REFERENCES.

1. Barker, O.B., Barker and Associates. 1999. A Techno-Economic and Historical Review of the South African Coal Industry in the 19th and 20th Centuries. In: Pinheiro, R. (Ed.) 1999. Bulletin 113. Division: Coal and Mineral Services. SABS, Pretoria, p. 1-63.
2. Bartkowiak, G. 2001. Memo: Dorstfontein reserves by thickness. Internal report: TOTAL Exploration of South Africa (Pty) Ltd., 2 pp.
3. Bell, K. and Spurr, M.R. 1986. The Klip Rivier Coalfield of Northern Natal. In: Anhaeusser, C.R.and Maske, S. (Eds.). 1986. Mineral Deposits of Southern Africa, Vol. 2. Geological Society of South Africa, Johannesburg, p. 2033-2046.
4. Bell, K. and Spurr, M.R. 1986. The Vryheid Coalfield of Northern Natal. In: Anhaeusser, C.R. and Maske, S. (Eds.). 1986. Mineral Deposits of Southern Africa, Vol. 2. Geological Society of South Africa, Johannesburg, p. 2023-2032.
5. Buddery, P.S. and Oldroyd, D.C. 1992. Development of a roof and floor classification applicable to collieries. Eurock '92. Telford, T., London, p. 197-202.
6. Clarke, J., Caldon, J. H. and Curth, Ernest A. 1982. Thin Seam Coal Mining Technology. Noyes Data Corporation, New Jersey, U.S.A., 385 pp.
7. De Jager, F.S.J. 1976. Steenkool. In: Delfstowwe van die Republiek van Suid-Afrika, Vyfde druk. Geologiese Opname, Dept. van Mynwese. Staatsdrukker, Pretoria, p. 383 – 390.
8. Greenfields, H.D. 1986. Eastern Transvaal Coalfield. In: Anhaeusser, C.R. andMaske, S. (Eds.). 1986. Mineral Deposits of Southern Africa, Vol. 2. Geological Society of South Africa, Johannesburg, p. 1995-2010.
9. Jacobs, R. 1989. Die geologie van Ermelomyne en die invloed daarvan op praktiese mynprobleme. Unpubl. M.Sc, Fakulteit Natuurwetenskappe, Universiteit van Pretoria, p.74 – 97.

10. Jordaan, J. 1986. Highveld Coalfield. In: Anhaeusser, C.R. and Maske, S. (Eds.). 1986. Mineral Deposits of Southern Africa, Vol. 2. Geological Society of South Africa, Johannesburg, p. 1985-1994.
11. Joy Mining Machinery. 1978 revised 2001. Predict cutting and bit wear rates. In: Joy Service Bulletin, 00FG-0106. Unpub., 3pp.
12. Karr, Clarence Jr. 1978. Analytical Methods for Coal and Coal Products. Academic Press, New York, p. 74 – 90.
13. Meyers, R.A. 1981. Coal Handbook. Marcel Decker, Inc., New York, U.S.A., p. 19 – 74.
14. Pinheiro, H.J., Pretorius and C.C., Boshoff, H.P. 1999. Analyses of Coal and Product Samples of South African Collieries 1998-1999. In: Pinheiro, R. (Ed.) 1999. Bulletin 113. Division: Coal and Mineral Services. SABS, Pretoria, p. 64-97.
15. SACS (South African Committee for Stratigraphy). 1980. Stratigraphy of South Africa. Compiled by Kent, L. E. 1980. Part 1: Lithostratigraphy of the Republic of South Africa, S.W.A. / Namibia and the Republics of Bophuthatswana, Transkei and Venda, Handbook 8. Geological survey of South Africa, Pretoria, 690pp.
16. Smyth, W. W. 1886. Coal and Coal Mining. Sixth Ed, revised and enlarged. Crosby Lockwood and Co., London, 263pp.
17. Snyman, C.P. 1998. Coal. In: Wilson, M.G.C. and Anhaeusser, C.R. (Eds.). 1998. The Mineral Resources of South Africa, Sixth Ed. Council for Geoscience, Pretoria, p. 136-205.
18. Spengler, M., 2002. Report: Tests on borehole samples of the parting between the 2 Lower and Upper seams. Internal Report: Dorstfontein Coal Mine, 3pp.
19. Spurr, M.R., Gillard, T.D. and Bell, K. 1986. The Utrecht Coalfield of Northern Natal. In: Anhaeusser, C.R. and Maske, S. (Eds.). 1986. Mineral Deposits of Southern Africa, Vol. 2. Geological Society of South Africa, Johannesburg, p. 2011-2022.
20. Stewardson, M.C. and Saunderson, R.D. 1999. South Dorstfontein: The Geology, Reserves and Grade of the No. 2 Seam. (Unpub.) Internal Report: AngloVaal Minerals, 76pp.

21. Van der Merwe, J. N. and Madden, B.J. 2002. Rock Engineering for Underground Coal Mining. Published under the auspices of SIMRAC and SAIMM, p. 50 – 52 and 201.

22. Van Zyl. W., 2001. Memo: Ventilation standards for continuous miner sections. Internal report: Dorstfontein Coal Mine, pp. 2.

23. Winter, M.F., Cairncross, B. and Cadle, A.B. 1987. A genetic Stratigraphy for the Vryheid Formation in the northern Highveld Coalfield, South Africa. South African Journal of Geology, Vol. 90 No. 4. Geol. Soc. of S.A, Johannesburg, p. 333 - 343.

24. Woodruff, S.D. 1966. Methods of Working Coal and Metal Mines. Vol.3. Pergamon Press, New York, p. 3 – 109, 224 – 254.

25. SAMREC. 2000. South African Code for reporting of mineral resources and mineral reserves (The SAMREC Code). Prepared by The South African Mineral Resource Committee (SAMREC) under the auspices of the South African Institute of Mining and Metallurgy, pp. 41.

26. The South African Coal Processing Society. 2002. Coal Preparation in South Africa. Compiled by: The South African Coal Processing Society, Johannesburg, p. 38 – 43.

ANNEXURES

Annexure 1. Thin seam coal deposits of major producing countries.

Annexure 2. U.S.A. Tax.

Annexure 3. Wirth brochure.

Annexure 4. Stamler BH10 brochure.

Annexure 5. Development of a floor and roof classification applicable to collieries.

Annexure 6. Geotechnical analysis.

Annexure 7. Cash flow sheet.

Annexure 8. Capital expenditure.

Annexure 9. Operational costs.

Annexure 10. Escalations.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ANNEXURE 2

West Virginia State Tax Department

Publication TSD-398
(Rev. August, 1999)

REDUCED SEVERANCE TAX RATE FOR THIN SEAM COAL PRODUCED FROM NEW MINES

Information contained herein is of a general nature and should be used only as a reference and not a substitute for tax laws or tax regulations.

Coal severance activities are subject to both a State tax, equal to the greater of 4.65 percent of gross receipts (less credits) or 75 cents per ton minimum tax on coal, and a local tax equal to 0.35 percent of gross receipts.

For tax years beginning after April 11, 1997, coal severance activities associated with new underground mines or underground mines not in production between October 14, 1996 and April 11, 1997 are subject to a reduced severance tax rate if the seam thickness of such mines is forty-five inches or less. The determination of actual seam thickness would be based upon a report by a professional engineer who uses an isopach mapping technique.

For qualified mines with a seam thickness of less than thirty-seven inches, the State tax equals the greater of 0.65 percent of gross receipts (less credits) or 75 cents per ton. The local tax remains at 0.35 percent of gross receipts.

For qualified mines with a seam thickness between thirty-seven inches and forty-five inches, the State tax equals the greater of 1.65 percent of gross receipts (less credits) or 75 cents per ton. The local tax remains at 0.35 percent of gross receipts.

If a coal processor purchases coal from a qualified thin seam mine then additional processing activities associated with such coal would be subject to the same reduced tax rate as applicable to the initial severance activity. However, processors must maintain a log with records of qualified tons and receipts subject to alternative tax rates.

Thin seam coal produced from qualified mines remains subject to the 75 cents minimum tax. The minimum tax provides some degree of tax equity among all West Virginia coal producers. Absent such an equalizer, qualified mines subject to preferential tax rates would enjoy a significant competitive advantage over other West Virginia mines. The minimum tax provisions should mitigate potential losses of employment, production and tax receipts at those mines not subject to preferential tax rate treatment.

Taxpayers must separately account coal receipts subject to the three alternative State tax rates of 4.65 percent, 0.65 percent and 1.65 percent. The following may provide some guidance:

Example 1:

KL Mining Company begins operations at a new low seam mine. First year coal sales total 200,000 tons at $30.00 per ton. The seam thickness as determined by isopach mapping techniques is less than 37 inches. The following tax calculations apply:

§ 11-12B Tax		
State Minimum Tax: 200,000 tons x $0.75/ton	**= $**	**150,000**
§ 11-13A Tax		
Gross Receipts: 200,000 tons x $30.00/ton	**= $**	**6,000,000**
Tax Rate on Receipts: 0.65% + 0.35%	**= x**	**1.0%**
Gross Tax: State Local	**$**	**60,000**
Annual Exemption Credit:	**-**	**500**
Net Tax:	**= $**	**59,500**
State Share: (0.65/1.00) x $59,500 = $38,675		
Net Minimum Tax: ($150,000 - $38,675)	**= +**	**111,325**
Total Tax (including local share):	**= $**	**170,825**

Example 2:

MSM Mining Company begins operations at two new low seam mines. First year coal sales total 300,000 tons at $30.00 per ton. The seam thickness as determined by isopach mapping techniques is less than 37 inches at Mine A (production = 100,000 tons) and between 37 and 45 inches at Mine B (production = 200,000 tons). The following tax calculations apply:

§ 11-12B Tax		
State Minimum Tax: 300,000 tons x $0.75/ton	=	$ 225,000
§ 11-13A Tax		
Gross Receipts: 300,000 tons x $30.00/ton	=	$ 9,000,000
Tax Rate of Receipts:		
(100,000 tons x $30.00/ton)/$9,000,000 x 0.65%		
(200,000 tons x $30.00/ton)/$9,000,000 x 1.65%		
1.3167% + 0.35%	=	x 1.6667%
Gross Tax: State Local		$ 150,000
Annual Exemption Credit:		- 500
Net Tax:	=	$ 149,500
State Share: (1.3167/1.6667) x $149,500 = $118,105		
Net Minimum Tax: ($225,000 - $118,105)	=	+ 106,895
Total Tax:	=	$ 256,395

Example 3:

