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FUEL RESEARCH INSTITUTE
OF SOUTH AFRICA

SURVEY REPORT NO. 350

ONDERWERP:
SUBJECT: COKING COAL INVESTIGATION.

Ultimate Analyses of Composite Samples from Boreholes drilled for the Geological Survey in the Witbank Coalfield in 1952 and 1956.

AFDELING:
DIVISION: SURVEY

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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

REPORT NO. 4 OF 1969

SURVEY REPORT NO. 350

COKING COAL INVESTIGATION

Ultimate Analyses of Composite Samples from Boreholes drilled for the Geological Survey in the Witbank Coalfield in 1952 to 1956.

INTRODUCTION

Four reports, covering boreholes 1 to 54, 55 to 156, 157 to 215, and 218 to 315, were issued on official drilling of the No. 5 Seam of the Witbank coalfield. Fuel Research Institute Survey Report No. 244 (Report No. 1 of 1959) entitled "The Reserves of Blend Coking Coal in the No. 5 Seam of the Witbank Coalfield" was written on the basis of the information obtained from these and other boreholes.

During the course of the drilling programme, composite samples were made up, mainly of No. 5 Seam coal, and various analyses carried out. These samples have never been reported, and are given here to complete the information on this drilling programme. The composite samples represent the areas (or subdivisions thereof) covered by the four reports. Composite samples of the No. 5 Seam cover all four areas, but all four No. 4 Seam samples and two No. 2 Seam samples represent Area No. 2, and the other two No. 2 Seam samples and samples from other seams represent Area No. 4. The locations of all boreholes included in the composite samples are given in the four original reports, and all but a few in the extreme south and east are given in Fuel Research Institute Report No. 1 of 1959.

/PRESENTATION ....

PRESENTATION OF RESULTS

The data on which this report is based are given in five tables and a plan of the area. In Table 1 the constitution of the composite samples is given, the identification of the components being only by borehole number and sample letter, the sample number not being given. In Table 2 proximate analyses and calorific values are given, as well as the average thicknesses and float yields repeated from Table 1. Table 3 contains the ultimate analysis on the dry ash-free basis together with corresponding calorific values and volatile matter contents derived from the data in Table 2. Table 4 contains forms of sulphur - on some samples only total sulphur was done - and ash fusion temperatures, and Table 5 gives the results of high temperature Gray-King carbonisation assays on No. 5 Seam samples from Area No. 1, and a Fischer Assay on the torbanite sample also from the No. 5 Seam, but from Area No. 2. Figure 1 is a plan showing approximate limits of the No. 5 Seam occurrences and the areas covered by Reports No. 1 to No. 4. Farm numbers (in the old system) are given for all farms from which coal was taken for the composite samples.

DISCUSSION

As most of the samples concern the No. 5 Seam, this seam will first be discussed separately. It must be pointed out that the samples, although kept in closed tins, were not sealed, and a certain amount of oxidation of the coal has occurred. The most important effects of such oxidation are a decrease in calorific value, a reduction in carbon content, and a decrease in coking properties. The effect of oxidation on these properties will be discussed in the following section.

A. NO. 5 SEAM

The proximate analyses (Table 2) are reasonably consistent, if the torbanite sample (No. 64/693) is

/excluded ....

excluded. Ash contents are reasonably close to 11% and volatile matter to 33%, but moisture is low in Area No. 1 at 2%, is about 3% in Areas No. 3 and 4, and varies from about 4% to 6% in Area No. 2. Calorific values are highest in Area No. 3 decreasing through Areas No. 4 and 1 to Area No. 2, which has the lowest values.

Ultimate analyses are given in Table 3. These are expressed on the dry ash-free basis, and calorific values and volatile matter on the same basis are also given.

The carbon content is at a maximum of 83.2% for sample 55/587 on Boschmanskrans, and values of 82.4% to 82.2% apply to samples representing Kleinkopje, Steenkoolspruit and Broodsneyersplaats. Values of 82.0% to 81.2% apply to all the samples from Area No. 1, and the other samples from Areas No. 3 and 4, except for sample 55/583 on Rietkuil in the south, where the carbon content is 80.9%. Very similar values (81.0%) apply to the coal on Blesboklaagte, and Boschmansfontein and adjoining farms and lower values of 79.8% apply to the coal further west (samples 54/688 and 54/690) with the lowest value of 78.9% applying to the coal representing three widespread boreholes south of this latter area. That the carbon contents of most of these samples have probably undergone no significant change due to oxidation can be seen from analyses of fresh product samples from Blesbok and Kendal Collieries which were analysed in 1956. The Blesbok sample with 81.9% carbon is comparable with most of the samples of Areas No. 1,3, and 4, and the Kendal sample with 79.4% is comparable with samples 54/688 and 54/690, representing coal to the south of this mine.

The hydrogen contents of the various samples are all fairly high, varying from 5.0% to 5.6%. The highest values apply to Area No. 1 and the lowest to Area No. 4, and tend to follow the volatile matter content, although the relationship is complicated by change in rank - the lower the rank, the higher the volatile matter content at a particular hydrogen content.

/The nitrogen ....

