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Cable Belt Conveyor in North Drift, Selby Mine
National Coal Board, North Yorkshire Area

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The S.A. Institute of Materials Handling
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The Materials Handling Research Group (University of the Witwatersrand)

CABLE BELT CONVEYOR IN NORTH DRIFT

SELBY MINE

NATIONAL COAL BOARD, NORTH YORKSHIRE AREA

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1. SUMMARY

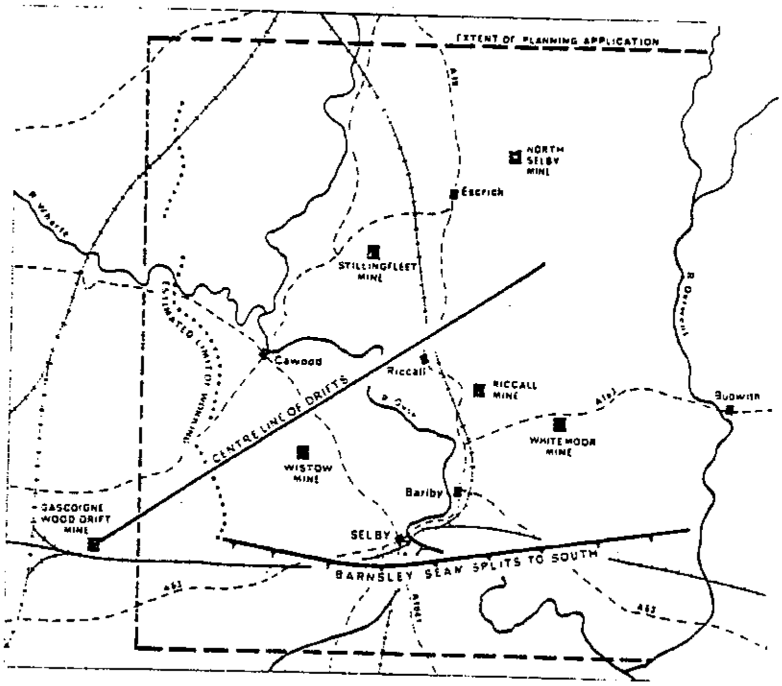
Cable Belt has been supplying long distance conveyor systems to the worldwide mining industries for over 35 years. In 1951 we supplied our first conveyor to the National Coal Board. In 1967 we supplied our first multiple loading point conveyor to the National Coal Board - 8,8 Km CABLE BELT conveyor at Longannet Power Station, Scotland. The CABLE BELT conveyor in the North Drift at Selby, with eleven loading points, will be the world's longest and largest surface drift CABLE BELT conveyor system.

This paper reviews the events leading up to the contract for the North Drift conveyor being placed with Cable Belt Ltd., the paper then goes on to discuss the major pieces of equipment in the system, with reference to their installation and commissioning.

2. INTRODUCTION

The Selby Mine Complex comprises 5 vertical shaft mines at Wistow, Ricall, Stillingfleet, Whitemoor and North Selby all feeding onto parallel single-flight surface drift conveyors, discharging to a new merry-go-round railway system at Gascoigne Wood. The layout of the complex has been designed to follow the Barnsley coal seam, which dips in a N. Easterly direction to the North of the historic town of Selby. The seam varies in thickness from 1,5m to 3,3m over the coalfield area.

Planning of the Mine Complex took into account maximum exploitation of the coal seam coupled with minimum environmental impact. The retreat mining method used ensures minimum subsidence and subsequent effect upon the surface water table. Various areas such as Selby town are to be left on adequate coal pillars. Surface structure heights have been limited to a maximum of 22m and coloured to blend in with the surrounding countryside as much as possible. Design of surface structures gives them the appearance of modern industrial complexes rather than the traditional mine-layout appearance.



Selby Location Map

When all five mines are in full production, total output from Selby will be 10 million tonnes per annum. The complex will employ 4 000 personnel at a total project cost of more than £1 billion.

3. PROJECT BACKGROUND

The N.C.B. commenced detailed exploration of the Barnsley Seam in 1971, which culminated with a public enquiry in 1975 and approval from the Secretary of State for the complex to be developed in March, 1976.

In January, 1977 technical specifications were issued for the two main spine roadway conveyors and called for multi-flight systems. After evaluation it was decided to re-write the tender for single-flight conveyors and in 1978 the tender was re-issued. Both conveyors were to be identical in terms of operating availability and had to meet the following criteria:

(i) Capability of handling the total output of the complex.