JM Mining Company Produces 1,000,000 tons from various mines that have been in operation for several years. Coal from these mines is sold under contract for $30.00 per ton. JM reopens Low Profit Mine, a low seam (i.e., less than 37 inches) not in operation since 1989. JM sells 150,000 tons of coal from Low Profit Mine at an average price of $25.00 per ton. JM also opens New Mine and sells 100,000 tons of coal from this mine at an average of $24.00 per ton. The seam thickness as determined by isopach mapping techniques is less than 37 inches at Low Profit (production = 150,000) and between 37 inches and 45 inches at New Mine (production - 100,000 tons). JM also has a Coal Loading Facility Credit equal to $30,000. The following tax calculations apply:

§ 11-12B Tax		
State Minimum Tax: 1,250,000 tons x $0.75/ton	=	$ 937,500
(1,000,000 + 150,000 + 100,000)		
§ 11-13A Tax		
Gross Receipts: 1,000,000 tons x $30.00/ton		
+ 150,000 tons x $25.00/ton		
+ 100,000 tons x $24.00/ton	=	$36,150,000
Tax Rate of Receipts:		
(1,000,000 tons x $30.00/ton)/$36,150,000 x 4.65%		
(150,000 tons x $25.00/ton)/$36,150,000 x 0.65%		
(100,000 tons x $24.00/ton)/$36,150,000 x 1.65%		
4.036% + 0.35%	=	x 4.386%
Gross Tax: State Local		$ 1,585,500
Credits (Coal Loading & Exemption):		- 30,500
Net Tax:	=	$ 1,555,000
State Share: (4.036/4.386) x $1,555,000 = $1,430,909		
Net Minimum Tax: ($937,500 - $1,430,909)	=	+ 0
Total Tax:	=	$ 1,555,000

If you have further questions regarding reduced severance tax for thin seam coal, please contact the Sales Tax Unit, Internal Auditing Division. A question in writing should be submitted to:

West Virginia State Tax Department
Internal Auditing Division - Sales Tax Unit
Post Office Box 425
Charleston, West Virginia 25322-0425

You may also telephone (304) 558-3333 or toll-free at: 1-800-982-8297

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ANNEXURE 1

Geological Parameters	Former USSR	USA	Spain	United Kingdom	Czechoslovakia	Poland	Colombia
Definition of thin seams	1.2 m (48 inches)	-	-	0.91 m (36 inches)	1.0 m (39 inches)	1.0 m (39 inches)	-
Seam dip	Gentle to very steep	Mainly flat	0-90	0-45 Mostly 0-6	0-16 51% 16-36 34% +36 15%	0-10 39% 1 0-45 54% +45 7%	Flat to steep
Seam depth	300- 1,1 00 m (984-3,609 ft)	Reserves calculated to a depth of 1,000 ft	500 m (1,640 ft)	1,100 m (3,609 ft)	400-600 m (1,312-1,968 ft) Some at 1,000 m (3,281 ft)	0-800 m (0-2,625 ft)	-
Coal strength	Variable	Variable	-	Hard	Hard	-	-
Roof	6.4% sandstone 8.0% limestone Rest shale	Generally good and strong. Frequent draw slate	Strong, variable	Shale	-	Sandstone, silts and conglomerates	Variable
Floor	Mostly clay shales	Medium	Strong, variable	Mostly clays	-	Sandstone, silts	-
Extent of Seams	Donetz and Lvov-Volynsky	Wide areas but thickness in seams varies over area	Fragmented	Northumberland, Durham, York-shire and Derby-shire	Ostrava Karvina and Eastern Bohemia	-	
Water	Mostly dry, but some very wet	Fairly dry when worked above drainage table	Variable	Mostly dry	-	-	-
Faults	Normally undisturbed	Normally undisturbed	Highly disturbed	Mainly undisturbed	Highly disturbed except Wales and Scotland	-	Disturbed
Cleat	Mostly well defined	Not generally well defined	-	Mostly well defined	-	Mostly well defined	Variable
Spontaneous combustion	Variable risk	Variable risk	-	Low risk in thin seams	-	-	Low risk
Methane	Variable emission	Generally low emission	Low emission	Mainly gassy	All gassy	Mainly gassy	Mainly non-gassy
Quality	Coking coal	Often coking and low sulphur	-	Often coking	High quality coking coal		-

Annexure 1. Thin seam coal deposits of major producing countries (Clark et al., 1982)

Geological Parameters	France	Belgium	Germany	China	Bulgaria	Romania
Definition of thin seams	1.0 m (39 inches)	0.6 m (24 inches)	0.7 m (28 inches)	-	1.3 m (51 inches)	-
Seam dip	0 -20 47% 20-45 46% +45 7%	0-45 mostly 0-30	0-10 63% 10-20 9.5% +20 27.5%	Flat or slight 69 7% 10-25 22.4% +25 7,9%	10-90 mostly -45	5-70
Seam depth	-	275-1,160m (902-3,806 ft)	Maximum 1,200 m (3,937 ft)	Mostly <200 m (656 ft)	150-300 m (492-984 ft)	-
Coal strength	-	Variable	Soft but hard in the Saar		-	-
Roof	-	Competent shale and sandstone	Shale, sandy shale in thin seams	-	Hard sandy shales	-
Floor	-	Good shale and sandstone	Shales, sandy shales	-	-	-
Extent of Seams	Nord, Pas de Calais, Cevennes	Charieroi-Namur, Liege	Aachen and lower Saxony	Widely distributed	Svoge Basin and Balkan field	Valea-Jiului and Anina
Water	-	-	Mostly dry	-	-	Dry
Faults	-	Undisturbed	Mainly undisturbed	Undisturbed	Highly disturbed	Highly disturbed
Cleat	Mostly well defined	Variable	Mostly well defined	-	-	Not generally well defined
Spontaneous combustion	-	-	Variable risk	-	Low risk	-
Methane	Mainly gassy	-	Low emission	Some gassy	Some gassy	Mainly gassy
Quality	-	Anthracite	Coking coal	-	Anthracite	Coking coal

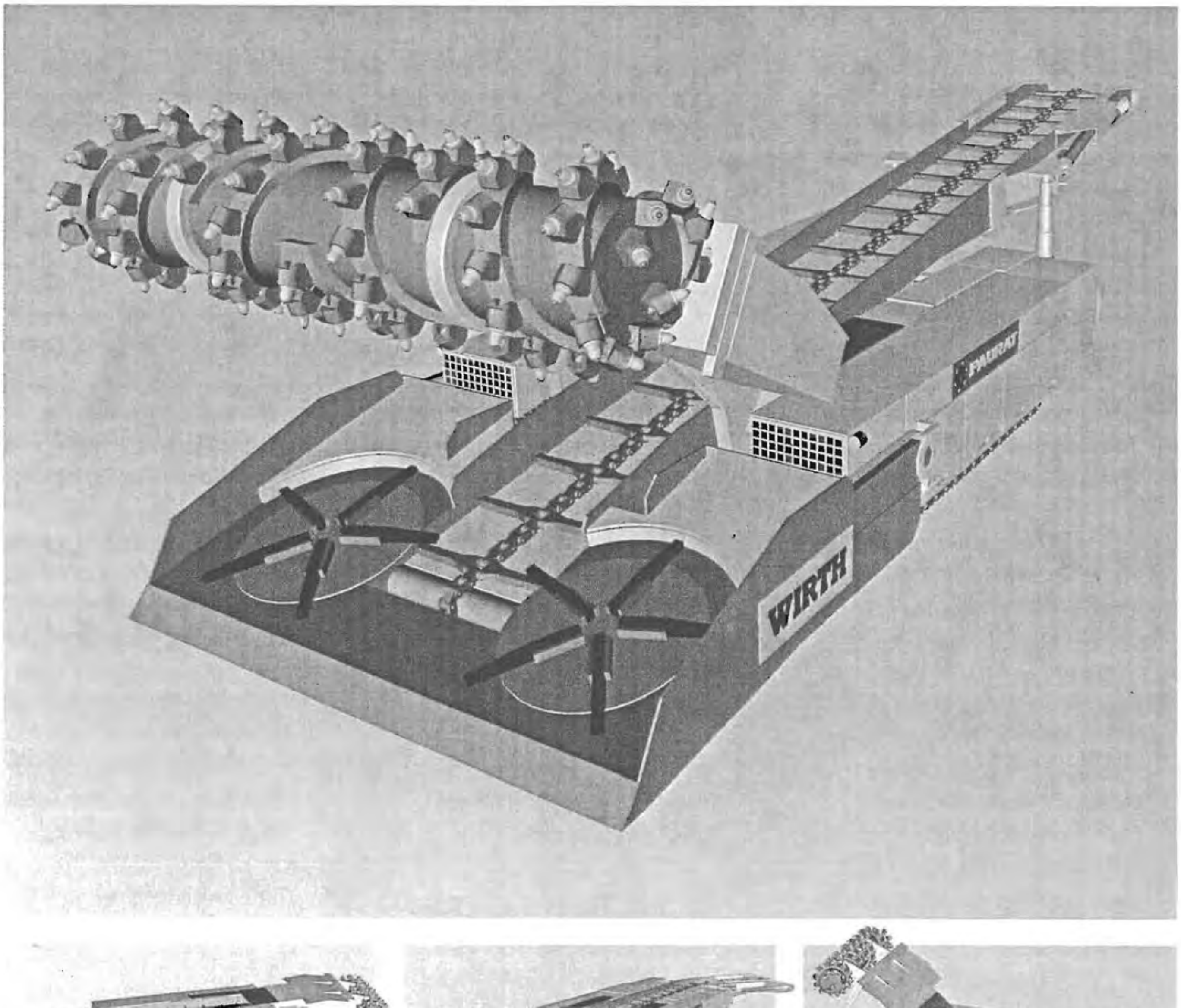
Annexure 1 cont. Thin seam coal deposits of major producing countries (Clark et al., 1982)

ANNEXURE 3

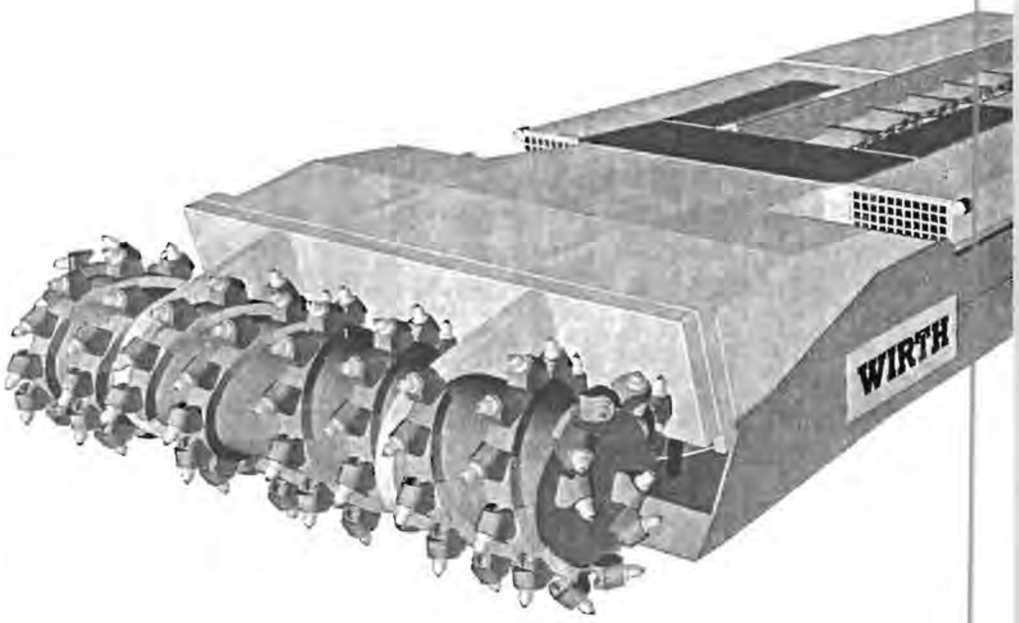
WIRTH

Low Seam Coal Header

H4.30



Low Seam Coal Header WIRTH PAURAT H4.30



1. The H4.30 Low Seam Coal Header combines the strength, robustness and versatility of WIRTH PAURAT's heavy-duty roadheader range with the ability to cut and load minerals, such as coal, potash, salt, etc. at a very high production rate.