The nitrogen content is reasonably constant, varying from 2.17% to 1.94%, with a low value of 1.85% applying to the Broodsnyersplaats sample. On the average values are higher in Areas No. 2 and 3.

Organic sulphur is also fairly constant; most values being between 0.5% and 0.6%. Most of the lower values are found in Area No. 1.

The oxygen content tends to show similar, but opposite, changes to the carbon content. The lowest value of 8.8% is found for the Boschmanskrans sample, and other samples from Areas No. 1, 3, and 4 vary from rather less than 10% to nearly 11%. In Area No. 2 two values are just over 11%, two are about 12.4% and one value is 13.1%.

Calorific values do not, on the average, show much variation, with average values of 14.9 lb/lb applying to Areas No. 3 and 4 and about 14.75 lb/lb for the other areas. However, the Area No. 2 values are misleading. This is probably due to the abnormally high moisture contents of Area No. 2 in Table 2, which must be ascribed to high ruling humidity when the moisture contents were determined. The calorific values on the other hand were apparently determined when humidity was low, so that the calculated dry ash-free calorific values are wrong. The reasons for the foregoing conclusions are briefly as follows: Comparing the moisture contents and dry ash-free calorific values on the ultimate samples and on their original components, it appears that whereas there was no significant difference in moisture content for the other three areas, Area No. 2 showed an increase of 1½% in the ultimate samples; also the dry ash-free calorific values of the other three areas decreased by about 0.15 lb/lb in the ultimate samples, while the Area No. 2 values increased by the same amount, which is impossible. It thus appears that the dry ash-free calorific values for Area No. 2 given in Table 3 are about 0.3 lb/lb too high.

Volatile matter varies from about 35% to 40% with the lower values being found in Areas No. 4 and 3.

/Forms ....

Forms of sulphur and ash fusion temperatures are given in Table 4. For the washed coal samples only small differences are found, with total sulphur between 0.6% and 0.9%, and mineral sulphur mostly between 0.2% and 0.3%. The three raw coal samples from Area No. 2 had from 1.4% to 1.7% sulphur, which averaged nearly 1% more than the corresponding float samples. Ash fusion temperatures were all above 1400°C in Area No. 3, and the lowest value in Area No. 4 was 1370°C. In Area No. 1 six out of eight values varied from 1320°C to 1370°C, and the floated samples from Area No. 2 gave a similar range of values; two of the raw coal samples had low ash fusion temperatures of 1270°C and 1300°C.

Gray-King carbonisation assays are given in Table 5. The values are generally fairly consistent with coke at about 70%, tar about 7% but with lower values of 5.2% and 4.4%, liquor about 6% to 7% with a high value of 9.4%, and gas generally between 17% and 18%. Sulphur is a little lower in the coke than in the original coal. Gas calorific values are mostly about 580 British thermal units per cubic foot, yielding about 60 therms per ton. Sample 53/417 gave 65.4 therms per ton, but this value appears suspect as the gas had the lowest density and the highest calorific value per cubic foot, which seems unlikely. The coke types vary only from C to B, but this is largely the result of weathering, as the following comparison of estimated original coke type (on low temperature assays) with the determined values indicated:

Sample No.	53/411	53/412	53/413	53/414	53/415	53/416	53/417	53/418
Original coke type	G	F	D	C/B	E	C	G	G
Determined coke type	C	B/C	B	B	B/C	B	C	C

Thus those samples with better original coking properties have shown a greater loss in coking power.

The Fischer assay on the torbanite sample shows only 18.3% of oil and tar, which confirms the relatively low volatile matter and hydrogen contents (52% and 6.28% d.a.f. respectively).

/B. OTHER ....

B. OTHER SEAMS

Compared with the No. 5 Seam, the other samples tend to be higher in carbon and lower in hydrogen and volatile matter content. This is largely due to a higher proportion of dull coal, the difference being least in the C Seam sample (57/598). Ash fusion temperatures are mostly 1350°C or higher, with significantly lower values for Seam No. 4 in sample 54/694 with 1270°C, and for the uncorrelated seam - actually the Witbank No. 2 Seam - with a value of 1310°C. Sulphur contents vary from 1% to 0.4%, both these values being for the No. 4 Seam.

(SIGNED) W.H.D. SAVAGE
CHIEF RESEARCH OFFICER

PRETORIA.
18th April, 1969.
/TW

TABLE 1.

CONSTITUTION OF COMPOSITE SAMPLES.

