DOE/MC/17783-T1

Rec-295
BINS-1164
NTIS-25
SP. 50

MASTER

THE UNCOVERING AND EVALUATION OF TWENTY FIVE
YEAR OLD UNDERGROUND COAL GASIFICATION BURN
AT A SITE IN GORGAS, ALABAMA

By
John P. Capp

April 1981

Work Performed Under Contract No. AP21-81MC17783

Morgantown Energy Technology Center
Morgantown, West Virginia

TECHNICAL INFORMATION CENTER
UNITED STATES DEPARTMENT OF ENERGY

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

"This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Printed Copy A02
Microfiche A01

THE UNCOVERING AND EVALUATION OF TWENTY FIVE YEAR OLD
UNDERGROUND COAL GASIFICATION BURN AT A SITE IN
GORGAS, ALABAMA

by

John P. Capp

April 1981

Prepared for

UNITED STATES DEPARTMENT OF ENERGY
Morgantown Energy Technology Center
Morgantown, West Virginia

Under Contract No. DE-AP21-81MC17783

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

THE UNCOVERING AND EVALUATION OF TWENTY FIVE YEAR OLD
UNDERGROUND COAL GASIFICATION BURN AT A SITE IN
GORGAS, ALABAMA

by

1

John P. Capp

BACKGROUND

During the late forties and into the fifties, the U.S. Bureau of Mines (USBM) and the Alabama Power Company conducted a series of underground coal gasification burns in the Pratt and America coal beds at Gorgas, Alabama. Following the first burn, by the so called "stream method," it was feasible to enter the burned out areas by deep mining and assess what had taken place during the operation of the test site. In the latter tests, however, it was not economically feasible to explore the burned out areas except by means of core drilling. Now, in early 1981, an opportunity has become available to engineers interested in the UCG process to further evaluate these old sites.

The Southern Company Services, a power plant operator, is involved in a large scale surface mining operation to provide coal for their power plants in the area. At the present time, the Russel Coal Company of Cordova, Alabama, has the mining contract to remove the coal from the Underground Coal Gasification (UCG) site; and currently, the mining is being done in the vicinity of the first hydraulic fracture area.

Because the Southern Company Services is also interested in the test area, contact was made with A. J. Liberatore, Morgantown Energy Technology Center (METC), to determine whether a cooperative evaluation could be executed. METC agreed to send an engineer to Gorgas. I had been there during the active operation of the burns and agreed to go to Gorgas, evaluate the exposed area, collect samples, take photographs, and provide this written report.

INTRODUCTION

I arrived at Gorgas on February 16, 1981, and spent the next several days taking photographs and making observations at the exposed burn site, taking samples, and discussing the best ways to coordinate future exposures with the coal mining process.

The Russell Company's surface mining plan is a typical parallel cut operation that will eventually remove all the overburden and extract the three seams of coal in the hill. All the UCG burns, in both the Pratt and the America, will eventually be exposed. I was informed that the coal company must submit a new mining plan within the next 60 days and requested that a copy of the plan

1

Chemical Engineer/Consultant

be made available to Department of Energy, Morgantown Energy Technology Center (DOE/METC) for future reference. This was agreed to by Southern Services engineer, Carey McBride. It should be pointed out here that everyone I met from both the Coal Company and the Power Company was extremely cooperative and interested in this program.

SITE EVALUATION

The uncovered burn area at the site of the first hydraulic fracture (Figure 1) can be described as a flat, roughly circular shaped area, varying in thickness from about 1 foot to 2 feet high and covered with a mixture of the various materials removed in the mining operation, i.e., broken bits of coal, rock, clay, etc. However it rained the night before the observation and during the entire evaluation period making it extremely difficult to determine whether fine gray colored materials were clay or residual ash.

Figure 1. Affected UCG burn area and approximate location of the highwall as of February 1981.

Photograph No. 1 is view of the pit from the top of the E-W highwall looking south. The burn area is situated near the center of the photo and to the left of the haul road just before it rises out of the pit.

Photograph No. 1

Figure 2 depicts the lithology of the America seam which is described in this report. (Details of this work are described in USBM Report of Investigation No. 5367).

Figure 2. Section of America coal bed.

Figure 3 is typical of the apparent location of the three main coal beds in the gasified area.

Figure 3. Typical section of coal strata between boreholes.

The area was situated about 75 feet from the west highwall face of cut No. 2. At least five 2-inch well casings were observed in the face of the highwall and one 2-inch well casing in the north highwall. The casings in the west facing wall were in a line roughly parallel to the face. From these observations, the highwall locations on the mining map, and reference points from the old Bureau reports, we were able to conclude that the exposed site was the burned area around hole No. HF 3 in the first hydraulic fracture area.

(Details of the operations at this area are given in USBM RI No. 5666). Having pinpointed this area on the mining map, it was a fairly easy matter to locate the other burned areas (hydrofrac No. 2 - electrolink, etc.) on the map also. This was accomplished and will be of value in keeping track of the mining progress relative to the UCG burns. There was some speculation at this point that

Site D (one of the so called rosette burns) had been mined through. This may be confirmed later on as mining progresses.