   The Coal Header with a weight of approx. 50 t is designed to withstand the toughest of under ground conditions during long periods of use. It can deal with rock inclusions, washouts and undulations in the seam.

2. The H4.30 is capable of cutting and loading a cross-section up to 3.5 m wide and up to 2.80 m high from a single central position. With an overall height of only 1,000 mm the machine can operate in cross-sections only 1.1 m high on plain floor conditions.

3. The machine is equipped with a WIRTH PAURAT "Helix" cutting drum powered by two water-cooled and water-tight electric motors via epicyclic gearboxes. The cutting drum is divided into three sections - a centre drum and two outer drums.

   In operation the drum not only cuts but also crushes and conveys the material onto the loading apron. Cutting is carried out by tungsten carbide tipped point attack picks arranged in a double spiral around the drum. Wear resistant steel scrolls convey the cut material to the loading apron, and also protect the pick boxes and limit pick penetration. The loading apron behind the drum conveys the material by the two loading stars on the chain conveyor.

4. The main frame of the machine is constructed from solid cast steel components to give it the necessary mass to react the cutting forces within the compact overall dimensions. The individual components are bolted together for ease of assembly and transport as well as service inside the production area.

   The crawler tracks are integrated into the main frame, each track being independently driven by an electric, AC, motor, with variable speed by inverter control.

   The crawlers are fitted with 500 mm wide track plates. The crawlers have sufficient power to enable the machine to operate on tramming gradients up to +/- 18 degrees.

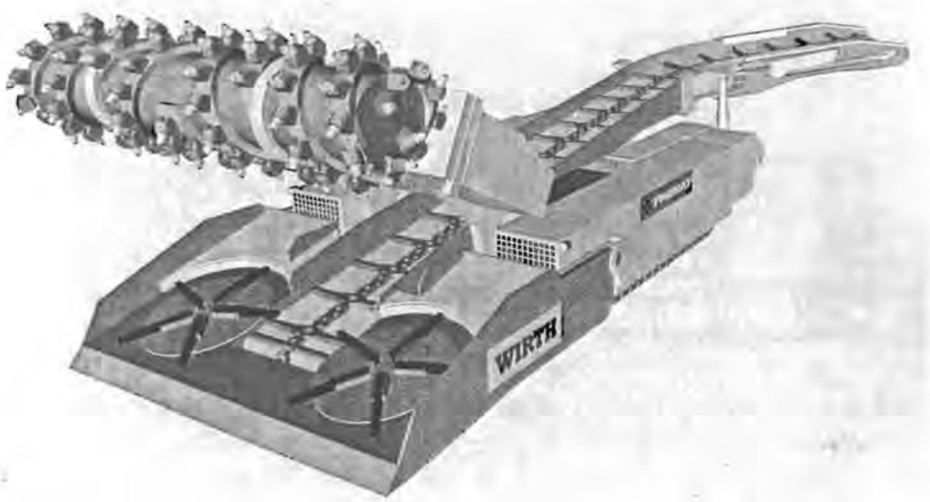
5. The machine is equipped with a high capacity roller chain conveyor powered by the two loading star

drives. The conveyor transports the cut and crushed material from the loading apron to the rear of the machine. The tail of the conveyor can be raised, lowered and slewed from side to side hydraulically enabling it to load almost any muck haulage system.

6. All drives, i.e. crawlers, conveyor, cutting drum and loading stars are electrically driven. All other functions of the machine are operated hydraulically. The power pack comprising tank, pumps with water electric motor, filters, coolers etc. is located on the right hand side of the machine. Preset level and temperature switches protect the system which is suitable for use with both normal mineral oil and HF-C fire resistant fluids, resp.

The main valves are operated by a radio remote control system.

7. As standard the machine is designed for use with an electrical power supply rated 1000 V / 50 Hz. The electrical system can also be modified for use with other voltages and 60 Hz frequency.



The machine can also be supplied for use in gassy mines in full compliance with the regulations of the relevant governing authorities.

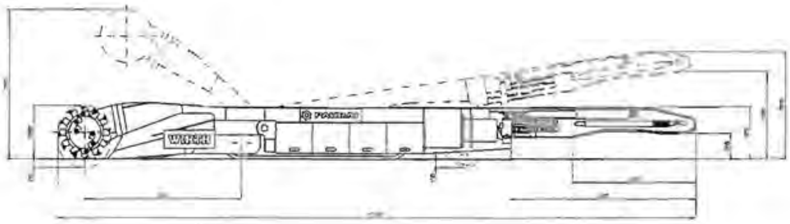
The switchgear for all the motors on the machine and the main circuit breaker for the power supply, are all contained in one contactor case located on the right hand side of the machine. All motors are protected against both thermal and current overload as well as against earth leakage.

Start and stop buttons for all motors as well as ampmeters and fault indication lamps are located at the control panel. Emergency stop buttons are provided at several points around the machine.

8. On the left hand side of the machine is the wet dust collection system installed, which in combination with the unique water spray system offers excellent dust absorbtion for good visibility at low consumption of water to reduce mud spillage at the floor.

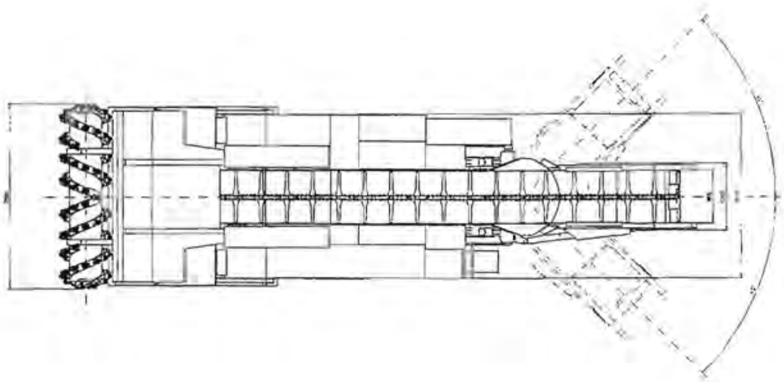
Low Seam Coal Header WIRTH PAURAT H4.30

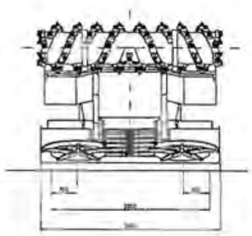
Technical Data:



List of technical data for WIRTH PAURAT H4.30

Machine Overall		
Weight	50	t
Lenght	12100	mm
Height	1000	mm
Cutting heigth	1100-2800	mm
Cutting width	3500	mm
Crawler Tracks		
Speed	0-30	m/min
Drive	AC-motors	
Cutting Drum		
Installed power	2 x 200	kW
Diameter	1000	mm
Hydraulics		
Installed power	45	kW
Electrics (standard)		
Voltage	1000	V
Frequency	50	Hz





WIRTH

Maschinen- und Bohrgeräte Fabrik GmbH
P.O. Box 16 60
41806 Erkelenz
Germany

Telephone: +49 24 31 83-0
Telefax: +49 24 31 83-267
e-mail: info@wirth-drilling.com
www.wirth-drilling.com

ANNEXURE 4

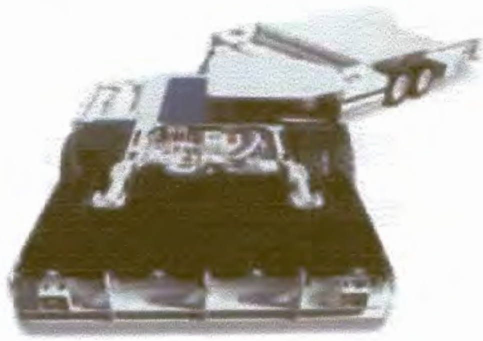
Stamler BH10 Battery Hauler

The Stamler BH10 Battery Hauler provides increased payload and low operating cost per ton. Compared to shuttle cars, the Stamler BH10 Battery Hauler offers a superior capacity, quiet and comfortable operation, and eliminates trailing cable problems.

High Performance Operation

- Substantial payload capacity in a variety of operating heights down to 890mm improves mine efficiency.
- Vertical articulation and patent pending "on demand" four wheel drive system allow efficient operation in difficult bottom conditions.
- Extended service life components are located in maintainance-friendly locations for easy access, even in low heights.
- Patented "Lift-from-grade" battery change system provides maximum uptime.
- Vertical articulation improves utility by allowing transport of components.
- Efficient, field-proven IGBT motor control system provides maximum shift battery life with the most efficient use of power.
- Ergonomically designed cabin offers good operator visibility.
- Quiet operation provides high operator comfort.

Features



Low Profile
Low profile allows operation in seams as low as 890mm.

Efficient Hydraulic System
Reliable, high output system provides power for improved haulage cycle time.

Patented "Lift From Grade" Battery Change System
Allows fast and easy battery change for maximum uptime.

Vertical Articulation
Total vertical articulation of 25° (15° up, 10° down) allows efficient operation in difficult bottom conditions and enables loading and unloading of material or components.