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO. 5 SEAM.		
53/411	Groenfontein 73 Blaauwkrans 62	2/A,3/A,4/A,5/A, 8/A,9/A,11/A, 15/A,20/A,21/A, 22/A,26/A,27/A, 32/A,33/A,34/A, 36/A,38/A,42/A.	Floats at 1.5 s.g. of mainly bright coal at the bottom of the seam. Av. Min. Max. Thickness In. 42 36 53 Yield % 83.6 75.3 88.9
53/412	Groenfontein 73 Blaauwkrans 62	2/ABC,3/AB,4/AB, 5/AB,8/AB,9/AB, 11/AB,15/AB,20/AB, 21/AB,22/AB,26/AB, 27/AB,32/AB,33/AB, 34/AB,36/AB,38/AB, 42/ABC.	Floats at 1.5 s.g. over major portion of seam, excluding upper inferior coal. Av. Min. Max. Thickness In. 56 47 76½ Yield % 78.2 66.1 84.4
53/413	Groenfontein 73 Blaauwkrans 62 Weltevreden 63 Vlaklaagte 71	1/A,12/A,19/A, 25/A,30/A,31/A, 49/A.	Floats at 1.5 s.g. of mainly bright coal at the bottom of the seam. Av. Min. Max Thickness In. 39½ 38 44 Yield % 77.5 70.2 87.9
53/414	Groenfontein 73 Blaauwkrans 62 Weltevreden 63	1/ABC,12/AB, 19/AB,30/AB.	Floats at 1.5 s.g. over major portion of seam, excluding upper inferior coal. Av. Min. Max. Thickness In. 51 45½ 61 Yield % 71.0 60.4 80.0
53/415	Groenfontein 73 Vlaklaagte 71	14/A,37/A,41/A, 43/A,46/A,47/A, 50/A,51/A.	Floats at 1.5 s.g. of mainly bright coal at the bottom of the seam. Av. Min. Max. Thickness In. 43 38 53 Yield % 72.7 60.3 84.0

53/416...../

TABLE 1 (CONTINUED)

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO. 5 SEAM (Cont.)		
53/416	Groenfontein 73 Vlaklaagte 71	43/AB,46/ABC, 47/ABC,50/AC, 51/AB.	Floats at 1.5 s.g. over major portion of seam, excluding inferior coal. Av. Min. Max. Thickness In. 63½ 54½ 76½ Yield % 64.5 55.6 72.9
53/417	Groenfontein 73 Klipfontein 60	9B/A,29/A,35/A, 40/AC,45/A,48/AC.	Floats at 1.5 s.g. of mainly bright coal at the bottom of the seam. Av. Min. Max. Thickness In. 41 36 47 Yield % 77.6 67.1 85.6
53/418	Groenfontein 73	9B/AB,45/AB.	Floats at 1.5 s.g. over the whole seam. Av. Min. Max. Thickness In. 54½ 52 57 Yield % 72.4 66.7 78.6
54/685	Blesboklaagte 78	133/AB,134/A, 135/AB,138/A, 139/A,140/A, 141/AB,142/A.	Floats at 1.5 s.g. over the whole seam, excepting upper inferior coal in two boreholes. Av. Min. Max. Thickness In. 47½ 31½ 62 Yield % 72.4 60.1 80.7
54/686	Blesboklaagte 78	As in 54/685	Raw coal sample corresponding to 54/685.
54/687	Boschmansfontein 75 Zaaiwater 74 Tweefontein 69	87/AC,68/A,69/A, 70/A,73/AB,75/A, 76/A,77/A,78/A, 80/A,81/A,82A/B, 83/A,84/A,86/B, 89/B,90/A,91/AC.	Floats at 1.5 s.g. over the whole seam, excluding inferior bands. Av. Min. Max Thickness In. 50½ 22 63½ Yield % 55.3 41.6 79.9

54/688...../

TABLE 1 (CONTINUED)

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO. 5 SEAM (Cont.)		
54/688	Kleinzinkerbosch-plaats 37 Zondagsvly 83 Goedgevonden 23 Schoongezicht 33	94/AB,95/AB, 96/BC,97/A, 98/BCD,99/B, 100/AB,101/AB, 104/AB,105/AB, 106/BC,107/AB, 108/A,109/AB, 110/A,111/BC, 112/AB,113/AB, 114/AB,121/AB, 130/A,132/AB	Floats at 1.5 s.g. over the whole seam, excluding inferior bands. Av. Min. Max. Thickness In. 65 56 88 Yield % 87.2 72.1 93.5
54/689	Kleinzinkerbosch-plaats 37 Zondagsvly 83 Goedgevonden 23 Schoongezicht 33	As in 54/688	Raw coal corresponding to 54/688.
54/690	Cologne 85 Bombardie 91 Springbok-laagte 82	115/AB,116/A,117/A, 118/A,119/AB,125/A, 126/A,127/A,128/AB.	Floats at 1.5 s.g. over the whole seam, excluding inferior bands. Av. Min. Max Thickness In. 63½ 52 72 Yield % 88.6 84.1 91.2
54/691	Cologne 85 Bombardie 91 Springbok-laagte 82	As in 54/690	Raw coal corresponding to 54/690.
54/692	Bombardie 91 Uitmalkaar 69 Kortlaagte 8	149/AB,150/ABC, 152A/AC.	Floats at 1.5 s.g. over the whole seam, excluding inferior coal in borehole 152A. Av. Min. Max Thickness In. 54 42½ 59 Yield % 84.2 77.4 89.2
54/693	Leeuwfontein 89	145/B	Torbanite, floats at 1.5 s.g Thickness 45" Yield 89.3%

55/581...../

TABLE 1 (CONTINUED)

