

FIGURE 6.

Desorption Characteristics of Cuttings Samples

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Weir-Pittsburg coal from 854-855'

$$\text{GAS CONTENT}_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{dark\ shale}) * (\text{weight}_{dark\ shale}))}{\text{weight}_{coal}}$$

total gas desorbed = 474 ccs

TOTAL DRY WEIGHT OF SAMPLE = 1441.70 grams

$\text{weight}_{light\text{-}colored\ lithologies}$ = 1231.28 grams (85.4%)

$\text{weight}_{dark\ shale}$ = 90.32 grams (6.3%)

weight_{coal} = 120.10 grams (8.3%)

sieve size	grams	% coal / % dark shale / % light-colored liths
>0.0930"	1147.92	5.31% / 6.93% / 87.77%
>0.0661"	164.16	18.95% / 3.43% / 77.62%
>0.0460"	84.44	20.77% / 3.17% / 76.06%
>0.0331"	24.51	27.71% / 6.02% / 66.27%
<0.0331"	20.67	18.19% / 4.89% / 76.93%
	1441.70 TOTAL	

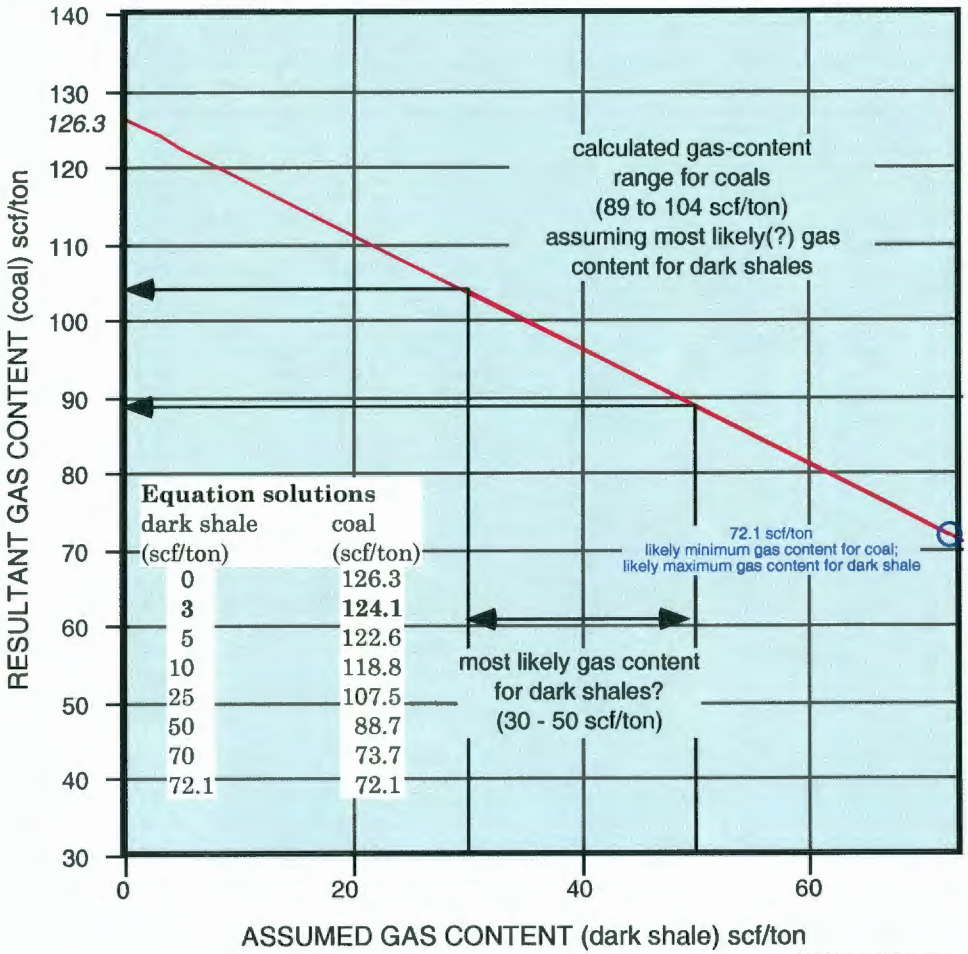

FIGURE 7.