OLDENBURG
STAMLER

ANNEXURE 5

Development of a roof and floor classification applicable to collieries

Le développement d'une classification pour le toit et le mur en charbonnages

Die Entwicklung einer Klassifikation von Dach und Sohle, anwendbar für Kohlengruben

P. S. BUDDERY and D. C. OLDROYD, Genmin, Witbank, South Africa

Coal measures strata together with coal mining may be viewed very much as special cases with regard to rock engineering considerations. The strata are frequently laminated, generally weak and variable in character and thickness over relatively short distances. Coal mining is typically highly mechanized resulting in rapid geographical expansion and large areas of exposed roof, sides and floor. A roof and floor classification system for use by a major coal mining operation needs to be based on tests that enable large numbers of samples to be tested, including samples from the weakest strata, in ways that are related to the commonest forms of strata control problems.

Les terrains de charbon et l'exploitation de charbon peuvent être considérés comme des cas particuliers de mécanique de roches. Le terrain est souvent stratifié, normalement faible et variable en propriété et épaisseur sur des distances limitées. L'exploitation de charbon est bien mécanisée, ce qui a comme conséquence l'expansion geographique rapide et l'exposition de terrains dans lesquels le toit, le mur et les parois. Une classification du toit et du mur, appliquée par un charbonnage important, doit être basée sur des tests d'un grand nombre d'échantillons, y inclus des échantillons de roches faibles, d'une telle façon que les problèmes classiques de comportement de terrains en charbonnages sont abordés.

Das Kohlengebirge und der Abbau von Kohle können als Spezialfälle in der Gebirgsmechanik betrachtet werden. Die Schichten sind häufig laminiert, allgeimen wenig fest und über relativ kurze Entfernungen veränderlich in Gepräge und Mächtigkeit. Die mechanisierte Gewinnung von Kohle ergibt einen schnellen Abbaufortschritt mit grossen Flächen von freigelegtem Dach, Stoss und Sohle. Das System einer Dach-und Sohlenklassifikation für den Gebrauch in einer Kohlenindustrie-Gruppe muss auf Versuchen beruhen, die es ermöglichen eine grosse Anzahl von Proben zu nehmen, einschliesslich solchen von geringster Festigkeit, und das auf die alltäglichen Probleme der Gebirgsbeherrschung bezogen ist.

INTRODUCTION

The economic coal measures of South Africa occur predominantly in the Middle Ecca stage, and to a much lesser extent in the Upper Ecca and Molteno stages, of the Karoo system. The Karoo system is of Permian age thus making the South African coal measures somewhat younger than their European counterparts.

The coal bearing strata consist chiefly of sandstones with subordinate shales, carbonaceous shales, siltstones and mudstones.

Many of the coal measures strata are inherently weak while others are highly susceptible to weathering. Significant variation in the properties and thicknesses of a particular stratum over short horizontal distances is also a notable feature of many of the coalfields, as is the occurrence of dolerite intrusions in the form of both dykes and sills.

The majority of underground coal is extracted by means of mechanized bord and pillar methods from seams lying at shallow depths. Consequently, most mines experience a rapid rate of geographical expansion resulting in vast expanses of exposed roof, sides and floor being created, many of which have to be maintained for long periods of time, particularly if pillar extraction is contemplated.

THE NEED FOR A COAL MEASURES CLASSIFICATION

A number of tests are available for the determination of rock strengths and other properties such as durability and the potential for swell. The carrying out of these tests is governed by guidelines laid down by the ISRM (ref.1). Similarly, well-established rock mass classification systems exist which have proven themselves in numerous practical applications. When dealing with the soft rocks of typical coal measures strata, however, there are certain drawbacks with regard to the use of these tests and classification systems. These include:

i) The tests or classification parameters may not relate directly to actual strata behaviour in coal mine roadways.

ii) Sample preparation requirements and test procedures may make it impossible to test weak strata so that the behaviour of these strata has to be inferred from experience.

iii) The tests are typically costly, time consuming and can only be conducted in specialist laboratories. This presents significant difficulties when very large numbers of tests are required such as during the feasibility stage of a major coal mining project.

iv) Rock mass classification systems will frequently assign the same class to a wide range of coal mine roofs.

TRANS-NATAL'S ROOF AND FLOOR CLASSIFICATION

The Coal Division of Genmin's Rock Engineering Department has always desired and striven to become more pro-active in order to anticipate strata control problems rather than to deal with them only once they become apparent. In order to do so it was essential to develop a means of classifying coal measures strata. The size of the department, budget constraints and the scope of work involved meant that the following philosophy had to be applied in devising a suitable classification system:

i) The tests should relate to the expected mode of failure of the strata.

ii) It should be possible to test even the weakest material.

iii) Large numbers of tests should be able to be conducted simply, quickly, at low cost and in-house.

The achievement of these aims was considered worth losing a degree of accuracy for.

Roof Classification

Roof failure in South African coal mines is predominantly governed by the frequency of laminations or bedding planes and their propensity to open and separate, and by the bord width. This is in accordance with the formula for tensile stresses in a fixed beam which gives the maximum tensile stress, P, developed in a beam of unit width as:

$$P = \frac{\rho g B^2}{2t} \qquad (1)$$

where: ρ = strata density
g = gravitational acceleration
B = bord width
t = beam thickness

Tests designed to indicate the potential for roof failure must therefore indicate the frequency of bedding planes and laminations, and their potential to open. During 1982 the introduction of a Coal Rock Structure Rating (CRSR) system was considered. This was based on three parameters; RQD, the results of impact splitting tests and a parameter related to joint condition and groundwater.

In coal measures strata it is impractical to satisfactorily distinguish between drilling induced and natural fractures in the rock. Therefore, the RQD was discarded from the system although it is still determined for all strata that are of interest and used, where necessary, to assist in interpretation.

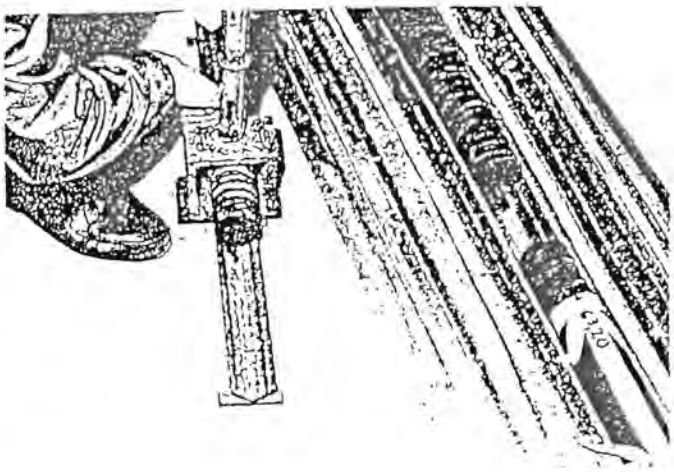


Fig.1. Impact splitting test

The third parameter proved difficult to determine. Furthermore, irrespective of the roof type, special support precautions are taken at all geological discontinuities exceeding 2m in length. Joints, therefore, unless they are exceptionally closely spaced have no influence on systematic roof support design. Consequently, in 1983 it was decided to confine the determination of roof ratings to the results of impact splitting tests.

Impact Splitting Tests

The impact splitting test involves imparting a constant impact to a length of core every 0,02m. The resulting fracture frequency is then used to determine a roof rating.

The instrument used is very simple (Fig. 1). It consists of an angle iron base which holds the core. Mounted on this is a tube containing a chisel with a mass of 1,5kg and a blade width of 25mm. The chisel is dropped onto the core from a constant height according to core size, 100mm for TNW (60mm dia.) and 64mm for NQ (48mm dia.).

The impact splitter causes weak or poorly cemented bedding planes and laminations to open under duress thus giving an indication of likely behaviour in situ when subjected to bending stresses, in some instances compounded by blasting.

When designing coal mine roof support, 2m of strata above the immediate roof are tested. If the roof horizon is in doubt then all strata from the lowest likely horizon to 2m above the highest likely horizon are tested so that all the potential horizons may be compared. For shaft boreholes the full length of strata is tested (ref. 2).

The strata is divided into geotechnical units which are very often shorter than the units described by the geologist. The RQD for each unit is determined and any geological discontinuities are noted. The units are then tested and a mean fracture spacing for each unit is obtained. Using either equation (2a) or (2b) an individual roof rating for each unit is determined.

$$\text{For } fs \leq 5 \quad \text{rating} = 4fs \qquad (2a)$$
$$\text{For } fs > 5 \quad \text{rating} = 2fs + 10 \qquad (2b)$$

where: fs = fracture spacing in cm

For example, a unit 1,2m long with 8 fractures will have a mean fracture spacing of 15cm and a unit rating of 40.

This value may be used to classify the individual strata units (Table 1) but for coal mine roofs the individual ratings are adjusted to obtain a roof rating for the first 2m of roof. The immediate roof unit will have a much greater influence on roof conditions than a unit 2m above the roof. Consequently, the unit ratings are weighted according to their position in the roof by using equation (3).

$$\text{Weighted rating} = \text{rating} \times 2(2 - h)t \qquad (3)$$

where: h = mean unit height above the roof (m)
t = thickness of unit (m)

The weighted ratings for all units are then totalled to give a final roof rating. For example, a coal mine roof has three units; 0-0.8m; 0.8-1.3m and 1.3-2.8m above the coal seam with ratings of 25, 32 and 8, respectively. For the purpose of determining a weighted rating the last unit is regarded as being from 1.3-2.0m above the coal seam. From equation 3 the weighted ratings at the mean heights of 0.4m, 1.05m and 1.65m are 64, 30.4 and 3.9, respectively. The final roof rating is therefore: 64+30.4+3.9 = 98.3.

After many years of experience and having collected data from numerous sites the classification given in Table 1 has been arrived at. Good agreement between expected and actual roof conditions has been found when using this rating system.

Table 1. Unit and coal roof classification system

Unit Rating	Rock Class	Roof Rating
<10	Very Poor	<39
11 - 17	Poor	40 - 69
18 - 27	Moderate	70 - 99
28 - 32	Good	100 - 129
>32	Very Good	>130

Floor Classification

The floor classification system was developed in late 1988/early 1989 for the feasibility study to the T-project which was investigating the extraction of torbanite and its conversion to syncrude. Torbanite is found in the N°5 coal seam of the Highveld coalfield (Fig. 6) which is notorious for poor floor conditions. Floor strata are liable to swell and degrade due to water. The mechanical action of mining equipment is also a major contributory factor to the degradation of the floor. In the light of the above it was decided to base the floor classification system on unconfined swelling strain and slake durability tests. In order to adhere to the aforementioned testing philosophy it has been necessary to modify the suggested methods as laid down by the ISRM. Only the modifications will be discussed here, for full details of the test methods the reader should refer to the ISRM suggested methods (ref.1).

Duncan Swell Test

The Duncan swell test measures the unconfined swelling strain in one or more directions when a sample of rock is immersed in water. When testing borehole cores from coal measures strata it is only necessary to measure the swelling strain perpendicular to the laminations since, in rocks liable to swell, the swelling strain perpendicular to the laminations will greatly exceed that in other directions.

