FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 6 OF 1964.

REPORT ON THE RESULTS OBTAINED FROM YIELD DETERMINATIONS CARRIED OUT ON THREE BULK SAMPLES OF D.N.C. COAL IN THE F.R.I. PILOT PLANT.

BY:

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1. INTRODUCTION:

The F.R.I. was requested by the Technical Manager, Iscor, to carry out washing tests on three bulk samples of D.N.C. coal in order to determine what yields could be expected when handling these types of coal as run of mine input at D.N.C.

2. THE COAL:

Three bulk samples, weighing about 40 tons each were taken at D.N.C. by colliery officials and were forwarded to the F.R.I. Pilot Plant at Pretoria in railway trucks. The following description of the samples was supplied by D.N.C.

2.1 Total Bottom Seam. (sample index W.B.) despatched from D.N.C. on 28th January, 1964 in truck No. DZ 131323 arrived in Pretoria on 31st January, 1964.

2.2 Top part of Bottom Seam. (sample index H.B.) despatched from D.N.C. on 4th February, 1964 in truck No. DZ 137919, arrived in Pretoria on 10th February, 1964.

2.3 Top Seam. (sample index T.C.) despatched from D.N.C. on 30th January, 1964 in truck No. DZ 131343, arrived in Pretoria on 7th February, 1964. The samples were washed in the F.R.I. Pilot Plant in this order.

3. THE TESTS:

For the results obtained in the Pilot Plant to be indicative of what can be expected of the D.N.C. plant when handling this type of material, the F.R.I. was requested to follow present D.N.C. practice as closely as possible in washing procedure.

All tests were therefore carried out in the following way:

3.1 The raw coal was crushed to $-\frac{1}{2}$" in a flextooth crusher and fed to the cyclone pre-wet screen where it was screened at 0.5mm.

3.2 The $-\frac{1}{2}$"+0.5mm. size fraction was washed in the cyclone washer.

3.3 The underflow from the cyclone pre-wet screen was

pumped ...../

pumped to thickener cyclones and the thickened pulp was treated in froth flotation cells using paraffin and M.I.B.C. as reagents.

This treatment conforms generally with what is known of D.N.C. practice, with the following exceptions:

3.4 At D.N.C. the very fine coal in the overflow from the thickener cyclones is settled in a Baum tower and returned to the froth flotation cells for cleaning. This was not found practicable in a test involving a total quantity of about 35 tons of raw coal (per bulk sample) because of the very small weight of fine coal involved.

3.5 The four Pilot Plant flotation cells are designed to operate in series so that the system of roughers, cleaners and scavengers employed at D.N.C. could not be simulated.

4. SAMPLING:

During each test, samples were taken of the following products by collecting increments at 2 minute intervals over the total test period:

(a) Crushed raw coal feed.
(b) Cyclone clean coal.
(c) Cyclone discard.
(d) Froth Flotation product.
(e) Froth flotation tailings.
(f) Froth flotation feed.

5. ANALYSIS OF SAMPLES:

All samples taken were air-dried and weighed to determine their free moisture contents and were then analysed in the following way:

5.1 Raw Coal. These samples were screened at 0.5mm. Results of these screen analyses are reported in Table 1.

Representative sub-samples of the +0.5mm. size fractions were then subjected to float and sink analyses on a fractional basis at 0.04 intervals in the specific gravity ranges of 1.36 to 1.56 in the case of the bottom seam samples and 1.50 to 1.70 in the case of the top seam sample. Results of these analyses are reported in Tables 2 - 4. Ash determinations were also carried out on representative sub-samples of the +0.5mm. size fractions.

5.2 Cyclone clean coal and discard. Representative samples of these products were subjected to float and sink analyses on a fractional basis at 0.02 intervals in specific gravity ranges extending to 0.1 specific gravity on both sides of the anticipated

cut points ...../

cut points. These results are also reported in Tables 2 - 4.

Proximate analyses and the determination of swelling numbers and sulphur contents were carried out on whole coal samples of these products. These results are reported in Table 5.

5.3 Froth flotation feed, products and tailings. Proximate analysis and swelling index determinations were carried out on all these samples excæpt the tailings samples on which only ash determinations were carried out. These results are reported in Table 5.

6. WEIGHTS OF RAW COAL AND PRODUCTS:

Raw coal entering the plant for each test was weighed on an electronic weightometer and all products leaving the plant except the froth flotation tailings were weighed on a weighbridge in cocopans.

After correcting for moisture, using the moisture contents of the samples taken, the following air-dry weights were arrived at:

Product	Test 274 Bottom Seam (Index W.B.)	Test 275 Bottom Seam (Index H.B.)	Test 276 Top Seam (Index T.C.)
Cyclone Clean Coal	25.90	25.16	29.71
Cyclone Discard	10.72	5.73	3.29
F.Flotation Product	3.84	3.79	3.08
Total	40.46	34.68	36.08
Raw Coal.			
D.N.C. Weight	41.7	36.61	38.33
F.R.I.	40.8	35.6	37.5

A complete weight balance could not be arrived at because of the unknown weights of froth flotation tailings and small amounts of very fine coal in the thickener cyclone overflow.