Desorption Characteristics of Cuttings Samples

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Neutral/Rowe coal from 1072-1074'

$$\text{GAS CONTENT}_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{\text{dark shale}}) * (\text{weight}_{\text{dark shale}}))}{\text{weight}_{coal}}$$

total gas desorbed = 280 ccs

TOTAL DRY WEIGHT OF SAMPLE = 1587.24 grams

$\text{weight}_{\text{light-colored lithologies}}$ = 190.45 grams (12.0%)

$\text{weight}_{\text{dark shale}}$ = 1335.97 grams (84.2%)

weight_{coal} = 60.82 grams (3.8%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930"	281.15	6.69% / 75.27% / 18.05%
>0.0661"	415.53	3.76% / 86.15% / 10.09%
>0.0460"	535.42	3.11% / 87.05% / 9.84%
>0.0331"	254.27	2.26% / 85.03% / 12.71%
<0.0331"	12.78	3.95% / 83.37% / 12.67%
	1587.24 TOTAL	

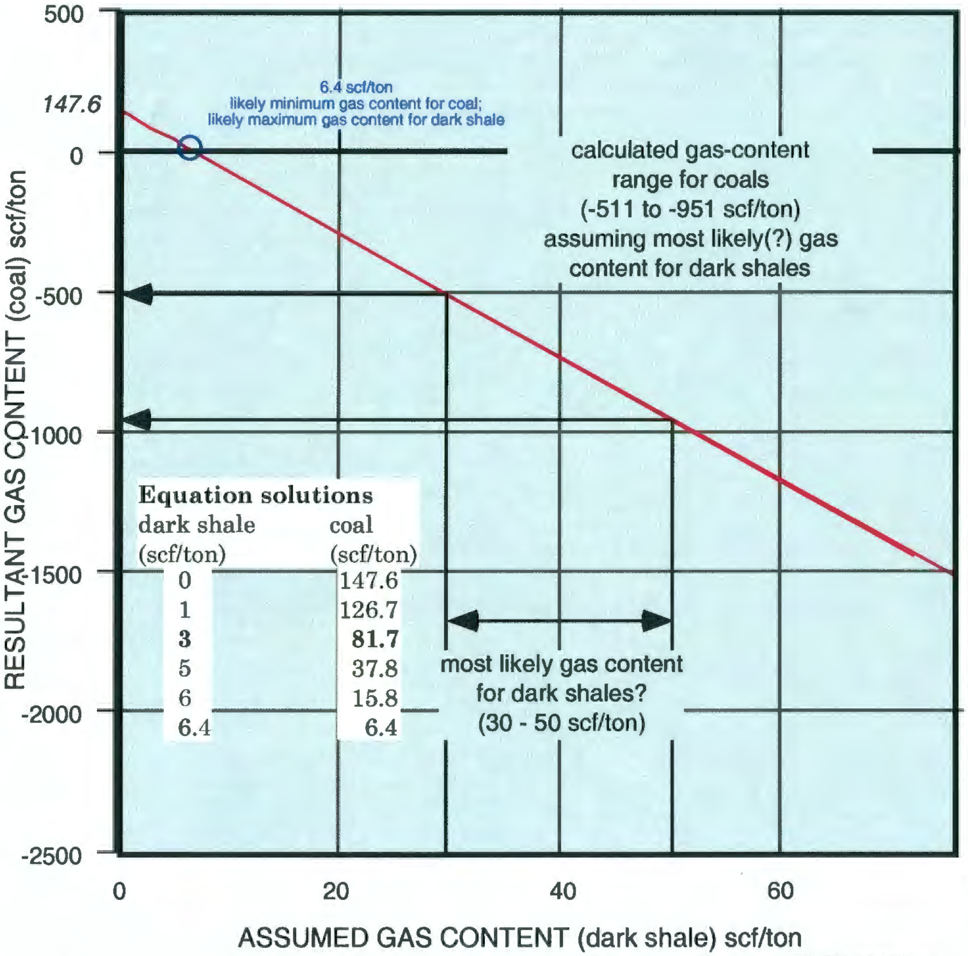

FIGURE 8.