Samples are not prepared but are chosen with their ends approximately parallel. This reduces the costs and time involved and, above all, allows the testing of weak samples that would otherwise break up during machining.

The test procedure requires that swelling displacement should continue to be recorded until it reaches a constant level or passes a peak. This can be extremely time consuming and, for practical purposes, is not necessary. For the vast majority of specimens, 90% or more of their final swell will have taken place by the time 30 minutes have elapsed. For this reason a 30 minute swelling strain is determined. A sample undergoing testing is shown in Fig.2.

The swelling strain, S_{30}, is calculated as follows:

$$S_{30} = \frac{d_{30}}{L} \times 100\% \qquad (4)$$

where: d_{30} = swelling displacement after 30 minutes
L = initial length of the sample.

At the end of the test the sample is immediately removed from the water. It is then assigned a rating from 1-6 according to its condition. A rating of 1 being assigned to an undisturbed sample and a rating of 6 to a totally degraded one (Fig.3). The swell index of the sample is then determined by multiplying the swelling strain by the condition rating.

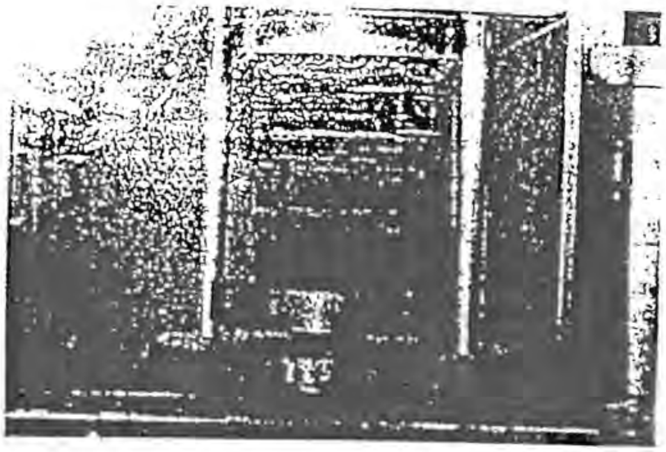


Fig.2. Duncan swell test

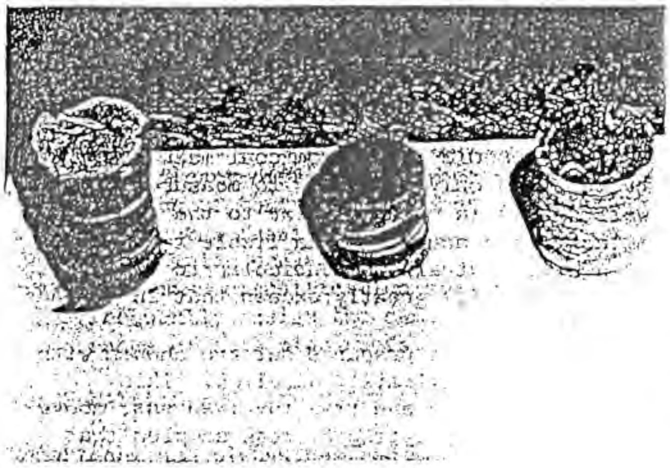


Fig.3. Samples after Duncan swell test. From left to right condition ratings are: 5; 3 and 1

Slake Durability Test

This test assesses the resistance offered by a rock sample to weakening and disintegration when subjected to two standard cycles of drying and wetting. The department had equipment manufactured - which conforms fully to the ISRM guidelines - with four drums thus allowing four samples to be tested at a time.

The slaking fluid used is in all instances water.

The International Standard calls for a representative sample comprising ten rock lumps, each weighing 40-60g. The size of core used by Trans-Natal means that 40-60g lumps can only be obtained from the more competent rock types. If only these rock are tested then the results would be biased towards good floor conditions. For this reason the lump requirement has been modified to 20-30g unprepared lumps (Fig.4).

The drying periods have been shortened from 2-6 hours to 1½-2 hours in order to speed up the procedure and because the lumps are smaller. Fig.5 shows the retained portions after the samples of Fig.4 had been tested.

The slake durability index (second cycle), I_{d2}, is calculated as follows:

$$I_{d2} = \frac{C}{A} \times 100\% \qquad (5)$$

where: A = dry mass prior to testing (g)
C = dry mass after two slaking cycles (g)

Treatment of Results

The brief from the T-Project management team was that the results should be descriptive and unambiguous.

Conventionally a high swell index implies a poor rock, conversely a high slake durability index implies a good rock. To avoid confusion it was decided to present the slake durability index as 100 - I_{d2}. Both floor indices therefore increase as expected floor conditions get worse.

The more than 250 Duncan swell and slake durability indices were carefully compared. The approach was to rate the various lithologies with regard to their potential to swell or weather based on all availabe information. Ranges of the two indices, with appropriate descriptions, were then chosen to fit the majority of data. The remaining anomalies were then dealt with by fine adjustments to the ranges. The final ranges arrived at are given in Table 2.

Table 2. Swelling and slake durability floor classification.

Rating	Description	Swell index	Slake durability index
A	Good	< 1	< 14
B	Moderate	1 - 3	14 - 26
C	Poor	3.1 - 15	26.1 - 36
D	Very Poor	> 15	> 36

There is not always complete correlation between the two indices. In these circumstances the index suggesting poorer floor conditions dictates the rating.

Each floor is then described to a depth of 0.6m according to the rating and thickness of each unit, e.g. Borehole BN14:A(0.32)/C(0.25)/A. The last layer is usually not given a thickness because it goes beyond 0.6m. Finally the condition of the immediate floor is classified according to Table 3.

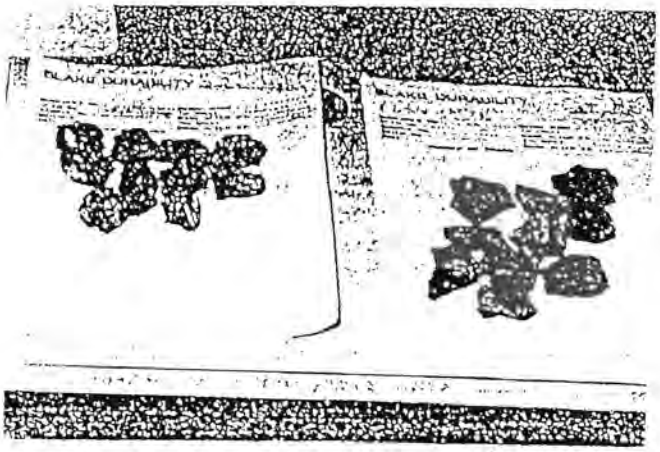


Fig.4. A weathering dolerite and shale prior to slake durability testing

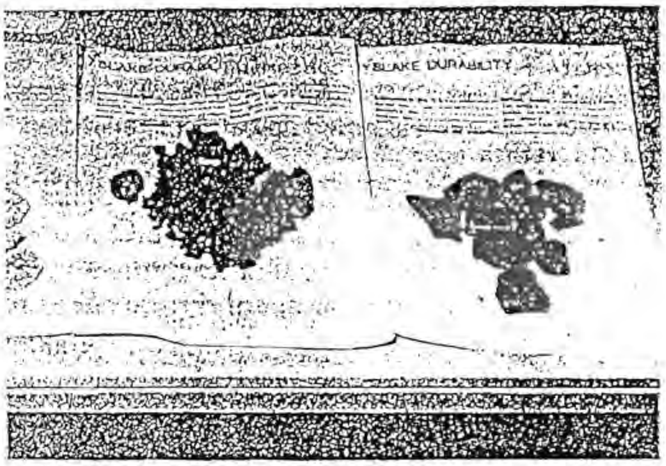


Fig.5. Samples from Fig.4. after testing

Table 3 Floor classification system

Description	Basis of classification
Good	A/B to a depth ≥ 0.4m
Possibly Poor	A/B to a depth < 0.4m The first figure in the bracket refers to the thickness of A/B and the second figure to the underlying C/D. e.g. BN14(0.32/0.25)
Poor	C/D in the immediate floor. The figure in the bracket refers to the thickness of C/D. e.g. BN37(0.12)

T-PROJECT

Sadly the T-Project never got off the ground. Had it done so it would have required massive capital investment. Consequently, the feasibility study had to be conducted to a high degree of confidence. Previous experience with the 5 seam floor and to a lesser extent the 5 seam roof meant that rock engineering considerations would play a major part in mine design, equipment selection and contamination.

Since the classification approach used by the Rock Engineering Department (RED) was novel and untried the project management decided to test the classification system against known conditions. Three holes were drilled at the nearby Matla Colliery. The location of these holes was not made known to the RED. Neither was a plan of the location of the exploration boreholes made available. When given the results for the individual boreholes the project management team expressed themselves happy with the classifications assigned to those boreholes with known conditions. Furthermore, the classifications assigned to the exploration holes correlated to other available geological data and made sense when plotted on a plan of the reserves.

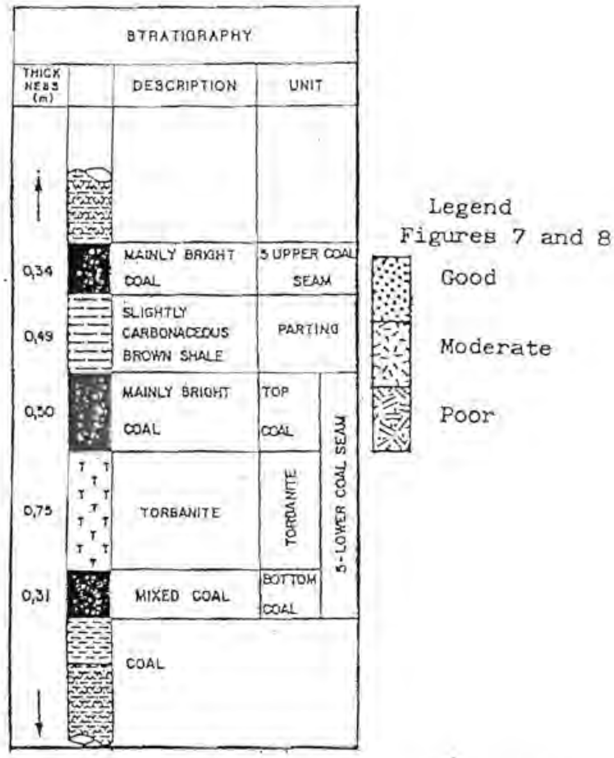


Fig.6. Generalised stratigraphic section, N°5 coal seam, T-Project and legend for figures 7 and 8