(ii) Single-flight operation.

(iii) Design limited to proven technology wherever possible.

(iv) Capability of handling designed loading conditions from the furthest loading point (1 830 m.t.p.h.).

(v) Belt width to take account of various loading conditions from Bunkers 1-11.

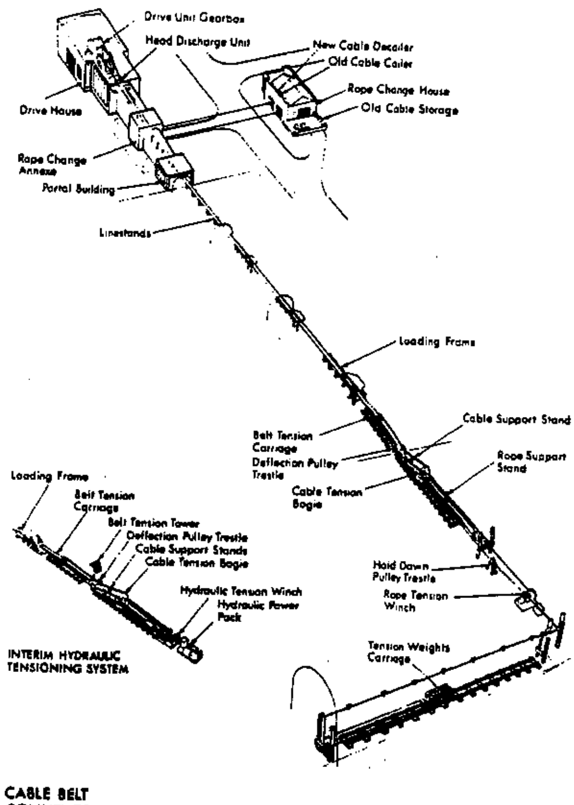
In September 1978 the N.C.B. awarded one contract to Cable Belt Ltd. for the design, manufacture, supply and installation of the single-flight conveyor in the North Drift and to Anderson Strathclyde/R.E.I. for the South Drift.

4. TECHNICAL CHARACTERISTICS

In terms of equipment size the conveyor proposed by Cable Belt was slightly different to the other 169 conveyors already supplied worldwide, but similar in duty to the CABLE BELT conveyor at the N.C.B.'s Longannet complex, Scotland. This installation has similar multiple loading point facilities.

By using proven design, backed by over 30 years of field experience, the conveyor was designed using proven technology. The conveyor friction and acceleration factors used, catenary design and the power calculation factors were all to the same specification as previous N.C.B. CABLE BELT conveyors.

The major design change was the conveyor operating speed - 7,62 m/s, some 50% higher than any CABLE BELT conveyor in operation at the time, but only 25% higher than a system that was already under construction in Australia.



CABLE BELT
CONVEYOR INSTALLATION
at the
THE GASCOIGNE WOOD MINE,
YORKSHIRE

Taking these point into account the technical characteristics of the conveyor were agreed as follows:

Length (m)	:	14 923
Lift (m)	:	990
Capacity (tph) (from furthest outbye loading point)	:	1 830
Belt speed (m/s)	:	7,62
Belt width (mm)	:	1 050
Drive cable diameter (mm)	:	57
Drive cable breaking load (tonnes)	:	240
Factor of safety	:	3,1:1
Line pitch top (m)	:	3,95
Line pulley pitch bottom (m)	:	7,9
Drive wheel diameter (m)	:	6,7
Loaded full speed power (kW) (at 1 830 tph from furthest outbye bunker)	:	8 173
Installed power (kW)	:	8 750
Empty power at full speed (kW)	:	2 080
Type of surface arrangement	:	Head Discharge

At its ultimate length the conveyor will be loaded from 11-bunker positions. If fully loaded from bunker 11 (the furthest inbye bunker) at 14 730 m, the conveyor is operating at its most efficient. If only loaded from bunker 1 (at 4 730m) because of the power available at the drive unit, the conveyor can carry 2 800 t.p.h., at full speed, providing the remainder of the conveyor inbye of this loading point is empty. In practice, the conveyor will run with variable capacities dependent on the feed rate from the in-between bunkers. Loading is automatically monitored in the fully computerised surface control room.