In order to more fully evaluate the HF 3 burn, the assistance of the loader operator was requested to, as carefully as possible, penetrate into the burn with the bucket to expose an internal face. This was done in two directions N-S and W-E for a distance of about 25-30 feet. The W-E cut was unproductive. It appeared that the loader operator may have inadvertently destroyed part of the burn during the mining and, after discovering what had been done, back-filled with the broken materials.

The N-S cut, however, appeared to be undisturbed; and after carefully facing up and cleaning away debris, it was evident that a burn had taken place at this point. Four samples were obtained of various types of materials from this cut, representative of fused rock, ash, coke, and burned shale. These materials appeared to be typically similar to those materials uncovered after the first Gorgas burn and reported in USBM RI No. 4169.

During the mining operation in the Pratt seam directly above this area, the coal company engineer reported that there was about 20 feet of excellent quality coke surrounding the HF 3 pipe. This confirmed some speculations that any UCG operations in the America seam would have only a minimal effect on the Pratt (about 50 feet above the America).

Tables 1 and 2 give the preburn coal analysis and post burn residue analysis of these materials as well as an analysis of the America bed coal taken from USBM RI No. 5367 for comparison. The original overall thickness of the America coal bed at this site was 64 inches (Figure 3), but this included almost 26 inches of partings leaving only 38 inches of coal. About 33 inches, or 88 percent, of the coal occurred above a 17-inch clay-shale parting. It is believed that much of the burning took place in the coal above the 17-inch parting, except where combustion was most intense. Since pieces of fused rock or shale occurred throughout the area, it can be assumed that temperatures exceeded 2500 F. If all the partings in the coal are added together, the sum is 26 inches or about the thickness of the area investigated. Sample No. 4 (burned shale) compares favorably with the parting analysis from the America bed after adjusting for the effects of burning. The coke (Sample No.3) is like the America bed upper section analysis. Photograph Nos. 2, 3, 4, and 5 were taken at sample points 1, 2, 3, and 4 respectively.

Table 1 -- Chemical Analysis of America-Bed Coal

Bench	Condi- tion	Proximate, percent			Ultimate, percent						Calo- rific value, Btu	Fusibility of ash, temperature, ° F.		
		Mois- ture	Vola- tile matter	Fixed car- bon	Ash	Hydro- gen	Car- bon	Nitro- gen	Oxy- gen	Sul- fur		Initial deform- ation	Soft- ening	Fluid
Upper ^{2/}	1	1.7	27.8	50.3	20.2	4.4	65.3	1.4	7.0	1.7	11,610	2,730	2,810	2,910
	2	-	28.3	51.1	20.6	4.3	66.4	1.4	5.6	1.7	11,810			
	3	-	35.6	64.4	-	5.4	83.7	1.8	6.9	2.2	14,870			
Parting ^{2/}	1	2.1	9.7	4.4	83.8	1.5	6.5	.2	7.5	.5	-	2,680	2,780	2,910
	2	-	9.9	4.5	85.6	1.4	6.6	.2	5.7	.5	-			
	3	-	-	-							-			
Lower ^{2/}	1	2.0	21.0	28.6	48.4	3.1	39.6	.9	6.9	1.1	6,980	2,510	2,710	2,910
	2	-	21.4	29.3	49.3	3.0	40.4	.9	5.3	1.1	7,120			
	3	-	42.3	57.7	-	5.8	79.7	1.8	10.6	2.1	14,040			
Composite ^{2/}	1	1.8	21.5	31.7	45.0	3.3	41.8	.9	7.9	1.1	7,410	2,630	2,770	2,910
	2	-	21.9	32.2	45.9	3.1	42.6	.9	6.3	1.2	7,650			
	3	-	40.5	59.5	-	5.8	78.7	1.7	11.6	2.2	14,130			

^{1/} 1. Sample as-received; 2. Dried at 105°C.; 3. Moisture- and ash-free.

^{2/} See figure 3; upper = ab, 37 inches; parting = bc, 17 inches; lower = cd, 10 inches; composite = ad, 64 inches, including all partings. Source USBM RI No. 5367.

Table 2
 Analysis of Materials ^{1/}, from UCG Site, Gorgas, Alabama
 Post Burn Evaluation; February 1981

Sample	(1) Fused Rock	(2) Ash	(3) Coke	(4) Burned Shale
Ash	98.95	86.35	31.60	87.99
Hydrogen	0.06	0.33	0.46	0.17
Carbon	0.39	7.11	62.58	9.53
Nitrogen	0.00	0.00	0.45	0.07
Oxygen	0.00	2.93	1.77	0.96
Sulfur	0.07	2.74	1.71	0.88
Moisture	0.07	0.54	1.43	0.40
CaO	0.89	0.94	1.26	2.87
K ₂ O	4.57	2.16	4.05	1.37
P ₂ O ₅	0.70	1.90	1.54	4.06
SiO ₂	59.10	44.83	45.19	41.86
Al ₂ O ₃	22.95	32.76	34.77	34.27
Fe ₂ O ₃	9.69	14.87	9.98	11.56
TiO ₂	1.04	1.65	1.39	2.19
MgO	1.01	0.45	0.80	0.59
Na ₂ O	<0.10	<0.10	1.16	1.05
SO ₃	0.37	0.36	0.43	0.64

^{1/} Weight percent, as received.