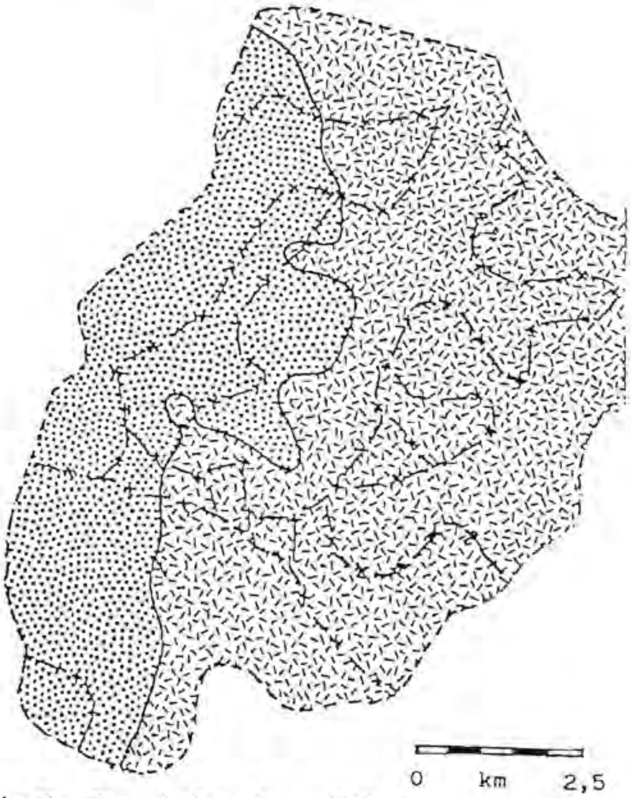


Fig.7. Expected roof conditions, T-Project

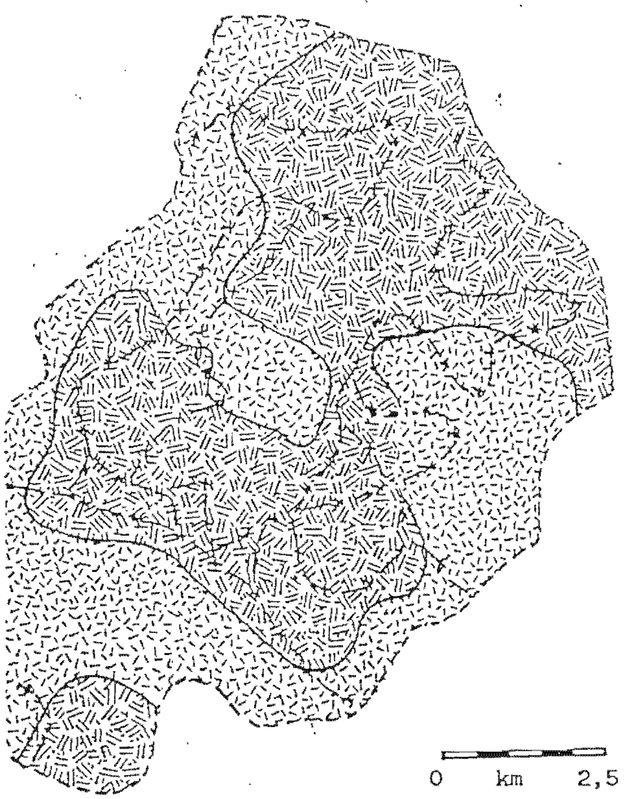


Fig.8. Expected floor conditions, T-Project

The management team chose to reduce the number of classes to two for each of the roof and floor plans. Thus the roof was rated moderate or good and the floor poor or moderate (Figs. 7 and 8).

This information was then applied in a number of ways. After considering all potential mining methods it was decided that longwall mining would be applied in areas where poor coal seam roof and floor conditions existed and the possibility of geological disturbances was minimal. Ribpillar mining would be applied in geologically complex areas where the coal seam roof and floor conditions were manageable. Mechanised bord and pillar mining would be applied in main and secondary entries, areas where surface structures needed to be protected and in mining panels not suited to longwall and ribpillar mining and where the coal seam roof and floor conditions were manageable.

Using the information it was possible to determine expected levels of contamination for the roof and floor. For example, no roof contamination was expected from the longwalls irrespective of the nature of the roof whereas for bord and pillar panels contamination was expected to be 10cm for good roofs and 20cm for moderate roofs. Floor contamination was expected to vary from 5cm for a longwall with a moderate floor to 50cm for bord and pillar panels with a poor floor.

Longwall panels were expected to have a consistent in-panel extraction factor of 92%. For ribpillar panels this was 82% with a moderate floor dropping to 78% with a poor floor.

Although the T-Project was shelved the project management team consider that from a technical perspective the feasibility study was a complete success.

CONCLUSIONS

Since its successful contribution to the T-project the Trans-Natal roof and floor classification system has been applied to further major projects as well as on a much smaller scale. Trans-Natal's mine and project management both view it as an essential tool in the investigation of greenfield sites and mine extensions. It has proven particularly valuable in shaft design (ref.2). The manner of the presentation of the results means that mine and project management are able to envisage the expected conditions in terms of their own experience.

The authors make no claims regarding their classification system other than that it successfully meets the needs of a rock engineering department which is endeavouring t provide a meaningful service to a major coal producer. It is not generally applicable to other minerals and strata types.

REFERENCES

1. ISRM. Suggested methods for determining swelling and slake-durability index properties. Committee on Laboratory Tests document 2, part 2, final draft, Nov 1972.
2. OLDROYD D.C. and BUDDERY P.S. The design and support of inclined shafts through coa measures strata, the use of rock classification.ibid.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ANNEXURE 6

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

TOTAL COAL HOLDINGS SOUTH AFRICA (PTY) LTD

DORSTFONTEIN COAL MINE

TESTS ON BOREHOLE SAMPLES OF THE PARTING BETWEEN THE 2 LOWER AND UPPER SEAMS

1. INTRODUCTION

Tests on the borehole samples of the parting between the 2 Lower and Upper seams are required to determine:

(i) Whether the parting can be supported using conventional roofbolting methods to allow the safe mining of the lower seam only.
(ii) The feasibility of mining the parting with a continuous miner if it cannot be safely supported.

The following tests were conducted:

(i) Rock mechanics – impact splitter
compressive strength

(ii) Mining – "J" factor (cutting)
"W" factor (wear)

2. ROCK MECHANICS

2.1 Impact Splitter Tests

This test was devised by rock engineering practitioners of the then Genmin group in 1982 and is used throughout the industry and particularly by the Ingwe Group. Roof failure in predominantly governed by the frequency of lamination or bedding planes, their propensity to open and the bord width. The impact splitter causes weak or poorly cemented bedding planes and laminations to open up under duress, thus giving an indication of likely in situ behaviour when subjected to bending stresses.

The rating system requires 2m of strata above the immediate roof to be tested. The borehole core is tested in geotechnical units preferably of about a half a metre in length. A mean fracture spacing for each unit is obtained and an equation used to determine the unit rating and the roof rating.

These were in-house tests. The results of the 3 borehole cores that were tested are:

UNIT POSITION (m)	DF 326		DF 327		DF 322	
	RATING	CLASSIFICATION	RATING	CLASSIFICATION	RATING	CLASSIFICATION
1.5 – 2.0	112.0	Very Good	110.0	Very Good	110.0	Very Good
1.0 – 1.5	110.0	Very Good	110.0	Very Good	110.0	Very Good
0.5 – 1.0	60.0	Very good	24.3	Moderate	21.1	Moderate
0 – 0.5	24.8	Moderate	20.0	Moderate	22.5	Moderate
2m Roof	227	Very Good	175	Very Good	175	Very Good

Despite the weighting of the individual units according to their position in the roof, the very competent upper units results in the overall classifications of the roof being "Very Good". The classification of the lower units that form the first 0,5 to 1,0m of the roof is of greater significance and this zone is classified as "Moderate".

2.2 Uniaxial Compressive Strength Tests

As the name uniaxial compressive strength (UCS) implies, in these tests a load is applied in one direction only with no lateral confinement. In this case the load was applied at right angles or near right angles to the laminae. The results of these tests therefore rather reflect the intrinsic strength of the material and not the strength of the roof when subjected to bending stresses that result in the de-lamination of the roof beam.

These tests were done at CSIR Mingtek. Three specimens from each of two borehole cores were tested. The results are tabulated below.

SPECIMEN PARTICULARS		SPECIMEN DIMENSIONS		TEST RESULTS	
CSIR SPECIMEN No. 2339-	CLIENT No.	DIAMETER (mm)	DENSITY (kg/m^3)	UCS (MPa)	MODE OF FAILURE
UCS – 01	DF 329	60,7	2450	99,2	XA
UCS – 04	DF 329	60,6	2380	95,0	XA
UCS – 05	DF 329	60,6	2450	98,8	XA
UCS – 02	DF 331	60,3	2450	97,3	XA
UCS – 03	DF 331	60,2	2510	110,3	XA
UCS - 06	DF 331	60,2	2470	111,7	XA

XA: Partial cone development

3. MINING

3.1 "J" Factor Tests

This test is used extensively by Joy Mining Machinery to predict the cutting rate of a machine such as a continuous miner. The "J" factor is determined by the controlled drilling of a specimen of the material that is to be cut. The "J" factor is the average depth of 5 holes in millimetres multiplied by 10. Material with "J" factors above 500 can be cut and becomes easier to cut as the number gets larger.

These tests were doneat CSIR Miningtek. Four specimens from one borehole were tested. The results of the tests are tabulated below.

SPECIMEN PARTICULARS		"J" FACTOR			
CSIR No.	CLIENT No.	TEST 1	TEST 2	TEST 3	AVER. + STD.
01 Top	DF328	220	210	204	211,1±8,0
01 Bot.	DF328	282	245	257	261,1±19,2
02 Top	DF328	176	194	188	186,1±9,3
02 Bot.	DF328	186	237	215	212,3±25,6

3.2 "W" Factor Tests

The "W" factor or wear factor is some indication of the pick wear that will result from both the abrasive material in the rock and the manner in which the material is found in the matrix. Bit wear takes place when drilling the holes to determine the "J" factor. This wear expressed in thousands of an inch is the "W" factor. "W" factors range from 0,000 to 0,018, with long life having a "W" factor under 0,003.

These tests were done at CSIR Miningtek. The results of the tests are tabulated below.