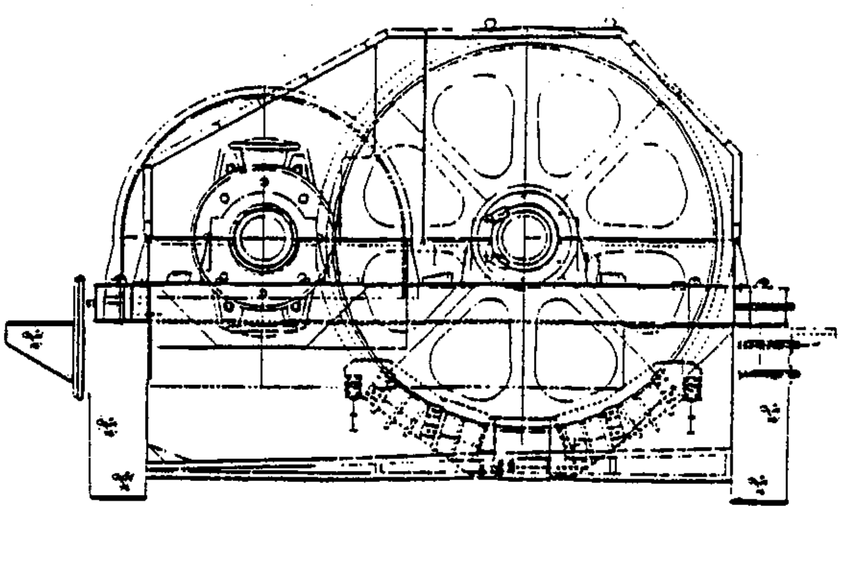
At 1 830 t.p.h. the power consumption per tonne conveyed is 4,46 kW.

4.1 DRIVE AREA

At the drive area, material is discharged onto takeaway conveyors, the drive cables are separated from the belt and run through to a separate room to the drive unit. Separation of the drive and discharge points minimises dusting.

The drive unit comprises a totally enclosed single reduction gearbox driving twin friction grip Koepe drive wheels. The drive unit and its twin input motors weigh approximately 400 tonnes.

The N.C.B. requirement to use rationalised winder motors necessitated a complete re-design of the Cable Belt drive unit. The 1,2 m diameter 7m long input shaft houses the differential unit and weights 95 tonnes.



Side view of drive unit

The differential unit equalises tension on the two drive cables and is built into the drive unit to take account of varying stretch in the drive cables and varying wear in the Koepe wheel liners. Field experience has proved that a mechanical differential operates more efficiently than a load cell device monitoring each drive wheel.

Each first motion pinion is 2,3m diameter and is coupled with the differential pinions and carriers, to make up the first motion shaft assembly.

The final shaft assemblies each comprise a shaft, with a maximum diameter of 1,13m and a gear wheel and Koepe drive wheel. The gear and Koepe wheels are approximately the same diameter - 6,2m.

The Koepe drive wheel size was selected to keep tread pressure within proven limits. Using standard Cable Belt polyurethane/composite tread linings a friction coefficient of 0,36 was used for the design of the the drive wheels.

The mechanism of the drive unit is totally supported by split roller bearings mounted directly onto the steel ring beam and outboard base frame. The drive unit casing is not load bearing and serves as an oil bath.

Gears are lubricated by individually monitored spray nozzles and the pedestal bearings are greased, because of their low turnover speed.

Each Koepe drive wheel has machined rims and eight double caliper brake units per wheel are mounted to brake on this rim. The spring-applied failsafe braking system is load cell operated. During the start-up sequence the brakes will only release when the drive unit has built up sufficient torque to overcome the pre-determined runback load. During the stopping sequence the brakes are partially applied when the conveyor speed falls to 4% of full speed.

The advantage of this type of braking system is that in the event of a total power failure and the conveyor attempting to run in reverse, the brakes are applied before the runback torque has been transmitted through the drive unit - a monitoring device will sense the runback and will operate a runback valve. This will dump the operating pressure of the brakes to tank and allow the brakes to be applied.