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO. 5 SEAM (Cont.)		
55/581	Rietfontein 26 Middeldrift 133 Kromfontein 76 Van Dyksdrift 77	157/A,161/A, 162/A,163/A, 173/A.	Floats at 1.5 s.g. over the whole seam. Av. Min. Max. Thickness In. 41½ 34½ 51 Yield % 83.6 79.9 88.6
55/582	Steenkool-spruit 46	168/A,169/ABC, 171/AB.	Floats at 1.5 s.g. over the whole seam. Av. Min. Max. Thickness In. 53 49 57 Yield % 81.5 79.2 84
55/583	Rietkuil 27	174/AB,175A/AB, 176/AB.	Floats at 1.5 s.g. over the whole seam, excluding a central 16" parting. Av. Min. Max. Thickness In. 32 25 42 Yield % 86.1 85.6 87.8
55/584	Vlaklaagte 35	180/A,182/A, 183/A.	Floats at 1.5 s.g. over the whole seam. Av. Min. Ma Thickness In. 63 50 74 Yield % 84.9 79.5 90.5
55/585	Kleinkopje 45	185/A,187B/A, 187C/A, 187D/A, 187/A.	Floats at 1.5 s.g. over the whole seam, excluding upper dull coal in borehole 187D. Av. Min. Max. Thickness In. 53 41½ 58 Yield % 85.5 82.1 88.8
55/586	Bosmanskrans 156 Haasfontein 79 Koornfontein 102 Welverdiend 128	188/AB,189/AB, 190/AB,191/AB, 192/A,198/A, 200/A.	Floats at 1.5 s.g. over the whole seam. Av. Min. Max Thickness In. 56½ 53 62 Yield % 88.5 85.6 90.8

55/587...../

TABLE 1 (CONTINUED)

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO 5 SEAM (Cont.)		
55/587	Bosmanskrans 156	202/A,203/A,204/A, 206/A,208/AB, 209/A,210/A,211/A, 214/A.	Floats at 1.5 s.g. over the whole seam.
			Av. Min. Max.
			Thickness In. 51½ 48 54
			Yield % 88.6 84.7 91.7
57/590	Wolvenfontein 124 [illegible] Roodepoort 8 Broodsnyers-plaats 216	250/A,255/A,256/A, 258/A,259/A.	Floats at 1.5 s.g. over the whole seam.
			Av. Min. Max.
			Thickness In. 49½ 40 58
			Yield % 82.1 61.8 92.5
57/591	Welverdiend 128 Broodsnyers-plaats 216	241/A,243/AB, 244/A,246/A,249/A, 251/A,265/A,266/A, 267/A,270/A.	Floats at 1.5 s.g. over the whole seam.
			Av. Min. Max.
			Thickness In. 53½ 29½ 72
			Yield % 87.7 82.3 91.9
57/592	Broodsnyers-plaats 216	252/A,253/A.	Floats at 1.5 s.g. over the whole seam.
			Av. Min. Ma
			Thickness In. 64½ 62 6[illegible]
			Yield % 84.5 81.4 87.8
57/593	Broodsnyers-plaats 216 Aberdeen 291	269/A,274/A, 275A/A,280/A, 284/A,285/A.	Floats at 1.5 s.g. over the whole seam.
			Av. Min. Max.
			Thickness In. 31½ 24½ 38
			Yield % 80.8 70.7 92.5
57/594	Koornfontein 102 Geluk 315 Goede Hoop 270 Bultfontein 217 Witmansrust 22	218/A,221A/A, 222/A,223/A,224/A, 225/A,226/A,227/A, 228/A,229/A.	Floats at 1.5 s.g. over the whole seam.
			Av. Min. Max.
			Thickness In. 52 45 58
			Yield % 81.6 75.8 87

54/694...../

TABLE 1 (CONTINUED)

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO. 4 SEAM		
54/694	Boschmansfontein 75 Zaaiwater 74	72/AB,79/AB, 85/ABC,90/AB, 91/AB,92/ABC.	Floats at 1.58 s.g. over the lower portion of the seam. Av. Min. Max. Thickness In. 107½ 97 120½ Yield % 86.5 83.3 89.7
54/695	Cologne 85 Bombardie 91 Springbok-laagte 82	118/AB,125/AB, 126/AB,131/ABC.	Floats at 1.58 s.g. over the lower portion of the seam. Av. Min. Max. Thickness In. 83 65 127 Yield % 78.3 69.5 84.8
54/696	Uitmalkaar 69	152A/ABC.	Floats at 1.58 s.g. over the lower portion of the seam. Thickness 113". Yield 74.0%.
54/697	Nooitgedacht 23	153/ABC,155/ABC.	Floats at 1.58 s.g. over the lower portion of the seam Av. Min. Max. Thickness In. 114 108 120 Yield % 79.5 73.3 85.0
	NO. 2 SEAM.		
54/698	Cologne 85 Bombardie 91 Leeuwfontein 89	118/CDE,125/ABC, 126/A,145/CD, 146/BCD.	Floats at 1.58 s.g. over the middle portion of the seam. Av. Min. Max. Thickness In. 118 99 130 Yield % 79.0 72.0 92.3
54/699	Boschmansfontein 75	90/CD.	Floats at 1.58 s.g. over the middle portion of the seam. Thickness 96½". Yield 84.3%.