SPECIMEN PARTICULARS		"W" FACTOR			
CSIR No.	CLIENT No.	TEST 1	TEST 2	TEST 3	AVER. + STD.
01 Top	DF328	0,0034	0,0039	0,0046	0,0040±0,0006
01 Bot.	DF328	0,0032	0,0034	0,0032	0,0033±0,0001
02 Top	DF328	0,0025	0,0027	0,0027	0,0026±0,0001
02 Bot.	DF328	0,0039	0,0032	0,0049	0,0040±0,0009

4. CONCLUSIONS

4.1 Impact Splitter Tests

The classification of the lower units of the roof as "Moderate" indicates that the roof can be supported provided about 0,4m of the rockbolt can be anchored in the competent sandstone above the 2 Upper seam. This means that a 0,9m long bolt can only be used if the parting and the upper seam together are not more than 0,5m thick. Rows of 4 full column anchored rockbolts every 1,5 m will be required. A reduction in the density may be possible but that will depend on observations of favourable roof behaviour over a period of time.

4.2 Uniaxial Compressive Strength Tests

The UCS of the specimens tested varied between 95.0 and 111,7 MPa. As stated in section 2.1, this test does indicate the ability of the parting to withstand the de-laminating bending stresses that occur in the roof. What it does indicate is that this material can be transformed into a competent beam if de-lamination is prevented by clamping the layers together.

4.3 "J" Factor Tests

"J" factors of between 282 and 176 indicate that the parting will be difficult to cut. Rock with "J" factors below 500 can be cut if the rock is highly laminated or fractured and provided high operating costs can be tolerated.

4.4 "W" Factor Tests

The results show that pick life will be greatly reduced as the majority of the "W" factors are greater than 0,003.

M G SPENGLER

ANNEXURE 7

Sensitivity

Operating Costs	0.00%
Selling Price (Export)	0.00%
Selling Price (Domestic)	0.00%
Yield	0.00%
Production	0.00%
Capital Expenditure	0.00%

			Dorstfontein									
Period		**Total**	**2,003**	**2,004**	**2,005**	**2,006**	**2,007**	**2,008**	**2,009**	**2,010**	**2,011**	**2,012**
Production	**T000's**											
Run of mine		3,514	314	377	377	377	377	377	377	314	314	314
Yield		85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%
Coal produced		2,993	267	321	321	321	321	321	321	267	267	267
Operating costs	**R/ton**											
Run of mine		104.37	82.08	82.91	87.89	93.16	98.75	104.68	110.96	123.41	130.82	138.67
Produced		122.54	96.36	97.35	103.19	109.38	115.94	122.90	130.27	144.90	153.59	162.81
Distribution costs	**R/ton**											
Railage costs		50.56	38.62	40.94	43.40	46.00	48.76	51.69	54.79	58.08	61.56	65.26
Port charges		9.33	7.13	7.56	8.01	8.49	9.00	9.54	10.11	10.72	11.36	12.05
Transport costs		20.71	15.82	16.77	17.78	18.85	19.98	21.18	22.45	23.79	25.22	26.74
Total sales	**T000's**	**2,993**	**267**	**321**	**321**	**321**	**321**	**321**	**321**	**267**	**267**	**267**
Export		1,773	158	190	190	190	190	190	190	158	158	158
Inland sales		1,220	109	131	131	131	131	131	131	109	109	109
Export selling price												
Export selling price	$/ton	$31.64	$27.77	$27.77	$27.77	$27.77	$27.77	$27.77	$27.77	$27.77	$27.77	$27.77
Exchange rate	$/R	8.5000	8.5000	8.7500	9.0074	9.2723	9.5450	9.8257	10.1147	10.4122	10.7184	11.0337
Export selling price	R/ton	268.98	236.05	242.99	250.13	257.49	265.06	272.86	280.89	289.15	297.65	306.41
Inland selling price	**R/ton**	**216.01**	**165.03**	**174.93**	**185.43**	**196.55**	**208.35**	**220.85**	**234.10**	**248.15**	**263.03**	**278.82**
Turnover	**R000's**	**740,441**	**55,345**	**69,027**	**71,757**	**74,608**	**77,588**	**80,703**	**83,960**	**72,804**	**75,772**	**78,876**
Export revenue		476,990	37,374	46,168	47,526	48,924	50,362	51,844	53,368	45,782	47,128	48,514
Inland revenue		263,450	17,971	22,859	24,231	25,685	27,226	28,859	30,591	27,022	28,643	30,362
Distribution costs		**163,579**	**11,328**	**14,361**	**15,173**	**16,033**	**16,942**	**17,905**	**18,924**	**16,668**	**17,619**	**18,626**
Railage costs		89,652	6,116	7,779	8,246	8,740	9,265	9,821	10,410	9,196	9,747	10,332
Port costs		16,549	1,129	1,436	1,522	1,613	1,710	1,813	1,922	1,697	1,799	1,907
Transport costs		36,732	2,506	3,187	3,378	3,581	3,796	4,024	4,265	3,768	3,994	4,233
Marketing fee - Inland	1.5%	3,952	270	343	363	385	408	433	459	405	430	455
Marketing fee - Export	3.5%	16,695	1,308	1,616	1,663	1,712	1,763	1,815	1,868	1,602	1,649	1,698
FOR revenue		**576,862**	**44,017**	**54,666**	**56,584**	**58,576**	**60,646**	**62,798**	**65,036**	**56,136**	**58,152**	**60,250**
Operating costs		**365,681**	**25,343**	**31,203**	**33,030**	**35,012**	**37,112**	**39,339**	**41,699**	**38,577**	**40,954**	**43,412**
Operating costs		366,769	25,751	31,217	33,090	35,075	37,180	39,410	41,775	38,721	41,044	43,506
Stock Movement		-1,087	-408	-14	-59	-64	-67	-71	-76	-143	-90	-94
Operating profit		**211,180**	**18,674**	**23,463**	**23,553**	**23,564**	**23,534**	**23,459**	**23,337**	**17,558**	**17,198**	**18,838**
Taxation		28,983	139	4,534	5,084	2,190	4,662	5,146	4,091	0	0	3,138
Profit after taxation		**182,197**	**18,535**	**18,930**	**18,469**	**21,374**	**18,872**	**18,313**	**19,246**	**17,558**	**17,198**	**13,700**
Working capital incr/(decr)		4,627	3,382	623	135	140	146	151	157	-424	156	161
Capital expenditure		114,569	18,210	8,351	6,607	16,265	7,994	6,306	9,700	23,844	11,737	5,554
Nominal Cash flow		**63,001**	**-3,057**	**9,956**	**11,728**	**4,969**	**10,732**	**11,856**	**9,388**	**-5,862**	**5,305**	**7,985**
Real Cash Flow		**46,302**	**-2,884**	**8,861**	**9,847**	**3,936**	**8,020**	**8,358**	**6,244**	**-3,678**	**3,140**	**4,459**

IRR:	**305.2%**		**-2,884**	**8,861**	**9,847**	**3,936**	**8,020**	**8,358**	**6,244**	**-3,678**	**3,140**	**4,459**
Discount rate		0.0%	2.5%	5.0%	7.5%	10.0%	12.5%	15.0%	17.5%	20.0%	22.5%	25.0%
Net Present Value		46,302	41,878	38,078	34,790	31,926	29,417	27,206	25,246	23,501	21,939	20,536

			Dorstfontein									
Period		Total	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012
Tax Computation												
Tax loss		0	0	0	0	0	0	0	0	0	-6,285	-824
Operating profit		211,180	18,674	23,463	23,553	23,564	23,534	23,459	23,337	17,558	17,198	16,838
Capital expenditure		114,569	18,210	8,351	6,607	16,265	7,994	6,306	9,700	23,844	11,737	5,554
Taxable Profit		96,611	464	15,112	16,947	7,299	15,540	17,153	13,636	-6,285	-824	10,459
Tax payable	30%	28,983	139	4,534	5,084	2,190	4,662	5,146	4,091	0	0	3,138
Working Capital												
Stocks			987	1,000	1,060	1,124	1,191	1,262	1,338	1,482	1,571	1,666
Stores (4 weeks op costs)	2		990	1,201	1,273	1,349	1,430	1,516	1,607	1,489	1,579	1,673
Debtor (6 weeks)	4		4,257	5,310	5,520	5,739	5,968	6,208	6,458	5,600	5,829	6,067
Creditor (4 weeks all costs)	4		2,852	3,506	3,713	3,931	4,163	4,409	4,669	4,261	4,513	4,779
Net Current Asset/(Liabilities)			3,382	4,005	4,140	4,280	4,426	4,577	4,734	4,310	4,466	4,627
Opening Balance			0	3,382	4,005	4,140	4,280	4,426	4,577	4,734	4,310	4,466
Yearly Movement			3,382	623	135	140	146	151	157	-424	156	161

ANNEXURE 8

12-Aug-03			Dorstfontein thin seam									
Year			2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Period			1	2	3	4	5	6	7	8	9	10
Escalated capital expenditure												
Underground												
Wirth Machine			15,000,000	-	-	-	-	-	-	-	-	-
Stamler Hauler			-	4,400,000	-	-	-	-	-	-	-	-
Ventilation			15,000	16,500	18,150	19,965	21,962	48,315	53,147	58,462	64,308	70,738
Telemetrey			120,000	-	-	-	-	-	-	-	-	-
Concrete roads			240,000	-	-	-	-	-	-	-	-	-
Extraordinary support			100,000	110,000	121,000	133,100	146,410	161,051	177,156	194,872	214,359	235,795
Conveyor belt and structure			900,000	1,100,000	1,210,000	1,331,000	1,464,100	1,610,510	1,771,561	1,948,717	2,143,589	2,357,948
Pumps and accessories			78,000	85,800	94,380	103,818	114,200	125,620	138,182	152,000	167,200	183,920
Roof Brushing			250,000	275,000	302,500	332,750	366,025	402,628	442,890	487,179	535,897	589,487
Electrical distribution			105,000	115,500	127,050	139,755	153,731	169,104	186,014	204,615	225,077	247,585
CM Overhaul			-	-	-	10,648,000	-	-	-	15,589,737	-	-
Equipment overall			-	1,155,000	3,630,000	1,996,500	4,392,300	2,415,765	5,314,683	2,923,076	6,430,766	-
Sub total - underground			**16,808,000**	**7,257,800**	**5,503,080**	**14,704,888**	**6,658,727**	**4,932,992**	**8,083,633**	**21,558,657**	**9,781,196**	**3,685,472**
Surface												
Overland conveyor			90,000	99,000	108,900	119,790	131,769	144,946	159,440	175,385	192,923	212,215
Infrastructure			90,000	99,000	108,900	119,790	131,769	144,946	159,440	175,385	192,923	212,215
Environmental			60,000	66,000	72,600	79,860	87,846	96,631	106,294	116,923	128,615	141,477
Strategic spares			90,000	99,000	108,900	119,790	131,769	144,946	159,440	175,385	192,923	212,215
Sub total - surface			**330,000**	**363,000**	**399,300**	**439,230**	**483,153**	**531,468**	**584,615**	**643,077**	**707,384**	**778,123**
Processing												
Plant & Laboratory modifcation			66,000	72,600	79,860	87,846	96,631	106,294	116,923	128,615	141,477	155,625
Discard dump			111,000	122,100	134,310	147,741	162,515	178,767	196,643	216,308	237,938	261,732
Slurry pond			45,000	49,500	54,450	59,895	65,885	72,473	79,720	87,692	96,461	106,108
Strategic spares			150,000	165,000	181,500	199,650	219,615	241,577	265,734	292,308	321,538	353,692
Sub total - processing			**372,000**	**409,200**	**450,120**	**495,132**	**544,645**	**599,110**	**659,021**	**724,923**	**797,415**	**877,157**
Sub total			**17,510,000**	**8,030,000**	**6,352,500**	**15,639,250**	**7,686,525**	**6,063,570**	**9,327,269**	**22,926,657**	**11,285,995**	**5,340,752**
Capex fees @ 4%			700,400	321,200	254,100	625,570	307,461	242,543	373,091	917,066	451,440	213,630
Total capital expenditure			**18,210,400**	**8,351,200**	**6,606,600**	**16,264,820**	**7,993,986**	**6,306,113**	**9,700,359**	**23,843,723**	**11,737,435**	**5,554,382**