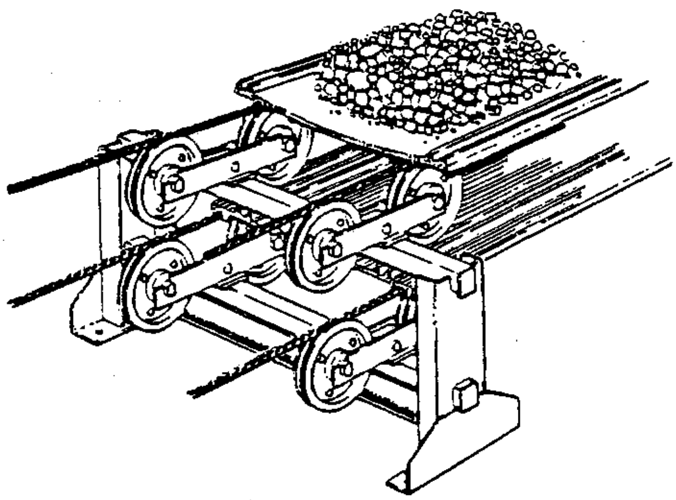
The two drive motors are D-frame variable speed thyristor controlled d.c. units. The power rating of each motor is 4 375 kW at 60 revolutions per minute. Normal operating speed, to take account of the variable loading conditions is between 20 and 60 revolutions per minute. For inspection and maintenance purposes the motors operate at a maximum of 6 revolutions per minute. The motors are controlled through a regulator which controls speed from 1% to 100% speed.

During the start up sequence, power is applied to the drive motors under control of the regulator, and built up at a set rate until motor torque is sufficient to overcome the conveyor run back torque, which releases the brakes. The conveyor is then started and held at 10% full speed until constant tension is established through its length. The conveyor is then run up to the pre-selected operating speed.

The drive unit and drive motors are supported on concrete plinths. It was decided that, because of the size or weight of some of the significant components of the drive unit, they would be assembled on site. The Koepe wheels were delivered split into two, the first motion and final shaft assemblies were delivered with shaft and gears unassembled. All units were mated up in the drive house. After build up of these components, assembly and primary commissioning of the drive unit was achieved within the projected time of five weeks.

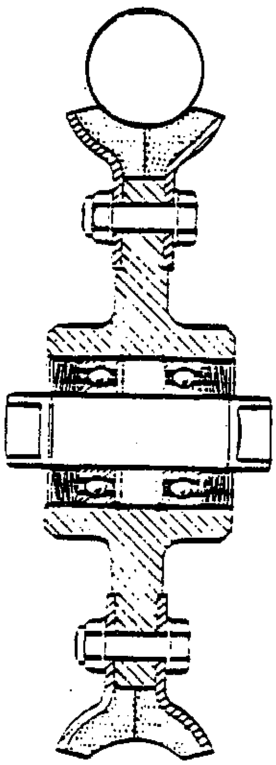
4.2 LINE EQUIPMENT

The linestand assembly is of standard Cable Belt design with four "POLYRIM" pulleys mounted on the top line of every linestand and four "POLYRIM" pulleys mounted on the bottom line at alternative linestands. Each twin set of pulleys is designed to move vertically and horizontally, to automatically compensate for minor misalignments that frequently occur in an underground mine. If required, mechanical adjustment can be made to the pulley unit positioning.



8 Pulley linestand

The design of the pulleys for this contract is similar to the standard Cable Belt"POLYRIM"pulley, except that to cater for the higher operating speeds and larger rope diameter, the tread groove diameter was increased from 270mm to 300mm and the liner tread-depth was increased.



Cross section of POLYRIM pulley

At the loading stations the 2 bay loading frames support the conveyor belt on impact idlers. Skirt plates are fitted to prevent spillage and these are designed to suit the particular requirements of each loading station.

During the stage at which the conveyor is being extended, drive cable tensioning will be via a hydraulic tension winch. At the final length, tension will be provided by a gravity tension carriage running on rails down a 3 in 1 incline.

The conveyor is monitored along its length by pullkeys and belt-cable dislodgement/belt break devices. For signalling purposes the conveyor is divided into seven major zones and each major zone is divided into nine minor zones. In the event of a lockout, its location is displayed in the control room and the lockout is located to within 70 m of the fault. Installation of the line equipment commenced as sections of the drift were made available by the National Coal Board after completion of the tunnel. Each linestand foundation consists of concrete slab ballasted into the ground. The linestand assemblies are bolted directly onto the concrete slabs. Sufficient packing is used to allow for future re-alignment due to ground movement.

4.3 CABLES

The 57mm drive cables on the Selby CABLE BELT conveyor are larger than any others previously supplied to the N.C.B. The Langs lay 6 x 19 round strand I.W.R.C. construction is similar to the drive cables used on other CABLE BELT contracts such as Worsley - Australia, Alpart - Jamaica and Orissa - India:

Nominal diameter	:	57mm
Breaking load	:	240 tonnes
Outer wire diameter	:	3,7mm
Steel grade	:	180
Strand construction	:	6 x 19 [12/6 x 6 F.1] I.W.R.C.
Core Construction	:	Steel

Selection of the size and type of drive cable for a CABLE BELT conveyor is purely dependent upon the drive tensions to be transmitted. Separation of the driving and carrying mediums means that there is no compromise in the design and selection of either.