7. YIELDS:

7.1 Cyclone yields were calculated from the weights of cyclone clean coal and discard. In addition to this, yield values were also calculated from ash balances and from the float and sink analyses of the feeds and products (I.S.O. method).

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Using these three methods of calculating the yields, the following values were arrived at:

TEST NO.	YIELDS OBTAINED FROM		
	WEIGHTS	ASH BALANCE	I.S.O. METHOD
274	70.7	71.7	71.6
275	81.4	84.3	84.6
276	90.0	92.5	90.7

7.2 Froth Flotation Yields. Because of the difficulty of obtaining accurate weight balances the yield values for the froth flotation process were calculated from ash balances only. The following values were obtained:

TEST NO.	FEED ASH %	PRODUCT ASH %	TAILINGS ASH %	YIELD %
274	16.6	11.8	82.5	93.2
275	14.8	10.8	26.5	74.5
276	18.3	9.3	39.0	69.7

7.3 Total Coking Coal Yield: From the available data the total coking coal yields could be calculated in the following ways:

7.3.1 From the weights of raw coal as received and the weights of the cleaned products recovered. These figures represent actual recovery and will include all losses. Accuracy would depend on the accuracy of the weighing machines used and on the reliablity of the moisture corrections applied. The raw coal weightometer is an electronic instrument which has recently been installed and calibrated by the suppliers. The weighbridge used for weighing the products is assized regularly while special core was taken in sampling to make moisture determinations as accurate as possible.

7.3.2 The total coking coal yields can be calculated theoretically from the screen analyses of the raw coal samples and the respective yield figures obtained for the two different cleaning processes. In this case it is assumed that no losses occurred and that the screening efficiency at the cyclone prewet screen was at least as efficient as the hand screening of the sample.

Using these two methods of calculating the total coking coal yields the following figures were arrived at.

Table ...../

TEST NO.	COAL	TOTAL COKING COAL YIELD %	
		ACTUAL RECOVERY	THEORETICAL
274	W.B.	72.9	73.7
275	H.B.	81.3	80.4
276	T.C.	87.7	87.4

8. Evaluation of Results:

Using the yield value obtained from the weights of the products together with the float and sink analysis of the clean coal and discard, the analysis of the feed coal to the cyclone washer was reconstituted for each test. Distribution factors were then calculated and distribution curves were drawn.

From these distribution curves the cut points were obtained and the probable errors were calculated for all the tests. A summary of plant performance data is given in Table 6.

TABLE 1.

SCREEN ANALYSIS OF CRUSHED RAW COAL.

SIZE.	TEST 274 W.B.		TEST 275 H.B.		TEST 276 T.C.	
	YIELD		YIELD		YIELD	
	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %
+0.5mm.	86.73	86.73	85.95	85.95	87.13	87.13
-0.5mm.	13.10	99.83	13.63	99.58	12.52	99.65
Loss	0.17		0.42		0.35	
Total	100.00	100.00	100.00	100.00	100.00	100.00

TABLE 2.

FLOAT AND SINK ANALYSIS OF CYCLONE RAW COAL AND PRODUCTS.

WASHING TEST NO. 274.

FEED : TOTAL BOTTOM SEAM INDEX W.B.

S.G. INTERVAL	RAW COAL		CLEAN COAL		DISCARD		RECONSTITUTED FEED		DIST. FACTOR
	YIELD		YIELD		YIELD		YIELD		
	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %	
F1.36	50.52	50.52	69.65	69.65	2.96	2.96	50.13	50.13	
1.36-1.38			11.54	81.19	0.87	3.83	8.41	58.54	97.0
1.38-1.40	16.91	67.43	7.90	89.09	1.14	4.97	5.92	64.46	94.4
1.40-1.42			7.69	96.78	3.00	7.97	6.32	70.78	86.1
1.42-1.44	6.84	74.27	1.94	98.72	4.94	12.91	2.82	73.60	48.6
1.44-1.46			0.32	99.04	4.56	17.47	1.57	75.17	14.6
1.46-1.48	1.83	76.10	0.14	99.18	3.23	20.70	1.05	76.22	9.5
1.48-1.50			0.16	99.34	2.41	23.11	0.82	77.04	13.4
1.50-1.52	1.05	77.15	0.10	99.44	0.53	23.64	0.23	77.27	30.4
1.52-1.54			0.16	99.60	1.63	25.27	0.59	77.86	18.6
1.54-1.56	1.51	78.66	0.10	99.70	1.80	27.07	0.60	78.46	11.7
S1.56	21.34		0.28		72.92		21.55		
Total	100.00	100.00	99.98	99.98	99.99	99.99	100.01	100.01	

TABLE 3.

FLOAT AND SINK ANALYSIS OF CYCLONE RAW COAL AND PRODUCTS.

WASHING TEST NO. 275.

FEED : TOP PART OF BOTTOM SEAM H.B.