57/595...../

TABLE 1 (CONTINUED)

Sample Number	Farms	Boreholes/ Component Samples	Description
	NO. 2 SEAM (Cont.)		
57/595	Bultfontein 217 Driefontein 235	239/AB,260/AB.	Floats at 1.58 s.g. over the lower portion of the seam. Av. Min. Max. Thickness In. 89½ 85 94 Yield % 89.3 88.8 89.6
57/596	Wilmansrust 22	290/BCD	Floats at 1.58 s.g. over the middle portion of the seam. Thickness 163". Yield 96.3%.
	NO. 1 SEAM		
57/597	Driefontein 235	260/A	Floats at 1.58 s.g. over the upper split of the seam. Thickness 65". Yield 89.8%.
	SEAM C.		
57/598	Morgenster 127 204 T	264C/ABC	Floats at 1.58 s.g. over the lower portion of the seam. Thickness 68". Yield 87.9%.
	UNCORRELATED SEAM		
57/599	Mooiplaats 424 165 TS	264/AB	Floats at 1.58 s.g. over the whole seam. Thickness 100". Yield 74.1%.

TABLE 2...../

TABLE 2.

PROXIMATE ANALYSIS.

Sample Number	Thick-ness In.	Yield %	Cal. Val. lb/lb	Moisture %	Ash %	Vol. Mat. %	Fix. Carb. %
NO. 5 SEAM "Area 1"							
53/411	42	83.6	13.07	1.9	10.1	34.7	53.3
53/412	56	78.2	12.81	1.8	11.4	32.8	54.0
53/413	39½	77.5	12.72	2.1	11.3	33.4	53.2
53/414	51	71.0	12.45	2.1	12.5	32.1	53.3
53/415	43	72.7	13.10	2.0	11.1	33.7	53.2
53/416	63½	64.5	12.45	2.2	13.0	31.7	53.1
53/417	41	77.6	12.83	1.9	10.4	33.4	54.3
53/418	54½	72.4	12.86	1.9	11.4	32.1	54.6
NO. 5 SEAM "Area 2"							
54/685	47½	72.4	12.54	4.3	11.6	32.9	51.2
54/687	50½	55.3	12.35	3.8	12.8	31.2	52.2
54/688	65	87.2	12.56	4.7	9.9	32.7	52.7
54/690	63½	88.6	12.50	5.1	9.6	33.4	51.9
54/692	52	84.2	12.39	6.3	9.3	34.3	50.1
54/693	45	89.3	11.44	3.3	20.7		
NO. 5 SEAM "Area 3"							
55/581	41½	83.6	12.92	3.1	9.5	32.1	55.3
55/582	53	81.5	12.85	3.1	10.0	30.7	56.2
55/583	32	86.1	13.26	3.3	7.2	34.9	54.6
55/584	63	84.9	13.05	2.8	10.0	33.9	53.3
55/585	53	85.5	13.06	2.6	10.1	32.1	55.2
55/586	56½	88.5	13.16	2.6	9.4	33.1	54.9
55/587	51½	88.6	13.19	2.8	9.5	31.6	56.1
NO. 5 SEAM "Area 4"							
57/590	49½	82.1	12.94	2.8	10.5	30.1	56.6
57/591	53½	87.7	13.00	2.9	10.1	31.0	56.0
57/592	64½	84.5	12.98	2.8	10.1	30.8	56.3
57/594	52	81.6	12.93	3.0	10.5	33.7	52.8

NO. 4 SEAM...../

TABLE 2 (CONTINUED)

Sample Number	Thick-ness In.	Yield %	Cal. Val. lb/lb	Moisture %	Ash %	Vol. Mat. %	Fix. Carb. %
NO. 4 SEAM							
54/694	107½	86.5	12.11	3.5	13.6	25.3	57.6
54/695	83	78.3	11.69	4.7	13.0	27.2	55.1
NO. 2 SEAM							
54/698	118	79.0	11.76	5.2	12.4	26.5	55.9
57/595	89½	89.3	12.59	2.4	11.4	29.1	57.1
NO. 1 SEAM							
57/597	65	89.8		2.8	13.1		
SEAM C							
57/598	68	87.9		3.4	14.8		
UNCORRELATED SEAM							
57/599	100	74.1		4.2	16.9		

TABLE 3...../

TABLE 3

ULTIMATE ANALYSIS
(Dry, ash-free basis)