Desorption Characteristics of Cuttings Samples

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Riverton coal from 1123-1126'

$$\text{GAS CONTENT}_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{dark\ shale}) * (\text{weight}_{dark\ shale}))}{\text{weight}_{coal}}$$

total gas desorbed = 1145 ccs

TOTAL DRY WEIGHT OF SAMPLE = 895.58 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 105.63 grams (11.8%)
$\text{weight}_{dark\ shale}$ = 600.36 grams (67.0%)
weight_{coal} = 189.59 grams (21.2%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930"	172.24	24.16% / 58.05% / 17.79%
>0.0661"	274.82	23.02% / 67.04% / 9.93%
>0.0460"	296.39	21.91% / 67.73% / 10.36%
>0.0331"	116.57	10.85% / 78.30% / 10.85%
<0.0331"	35.56	19.99% / 67.78% / 12.23%
	895.58 TOTAL	

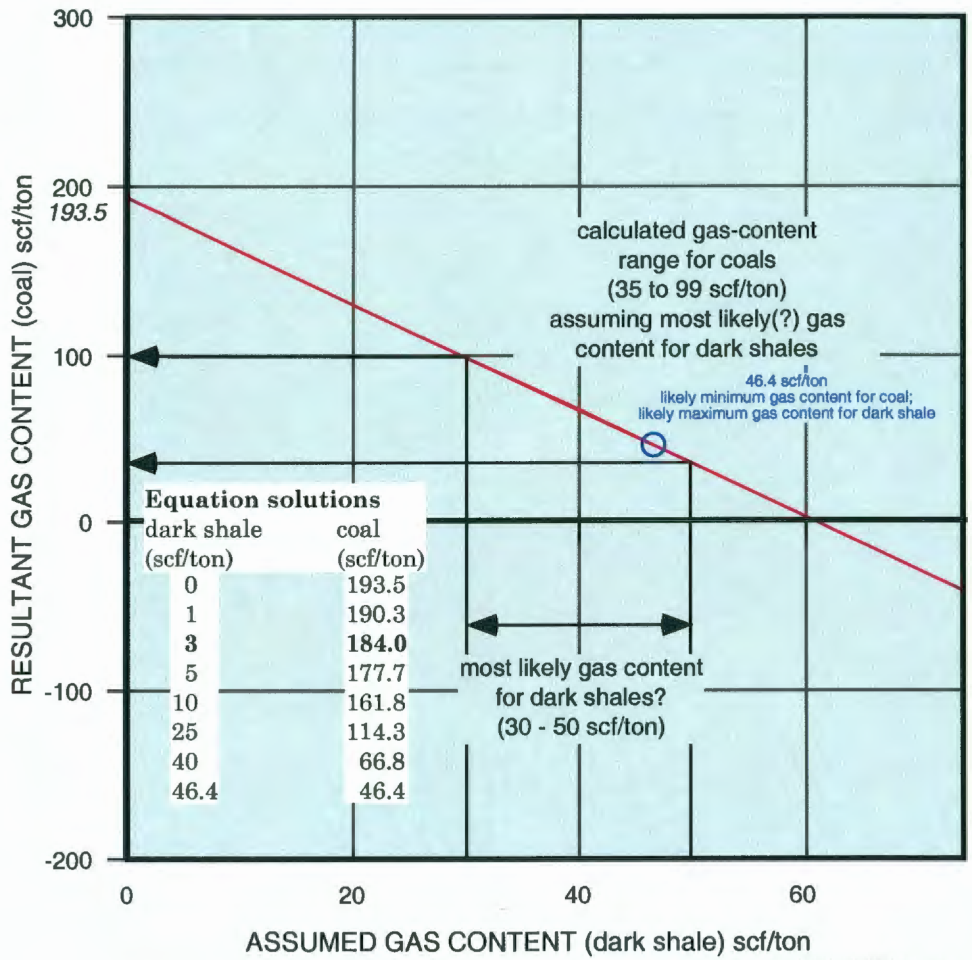

FIGURE 9.