S.G. INTERVAL	RAW COAL		CLEAN COAL		DISCARD		RECONSTITUTED FEED		DIST. FACTOR
	YIELD		YIELD		YIELD		YIELD		
	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %	
Fl.36	61.65	61.65	68.11	68.11	5.19	5.19	56.42	56.42	
1.36-1.38			11.48	79.59	1.26	6.45	9.58	66.00	97.6
1.38-1.40	14.88	76.53	8.42	88.01	1.86	8.31	7.21	73.21	95.1
1.40-1.42			7.65	95.66	3.17	11.48	6.82	80.03	91.3
1.42-1.44	8.70	85.23	2.75	98.41	4.31	15.79	3.04	83.07	73.7
1.44-1.46			0.55	98.96	4.59	20.38	1.30	84.37	34.6
1.46-1.48	2.28	87.51	0.25	99.21	4.27	24.65	0.99	85.36	20.2
1.48-1.50			0.19	99.40	3.91	28.56	0.88	86.24	17.0
1.50-1.52	0.95	88.46	0.11	99.51	0.94	29.50	0.26	86.50	34.6
1.52-1.54			0.13	99.64	2.79	32.29	0.63	87.13	17.5
1.54-1.56	1.49	89.95	0.17	99.81	2.67	34.96	0.64	87.77	21.9
S1.56	10.05		0.17		65.04		12.22		
Total	100.00	100.00	99.98	99.98	100.00	100.00	100.00	99.99	

TABLE 4.

FLOAT AND SINK ANALYSIS OF CYCLONE RAW COAL AND PRODUCTS.

WASHING TEST NO. 276.

FEED : TOP SEAM.

S.G. INTERVAL	RAW COAL		CLEAN COAL		DISCARD		RECONSTITUTED FEED		DIST. FACTOR
	YIELD		YIELD		YIELD		YIELD		
	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %	FRACT. %	CUM. %	
Fl.50	88.59	88.59	96.72	96.72	8.94	8.94	87.97	87.97	
1.50-1.52			0.34	97.06	0.16	9.10	0.33	88.30	93.9
1.52-1.54	1.00	89.59	0.74	97.80	0.58	9.68	0.73	89.03	91.8
1.54-1.56			0.71	98.51	0.66	10.34	0.71	89.74	90.1
1.56-1.58	1.11	90.70	0.39	98.90	0.85	11.19	0.43	90.17	81.4
1.58-1.60			0.28	99.18	1.13	12.32	0.36	90.53	69.4
1.60-1.62	0.76	91.46	0.19	99.37	2.16	14.48	0.39	90.92	43.6
1.62-1.64			0.11	99.48	2.48	16.96	0.35	91.27	28.6
1.64-1.66	0.74	92.20	0.12	99.60	1.89	18.85	0.30	91.57	36.7
1.66-1.68			0.11	99.71	2.44	21.29	0.34	91.91	29.4
1.68-1.70	0.66	92.86	0.11	99.82	2.86	24.15	0.39	92.30	25.6
Sl.70	7.15		0.18		75.85		7.72		
Total	100.01	100.01	100.00	100.00	100.00	100.00	100.00	100.01	

TABLE 5.

ANALYSIS OF PRODUCTS.

TEST NO.	COAL	PRODUCT	MOISTURE %	ASH %	VOL.MAT. %	FIX.CARBON %	SWELLING NO.	SULPHUR %
274	W.B.	C. Product	1.2	10.3	28.3	60.2	6½	0.98
		C. Discard	1.4	50.2	17.5	30.9	0	
		F.F. Product	1.3	11.8	27.5	59.4	7½	1.22
		F.F. Feed	1.3	16.6	26.8	55.3	5	
275	H.B.	C. Product	1.1	10.6	31.6	56.7	6	0.96
		C. Discard	1.2	43.1	21.8	33.9	1	
		F.F. Product	1.2	10.8	30.6	57.4	8-8½	1.33
		F.F. Feed	1.2	14.8	30.5	53.5	7	
276	T.C.	C. Product	1.2	9.5	27.5	61.8	4	1.32
		C. Discard	1.0	49.4	21.3	28.3	0	
		F.F. Product	1.2	9.5	28.2	61.1	6½-7	1.63
		F.F. Feed	1.1	18.3	26.9	53.7	4½-5	

TABLE 6.

PLANT PERFORMANCE DATA.

WASHING TEST NO.	CYCLONE WASH							FROTH FLOTATION					TOTAL COKING COAL	
	FEED	PRODUCT		DISCARD		CUT POINT	PROBABLE ERROR	FEED	PRODUCT		TAILINGS		YIELD* %	ASH % (CALC.)
	ASH %	YIELD* %	ASH %	YIELD* %	ASH %			ASH %	YIELD* %	ASH %	YIELD* %	ASH %		
274 W.B.	21.6	70.7	10.3	29.3	50.2	1.43	0.008	16.6	93.2	11.8	6.8	82.5	72.9	10.5
275 H.B.	15.8	81.4	10.7	18.6	43.1	1.44	0.016	14.8	74.5	10.8	25.5	26.5	80.4	10.7
276 T.C.	18.3	90.0	9.3	10.0	39.0	1.60	0.028	18.3	69.7	9.3	30.3	39.0	87.4	9.3

* Cyclone and total coking coal yields from weight balance.
Froth flotation yields from ash balance.