PHOTOGRAPH NO. 2

PHOTOGRAPH NO. 3

PHOTOGRAPH NO. 4

PHOTOGRAPH NO. 5

COAL BEDS -- (PRATT, NICKEL PLATE, AND AMERICA)

The three coal beds (Pratt, Nickel Plate, and America) and the associated overburden in the process of being stripped typically appear as shown in Photograph No. 6. Photograph No. 7 shows four 2-inch pipes imbedded in the N-S highwall, one above the Pratt bed at the left and three below the Pratt at equally spaced intervals toward the right. In all probability, these were used to establish a reaction path by means of backward linkage burning between HF 3 and other wells in the hydrofraced area. Photograph Nos. 8 and 9, illustrate the effects of burning in the vicinity of the 2-inch pipes described in Photograph No. 7. In Photograph No. 8, the effects are illustrated by discolored and rubbly shale. Note a definite demarcation near the center between burned and unburned sections of coal bed. Although one cannot discount the effects of blasting during the mining operation, it appears that the rubbled shales collapsed into the voids as coal was consumed by the gasification reaction. The effects of burning are somewhat less dramatic in Photograph No. 9, but red colored, rubblized shales are clearly visible. Photograph No. 10 shows the corner where the N-S and E-W highwalls meet. It also shows a 2-inch well casing in the upper left hand corner and the effects of burning immediately below at coal bed level that are similar to those described above. Photograph No. 11 is of the same general area but more dramatically shows the demarcation between the burned and unaffected portions of the coal bed. The presence of the men and equipment serves to provide a reference for relative size and space.

There are a number of impediments that should be mentioned in attempting to conduct an investigation of this type. Foremost is the fact that the coal operator is extracting coal in the most economically feasible way possible and, therefore, is not very likely to be as careful with sensitive areas as desired even though the operator appears to be cooperative. Furthermore, the operator will not be likely to deviate from his mining plan for our convenience without compensation -- which may be a considerable amount, depending upon circumstances. An example of this would be a request to move the line of blast holes so that the resulting highwall would intersect a burn area.

Should the mining plan coincide with any burned area of interest, there are still a number of difficulties to be considered. The constant moving of vehicles (trucks, loaders, dozers) and other equipment into and out of the pit is a threat to the integrity of the burned section. Any observations requiring detailed study at the base of the highwall is extremely dangerous due to falling rock or slides from above.

Finally, the experimental site is so old that it may be impossible to reach valid conclusions beyond a reasonable doubt.

In spite of all of these difficulties, post burn observations provide the UCG research personnel an opportunity to view directly things that were only speculative previously.

PHOTOGRAPH NO. 6

PHOTOGRAPH NO. 7

PHOTOGRAPH NO. 8

PHOTOGRAPH NO. 9

PHOTOGRAPH NO. 10

PHOTOGRAPH NO. 11

RECOMMENDATIONS

If the DOE is interested in further pursuit of observations of this type, I recommend the following:

1. Maintain close, periodic contact with the mining operations engineers at Southern Company Services.
2. Consider cooperative agreement, including compensation, with the coal operator or Southern Company Services to properly develop and protect a sensitive area in order to study with least possible disturbance.
3. Any observations and extended study at the base of the highwall should be performed under a protective canopy or temporary structure for obvious safety reasons.
4. Finally, the last or closing phase of any UCG experimental operation should include the strip mining of the overburden, if technically feasible, or at the very least, an extensive core drilling survey and sampling plan.

ACKNOWLEDGEMENTS

Mr. Carey McBride, Mining Engineer with Southern Company Services, who was the guide during the visit.

Mr. Gibson Lanier, Birmingham Office, who made the visit and the cooperation possible.

Mention is also made of Mr. Phillip Douglas, Gorgas Office, and Mr. Don Russel of Russel Coal company for their cooperation.

Special acknowledgement to Mr. Arthur J. Liberatore, UCG Program Manager, METC, for arranging the trip and assisting in preparing this report for publication and distribution.

PERSONNEL CONTACTS LIST

Mr. Donald Thornburg, Alabama Power Company, (205) 250-1000.

Mr. Gibson Lanier, Manager Fuels Technical Services, Southern Company Services, Birmingham Office.

Mr. Don Russel, (owner and president) Russel Coal Company, Cordova, Alabama, (205) 483-9214.

Mr. Herb Clouse, Mining Engineering Supervisor, Russel Coal Company.

Mr. Carey McBride, Mining Engineer, Southern Company Services at Gorgas, Alabama, (205) 686-5711.

Mr. Phillip Douglas, Fuels Services, Southern Company Services at Gorgas, Alabama, (205) 686-5711.

Mr. Colt Pears, Southern Research, (205) 229-1000.

Mr. A. J. Liberatore, DOE, METC (304) 599-7161.

4:dg:411:19