Sample No.	Carbon %	Hydrogen %	Nitrogen %	Sulphur %	Oxygen %	Cal.Val. lb/lb	Volatiles %
NO. 5 SEAM "Area 1"							
53/411	81.31	5.50	2.10	0.51	10.58	14.85	39.4
53/412	81.91	5.50	2.03	0.48	10.08	14.76	37.8
53/413	81.33	5.36	2.02	0.54	10.75	14.69	38.6
53/414	81.58	5.36	1.94	0.48	10.64	14.58	37.6
53/415	81.24	5.33	2.07	0.48	10.88	15.07	38.8
53/416	81.73	5.33	2.02	0.50	10.42	14.68	37.4
53/417	81.92	5.58	2.09	0.59	9.82	14.63	38.1
53/418	81.82	5.56	2.03	0.52	10.07	14.83	37.0
NO. 5 SEAM "Area 2"							
54/685	80.97	5.30	2.11	0.55	11.07	14.91	39.1
54/687	80.98	5.16	2.11	0.62	11.13	14.81	37.4
54/688	79.78	5.13	2.13	0.56	12.40	14.71	38.3
54/690	79.79	5.16	2.17	0.55	12.33	14.65	39.2
54/692	78.90	5.38	2.01	0.61	13.10	14.68	40.6
54/693	79.09	6.28				15.05	52.0*
NO. 5 SEAM "Area 3"							
55/581	81.81	5.19	2.15	0.48	10.37	14.78	36.7
55/582	82.23	5.15	2.05	0.58	9.99	14.79	35.3
55/583	80.90	5.46	2.15	0.62	10.87	14.82	39.0
55/584	81.78	5.45	2.17	0.52	10.08	14.97	38.9
55/585	82.37	5.32	2.07	0.52	9.72	14.96	36.8
55/586	81.90	5.30	2.08	0.57	10.15	14.95	37.6
55/587	83.17	5.29	2.11	0.61	8.82	15.04	36.0
NO. 5 SEAM "Area 4"							
57/590	81.98	5.03	2.03	0.58	10.38	14.93	34.7
57/591	82.01	5.10	1.98	0.61	10.30	14.94	35.6
57/592	82.20	5.09	1.85	0.64	10.22	14.90	35.4
57/594	81.33	5.36	2.08	0.57	10.66	14.95	39.0
NO. 4 SEAM							
54/694	82.56	4.49	2.05	0.57	10.33	14.61	30.5
54/695	80.07	4.58	2.07	0.64	12.64	14.20	33.0
NO. 2 SEAM							
54/698	80.08	4.75	1.94	0.31	12.92	14.27	32.2
57/595	82.47	4.81	2.00	0.42	10.30	14.61	33.8
NO. 1 SEAM							
57/597	82.57	4.82	1.89	0.50	10.22	15.04*	34.4*
SEAM C							
57/598	80.75	4.85	1.99	0.45	11.96	14.57*	37.0*
UNCORRELATED SEAM							
57/599	81.56	4.20	1.79	0.27	12.18	14.35*	28.9*

*Calculated from analyses of original component samples.

/TABLE 4 ....

TABLE 4

FORMS OF SULPHUR AND ASH FUSION TEMPERATURES

Sample No.	Total sulphur, %	Organic sulphur, %	Mineral sulphur, %	Ash fusion temperature, °C
54/411	0.72	0.45	0.27	1370
54/412	0.66	0.42	0.24	1360
54/413	0.74	0.47	0.27	1320
54/414	0.65	0.41	0.24	1320
54/415	0.74	0.42	0.32	1330
54/416	0.64	0.42	0.22	1340
54/417	0.81	0.52	0.29	+1400
54/418	0.67	0.45	0.22	+1400
NO. 5 SEAM "Area 2"				
54/685	0.65	0.47	0.18	+1400
54/686	1.62			1400
54/687	0.75	0.52	0.23	1400
54/688	0.73	0.48	0.25	1330
54/689	1.68			1270
54/690	0.68	0.47	0.21	1330
54/691	1.43			1300
54/692	0.87	0.52	0.35	1330
54/693				+1400
NO. 5 SEAM "Area 3"				
55/581	0.58	0.42	0.16	+1400
55/582	0.71	0.50	0.21	+1400
55/583	0.67	0.55	0.12	+1400
55/584	0.71	0.45	0.26	+1400
55/585	0.63	0.45	0.18	+1400
55/586	0.80	0.50	0.30	+1400
55/587	0.75	0.53	0.22	+1400
NO. 5 SEAM "Area 4"				
57/590	0.79	0.50	0.29	1370
57/591	0.80	0.53	0.27	1380
57/592	0.72	0.56	0.16	1370
57/593	0.88			+1400
57/594	0.80	0.49	0.31	+1400
NO. 4 SEAM				
54/694	1.01	0.47	0.54	1270
54/695	0.83	0.53	0.30	1350
54/696	0.40			1330
54/697	0.73			1380
NO. 2 SEAM				
54/698	0.85	0.26	0.59	1360
54/699	0.71			1350
57/595	0.76	0.36	0.40	1360
57/596	0.92			1380
NO. 1 SEAM				
57/597	0.66	0.42	0.24	+1400
SEAM C				
57/598	0.76	0.37	0.39	1380
UNCORRELATED SEAM				
57/599	0.53	0.21	0.32	1310

/TABLE 5 ....

TABLE 5.