Desorption Characteristics of Cuttings Samples

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

surface
100'
200'
300'
400'
500'
600'
700'
800'
O 854'-855' Weir-Pittsburg
900'
1000'
O 1072' to 1074' Neutral/Rowe coal
O 1123'-1126' Riverton
1200'

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for all samples

UNIT	coal in sample	maximum scf/ton	scf/ton w/ shale @ 3 scf/ton	minimum scf/ton
Weir-Pitt	8%	126.3	**124.1**	72.1
Neutral/Rowe	4%	147.6	**81.7**	6.4
Riverton	21%	193.5	**184.0**	46.4

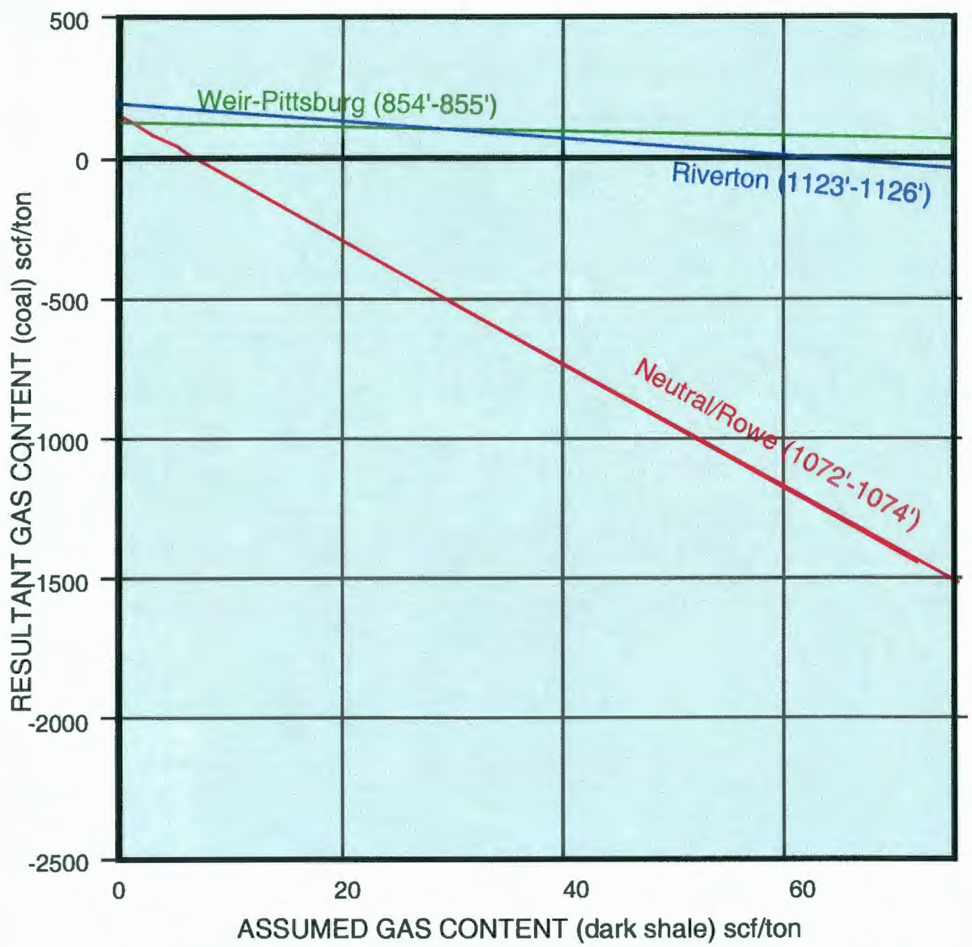

FIGURE 10.