12-Aug-03			Dorstfontein thin seam									
Year			2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Period			1	2	3	4	5	6	7	8	9	10
Capital Expenditure	**R000's**											
Unescalated capital expenditure												
Underground												
Wirth Machine			15,000,000	-	-	-	-	-	-	-	-	-
Stamler Hauler			-	4,000,000	-	-	-	-	-	-	-	-
Ventilation			15,000	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000	30,000
Telemetrey			120,000	-	-	-	-	-	-	-	-	-
Concrete roads			240,000	-	-	-	-	-	-	-	-	-
Extraordinary support			100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Conveyor belt and structure			900,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Pumps and accessories			78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000
Roof Brushing			250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Electrical distribution			105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000
CM Overhaul			-	-	-	8,000,000	-	-	-	8,000,000	-	-
Equipment overall			-	1,050,000	3,000,000	1,500,000	3,000,000	1,500,000	3,000,000	1,500,000	3,000,000	-
Sub total - underground			**16,808,000**	**6,598,000**	**4,548,000**	**11,048,000**	**4,548,000**	**3,063,000**	**4,563,000**	**11,063,000**	**4,563,000**	**1,563,000**
Surface												
Overland conveyor			90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000
Infrastructure			90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000
Environmental			60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Strategic spares			90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000
Sub total - surface			**330,000**	**330,000**	**330,000**	**330,000**	**330,000**	**330,000**	**330,000**	**330,000**	**330,000**	**330,000**
Processing												
Plant & Laboratory modifcation			66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000
Discard dump			111,000	111,000	111,000	111,000	111,000	111,000	111,000	111,000	111,000	111,000
Slurry pond			45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Strategic spares			150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Sub total - processing			**372,000**	**372,000**	**372,000**	**372,000**	**372,000**	**372,000**	**372,000**	**372,000**	**372,000**	**372,000**
Sub total			**17,510,000**	**7,300,000**	**5,250,000**	**11,750,000**	**5,250,000**	**3,765,000**	**5,265,000**	**11,765,000**	**5,265,000**	**2,265,000**
Capex fees @ 4%			700,400	292,000	210,000	470,000	210,000	150,600	210,600	470,600	210,600	90,600
Total capital expenditure			**18,210,400**	**7,592,000**	**5,460,000**	**12,220,000**	**5,460,000**	**3,915,600**	**5,475,600**	**12,235,600**	**5,475,600**	**2,355,600**

ANNEXURE 9

			Dorstfontein thin seam									
Year			2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Period			1	2	3	4	5	6	7	8	9	10
Operating Costs	**R000's**											
Cash costs - Unescalated			**25,753**	**29,451**	**29,451**	**29,451**	**29,451**	**29,451**	**29,451**	**25,753**	**25,753**	**25,753**
Mining contractor costs	R/ton		50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Mining contractor costs	R000's		15,688	18,825	18,825	18,825	18,825	18,825	18,825	15,688	15,688	15,688
Outbye costs	R000's		300	300	300	300	300	300	300	300	300	300
Repair and maintenance	R000's		2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241
Other underground costs	R000's		570	570	570	570	570	570	570	570	570	570
Plant costs	R/ton		7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Plant costs	R000's		2,353	2,824	2,824	2,824	2,824	2,824	2,824	2,353	2,353	2,353
Laboratory & Weighbridge	R000's		436	436	436	436	436	436	436	436	436	436
ROM stockpile	R000's		189	189	189	189	189	189	189	189	189	189
Product stockpile	R000's		486	486	486	486	486	486	486	486	486	486
Service costs	R000's		609	609	609	609	609	609	609	609	609	609
Safety and training	R000's		159	159	159	159	159	159	159	159	159	159
Utility costs	R000's		1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Other costs	R000's		893	893	893	893	893	893	893	893	893	893
Operating fee 2,5%	R000's		630	720	720	720	720	720	720	630	630	630
Cash costs - Escalated	**R000's**		**25,751**	**31,217**	**33,090**	**35,075**	**37,180**	**39,410**	**41,775**	**38,721**	**41,044**	**43,506**
Mining cost			15,688	19,955	21,152	22,421	23,766	25,192	26,704	23,588	25,003	26,504
Outbye costs			300	318	337	357	379	401	426	451	478	507
Repair and maintenance			2,241	2,375	2,518	2,669	2,829	2,999	3,179	3,370	3,572	3,786
Other underground costs			570	604	640	679	720	763	809	857	908	963
Plant costs			2,353	2,993	3,173	3,363	3,565	3,779	4,006	3,538	3,751	3,976
Laboratory & Weighbridge			436	462	490	520	551	584	619	656	695	737
ROM stockpile			189	200	212	225	239	253	268	284	301	319
Product stockpile			486	515	546	579	614	650	689	731	775	821
Service costs			609	645	684	725	768	815	863	915	970	1,028
Safety and training			159	169	179	189	201	213	226	239	253	269
Utility costs			1,200	1,272	1,348	1,429	1,515	1,606	1,702	1,804	1,913	2,027
Other costs			893	946	1,003	1,063	1,127	1,195	1,266	1,342	1,423	1,508
Operating fee 2,5%			628	761	807	855	907	961	1,019	944	1,001	1,061

			Dorstfontein thin seam								
Year			**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Period			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cash costs - R/ton ROM			**82.08**	**82.91**	**87.89**	**93.16**	**98.75**	**104.68**	**110.96**	**123.41**	**130.82**	**138.67**
Mining cost			50.00	53.00	56.18	59.55	63.12	66.91	70.93	75.18	79.69	84.47
Outbye costs			0.96	0.84	0.90	0.95	1.01	1.07	1.13	1.44	1.52	1.62
Repair and maintenance			7.14	6.31	6.69	7.09	7.51	7.97	8.44	10.74	11.38	12.07
Other underground costs			1.82	1.60	1.70	1.80	1.91	2.03	2.15	2.73	2.90	3.07
Plant costs			7.50	7.95	8.43	8.93	9.47	10.04	10.64	11.28	11.95	12.67
Laboratory & Weighbridge			1.39	1.23	1.30	1.38	1.46	1.55	1.64	2.09	2.22	2.35
ROM stockpile			0.60	0.53	0.56	0.60	0.63	0.67	0.71	0.91	0.96	1.02
Product stockpile			1.55	1.37	1.45	1.54	1.63	1.73	1.83	2.33	2.47	2.62
Service costs			1.94	1.71	1.82	1.93	2.04	2.16	2.29	2.92	3.09	3.28
Safety and training			0.51	0.45	0.47	0.50	0.53	0.57	0.60	0.76	0.81	0.86
Utility costs			3.82	3.38	3.58	3.80	4.02	4.27	4.52	5.75	6.10	6.46
Other costs			2.85	2.51	2.66	2.82	2.99	3.17	3.36	4.28	4.54	4.81
Operating fee 2,5%			2.00	2.02	2.14	2.27	2.41	2.55	2.71	3.01	3.19	3.38
Cash costs - R/ton produced			**96.36**	**97.35**	**103.19**	**109.38**	**115.94**	**122.90**	**130.27**	**144.90**	**153.59**	**162.81**
Mining cost			58.70	62.23	65.96	69.92	74.11	78.56	83.27	88.27	93.57	99.18
Outbye costs			1.12	0.99	1.05	1.11	1.18	1.25	1.33	1.69	1.79	1.90
Repair and maintenance			8.39	7.41	7.85	8.32	8.82	9.35	9.91	12.61	13.37	14.17
Other underground costs			2.13	1.88	2.00	2.12	2.24	2.38	2.52	3.21	3.40	3.60
Plant costs			8.81	9.33	9.89	10.49	11.12	11.78	12.49	13.24	14.03	14.88
Laboratory & Weighbridge			1.63	1.44	1.53	1.62	1.72	1.82	1.93	2.45	2.60	2.76
ROM stockpile			0.71	0.62	0.66	0.70	0.74	0.79	0.84	1.06	1.13	1.19
Product stockpile			1.82	1.61	1.70	1.81	1.91	2.03	2.15	2.73	2.90	3.07
Service costs			2.28	2.01	2.13	2.26	2.40	2.54	2.69	3.42	3.63	3.85
Safety and training			0.59	0.53	0.56	0.59	0.63	0.66	0.70	0.89	0.95	1.01
Utility costs			4.49	3.97	4.20	4.46	4.72	5.01	5.31	6.75	7.16	7.59
Other costs			3.34	2.95	3.13	3.32	3.51	3.73	3.95	5.02	5.32	5.64
Operating fee 2,5%			2.35	2.37	2.52	2.67	2.83	3.00	3.18	3.53	3.75	3.97

ANNEXURE 10

			Dorstfontein thin seam									
Year			**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Period			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Escalation Rates												
Deflator			6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Deflator factor			1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689	1.791
S.A. PPI	%		0.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
S.A. PPI Growth Factor			1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
US CPI	%		0.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
US CPI Growth Factor			1.000	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195
Dollar Selling price	%		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dollar Selling price Growth Factor			1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Inland Selling price	%		0.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Inland Selling price Growth Factor			1.000	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689
ESKOM	%		0.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
ESKOM			1.000	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689
Operating Costs	%		0.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Operating Costs Growth Factor			1.000	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689
Railage Costs	%		0.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Railage Costs Growth Factor			1.000	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689
Port charges	%		0.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Port charges Growth Factor			1.000	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689
Transport costs	%		0.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
Transport costs Growth Factor			1.000	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689
Capital Expenditure	%		0.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Capex Growth Factor			1.000	1.100	1.210	1.331	1.464	1.611	1.772	1.949	2.144	2.358