HIGH TEMPERATURE GRAY-KING ASSAYS

Sample Number	Coke %	Tar %	Liquor %	Gas %	Rel. Density of Gas (Air = 1)	Sulphur in Coke %	Coke Type	Gas Cal. Val.* Btu/cubic ft.	Gas Therms per Ton
NO. 5 SEAM (Area 1)									
53/411	68.3	7.0	7.5	18.3	0.513	0.58	C	577	61.2
53/412	70.1	6.7	6.4	17.7	0.506	0.60	B-C	579	59.9
53/413	68.3	8.5	5.7	18.6	0.511	0.62	B	558	58.1
53/414	70.0	5.2	7.4	17.6	0.514	0.62	B	578	57.2
53/415	69.3	7.8	6.0	17.7	0.496	0.61	B-C	588	61.7
53/416	70.7	7.7	5.3	17.1	0.487	0.55	B	583	60.5
53/417	69.8	6.9	5.8	17.4	0.468	0.60	C	600	65.4
53/418	70.5	4.4	9.4	16.9	0.489	0.47	C	582	59.0
NO. 5 SEAM (Torbanite) (FISCHER ASSAY)									
54/693	67.2	18.3	7.8	6.7	0.882				

* Gross calorific value, wet, 60 °F, 30" mercury.

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

A P P E N D I X.

ANALYTICAL METHODS AND THEIR SIGNIFICANCE

I. SAMPLING AND PREPARATION.

Sampling and preparation are carried out according to South African Standard Specification, S.A. No. 13 of 1937, "Standard Methods for the Sampling of Coal in South Africa," issued by the South African Standards Institution.

NOTE: 1. ALL ANALYSES ARE CARRIED OUT ON AIR-DRY COAL.

2. Unless otherwise stated analyses are according to B.S.S. 1016 of 1942, "British Standard Methods for the Analysis and Testing of Coal and Coke".

II. PROXIMATE ANALYSIS:

(1) Moisture Content: This is the loss of weight when heating 1 gram of coal at 105 - 110°C for one hour, expressed as a percentage. Since 1955 all determinations have been conducted in a vacuum oven with nitrogen atmosphere.

(2) Ash Content: This is the residual ash after combusting 1 gram of coal in a muffle furnace. The coal is slowly heated to 775°C (± 25°C) and kept at this temperature until constant weight is reached while air circulates through the furnace. The result is expressed as a percentage.

(3) Volatile Matter Content: This is calculated from the loss of weight obtained by heating 1 gram of coal at 925°C for 7 minutes by subtracting the weight of moisture present in the coal, and expressing the result as a percentage.

(4) Fixed Carbon Content: This is obtained by subtracting the sum of moisture, ash and volatile matter contents, expressed as percentages, from 100.

III. CALORIFIC VALUE:

This value, reported in Evaporative Units (lb/lb), is calculated from the amount of heat generated by combusting 1 gram of coal in oxygen at 25 to 30 atmospheres pressure in a Berthelot or Scholes type of combustion bomb.

The determination...../

The results are expressed on a dry ash-free basis, so as to present the composition of the organic substance itself, unmixed with mineral matter.

The oxygen content is obtained by subtracting the sum of the carbon, hydrogen, nitrogen and sulphur percentages from 100. The value obtained therefore includes all analytical errors.

VI. FORMS OF SULPHUR:

The figures showing the forms of sulphur in a sample are on an "as received" basis, i.e. including adventitious mineral matter.

The extraction of the mineral (i.e. "Sulphate" + "Pyritic") sulphur from a sample is done with dilute nitric acid.

The Organic Sulphur is obtained by difference, viz. the difference between the Total Sulphur and the Mineral Sulphur.

The total sulphur content of the floats at 1.58 s.g. is usually also included in the "forms of sulphur" table. This is done for comparative purposes since it indicates the minimum sulphur content obtainable by washing large coal, if the pyrites occur in nodular form. With finely disseminated pyrites in the coal the sulphur content will not be reduced to the extent shown.

VII. CARBONISATION ASSAYS:

Two forms of carbonisation assays are done, viz: the low temperature (600°C) and the higher temperature (900°C). The apparatus and methods are based on those described in "Methods of Analysis of Coal and Coke", D.S.I.R., Fuel Research, Physical and Chemical Survey of the National Coal Resources No. 44, (London, H.M. Stationery Off., 1940).

The Low Temperature assay is used mainly for assessing the coking properties of the coal. Values of D to F for the coke type indicate that the coal may produce metallurgical coke if used as the major component in a blend with a suitable strongly coking coal. Values of G or better indicate that the coal is suitable for coking on its own.

In the High Temperature assay the coal is heated to 900°C and the vapours evolved pass through a cracking unit kept at 800°C. The yields of products obtained are approximately the same as are obtained in coke ovens, or in gas works without steaming.

VIII. FLOAT AND SINK ANALYSIS:

(a) Relatively coarse samples.

In order to assess the beneficiation possible by washing, samples crushed to minus 2" or 1" are subjected to float and sink tests at a selected specific gravity. The yields and quality of the

float are...../

float are comparable with products that could be obtained by washing normal commercial sizes of coal in an efficient heavy medium plant, the quality of the floats being only slightly better than that of the corresponding commercial products.

In certain cases the samples are separated at more than one specific gravity into floats, intermediate fractions and sinks. This gives more complete information, and the quality of the products at different yields and the washability of the coal can be assessed. (The accuracy of the assessment increases with the number of specific gravity fractions).

Separations are sometimes conducted at finer sizes e.g. minus $\frac{1}{4}$" or 3/16". The results obtained are not normally comparable with washing of ordinary commercial sizes of coal, but indicate results theoretically obtainable if the coal were all crushed to this size before washing.