Desorption Characteristics of Cuttings Samples (ie., coal & dark shale)

Production Maintenance Services #1 McClenning; NE NE sec. 32-T.33S.-R.16E., Montgomery County, KS

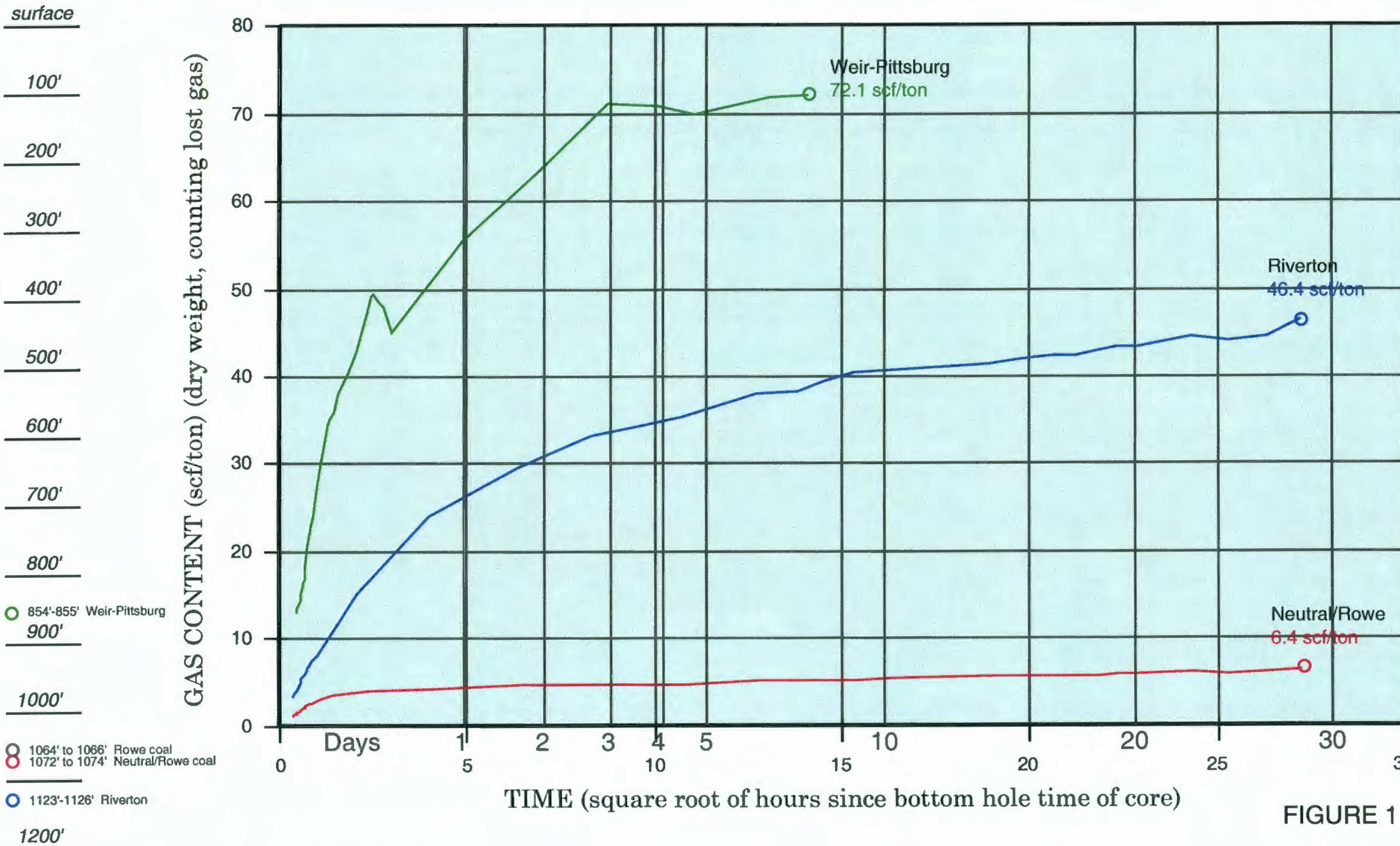

FIGURE 11.