Analytical samples are prepared of the various fractions. Floats and intermediate fractions are extensively analysed, but only ash content is determined on the sinks.

(b) Samples crushed to -16 mesh B.S.S. (minus 1mm.)

Float and sink tests are conducted on minus 1 mm. coal on 20 gram samples in a centrifuge according to the method described by P.E. Hall in Jnl. Chem. Metal. Min. Soc. of S.A. Vol. 34, No. 8, p.263 (1934).

Samples for ultimate analysis, carbonisation assays, etc., are normally floated at 1.58 s.g. in order to remove high ash components and adventitious mineral matter such as shale, pyrites and carbonates.

Further, in order to obtain information on the specific gravity distribution of the sample, float and sink tests are conducted at a series of specific gravities. The yields are reasonably comparable with results on coarse coal, except that there is a tendency for concentration in the lightest and heaviest fractions. Thus some idea of the ease with which a coal can be washed at various specific gravities can be obtained and, consequently, also of types of suitable washing plants. The ash contents of the cumulative floats are, however, lower than for coarse coal at similar yields, the difference varying from about 1% to 6%, depending on the type of coal and the yield. This difference makes it very difficult to estimate the ash contents on commercial sizes from fine coal float and sink tests.

IX. ASH FUSION TEMPERATURES:

Ash fusion temperatures are usually determined by heating cones of the ash at a standard rate inside a tube furnace in a mildly reducing atmosphere, and observing the

minimum...../

minimum temperature at which the cone will fuse.

Ash fusion temperatures are normally determined on raw coal or coarse coal float samples, and are thus comparable with hand-picked and washed coal. In some cases, where coarse coal float and sink tests were not carried out, ash fusion temperatures are determined on -1mm. coal floated at 1.58 s.g.; the results obtained can only be regarded as giving an indication of the effects of washing.

A direct correlation between ash fusion temperature as determined in the laboratory and behaviour of the ash in practice has not so far been possible. Although the determinations are carried out under conditions designed to resemble as closely as possible those actually obtaining in a furnace, the differences between small and large scale conditions are appreciable. The results indicate, however, the probable behaviour of the ash in practice and the following scheme may be used for interpreting the laboratory results:-

Ash Fusion Temperatures:

(a) below 1250°C - likely to cause clinkering trouble under all furnace conditions;

(b) 1250 - 1400°C - unlikely to produce clinker under general conditions, although trouble may be experienced with appliances like producers and forced draught boilers;

(c) above 1400°C - highly refractory ash which will probably not clinker under any conditions.

----------oOo----------

29° E

AREA 1

WITBANK

SCHOONGEZICHT

WITBANK

CLEWER

BLAAUWKRANS 62

KLIPFONTEIN 60

WELTEVREDEN 63

TWEEFONTEIN

71 VLAKLAAGTE

GROENFONTEIN 73

26° S

WILDEBEES-FONTEIN

PRINSHOF

72 KLIPPAN

WOLVEKRANS

AREA 3

127 HARTBEESFONTEIN

WOLVEN-FONTEIN 124

BOSCHMANS-KRANS 156

BLESBOK-VLAKTE

ROODEPOORT 8

216 BROODSNEYERS-PLAAS

BOSCHMANSKOP

26° S

MOOIPLAATS 424

HEUVELFONTEIN

BANKFONTEIN

SMALDEEL

KLIP-FONTEIN

OOGIESFONTEIN

GROOTPAN

KLEINZUIKERBOSCHPLAAT

WATERPAN

TWEEFONTEIN 69

KLIP-PLAAT

KLEINKOPJE 45

VLAKLAAGTE

WELVERDIEND 128

STEENKOOL SPRUIT 46

ENKELDEBOSCH

AREA 4

SCHOONGEZICHT 33

ZONDAGS-VLEI 83

23 GOEDGEVONDEN

ZAAIWATER 74

BOSHMANS-FONTEIN 75

VAN DYKSDRIFT 77

79 HAAS-FONTEIN

KOORNFONTEIN 102

315 GELUK

291 ABERDEEN

DRIEFONTEIN 235

LEEUWFONTEIN 89

COLOGNE 85

82 SPRINGBOKLAAGTE

KLIPPOORTJE

BLESBOK-FONTEIN 78

HARTBEES-FONTEIN

KROM-FONTEIN 76

GOEDEHOOP 270

VAALKRANS

WILMANSRUST 21

BULT-FONTEIN 217

GLORIA

HENDRINA

ZONDAGS-FONTEIN

MIDDEL-DRIFT 133

DIEP-SPRUIT

RIETFONTEIN 26

WELSTAND

VLAKLAAGTE 35

22 WILMANSRUST

NOOIT-GEDACHT

91 BOMBARDIE

ROODEPOORT

AREA 2

NOOIT-GEDACHT 23

RIETKUIL 27

MORGENSTER 127

KORTLAAGT 8

69 UITMALKAAR

29° E

TABLE 1

PLAN OF WITBANK COAL FIELD
SHOWING No. 5 SEAM LIMITS.

SCALE 1: 250,000

LIMITS OF No. 5 SEAM.

No 5 seam present.