Drive cables are selected to give a minimum 3:1 factor of safety during the worst transient conveyor conditions - this figure has been used by the National Coal Board for over 30 years.

The factor of safety calculation methods for the CABLE BELT conveyor ensures equalisation of tensions throughout the system, both for starting and for all transient loading conditions. The Cable Belt calculation of factor of safety has already built into it some functions which make it more conservative than the normal method of calculation used elsewhere. For example, in calculating the breaking load of the cables a nominal figure is used, which is some 10% lower than the actual breaking load, as determined by independent proof testing. This, in turn, is even lower than the figure that would be arrived at if the breaking load of the cable was calculated as being the breaking load of one wire multiplied by the number of wires in the cable.

The differential incorporated in the drive unit guarantees load sharing on the drive cables. It is therefore not possible to impose unequal loads on the drive cables on a CABLE BELT conveyor.

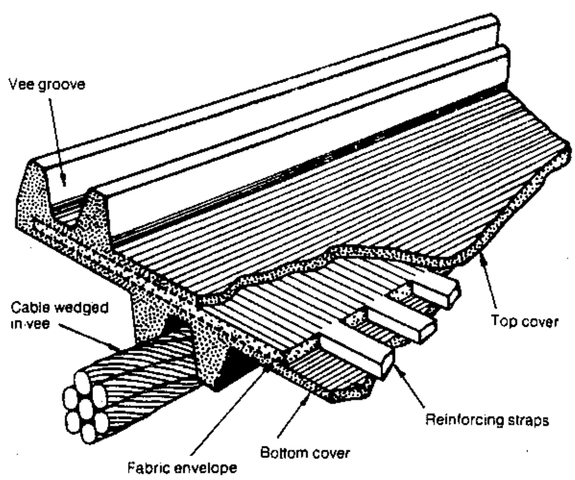
Prior to cable selection samples were independently subjected to a full range of flexing fatigue, tensile and friction coefficient tests. Testing also confirmed a standard long-splice of 60m was suitable for this duty specification.

It was agreed with the supplier of the drive cables that reels of cable, sufficient to install the conveyor to its ultimate length of 14 930 m, would be supplied on one order.

It is intended to increase the length of the conveyor in the future in increments of 2,5 Kms. Drive cables were therefore supplied in 5 Km lengths. To protect the cables from the elements, a storage house was built adjacent to the drive house. The storage house includes reeling facilities. Installation of the drive cables commenced with feeding a pilot rope through a sheave arrangement, onto the conveyor, around the drive unit down the bottom line of the conveyor and returning on the top line to a winch in the drive area. The pilot rope was then attached to the first 5 Km length of cable, which, using the winch, was pulled on. After 5 Km of drive cable had been pulled on, the first long splice between lengths of drive cable was made outside the drive unit. The second long splice, completing the endless loop drive cable, was made in the drive area.

4.4 BELT

Historically, the N.C.B. has always rationalised their belt widths for CABLE BELT conveyors for standardisation of spares holdings etc. Due to the variable loading conditions at Selby - from 1 830 m t.p.h. to 2 800 m t.p.h. - it was decided to select a belt width that would not compromise any of the loading requirements.



Belt section & cable

A 1 050 mm wide belt was therefore selected as being the most suitable for this duty.

The belt is of standard flame-resistant, neoprene based construction, with flexible steel straps. Cable Belt have been supplying this type of belting to the N.C.B. for 35 years.

The belting meets N.C.B. specification No.158 for fire resistance and it also includes anti-static properties.

Belt installation is commenced after cable installation is completed. A frame is permanently mounted above the conveyor line in the drive area. 152 m reels of belt are dropped into the frame and the conveyor is run at creep speed to pull the belt around the system. Because the belt is under no tension on the CABLE BELT conveyor, joints simply consist of mechanical belt clips on each end of belt to be jointed, through which is passed a steel rod.

5. INSTALLATION

The contract for the CABLE BELT conveyor at Selby called for Cable Belt to be responsible for installation.

The installation procedure for an underground conveyor is dependent upon the unforeseen technical problems that can occur with tunnel driveage. In the case of Selby, delays occurred due to unforeseen faults and associated water and drainage problems. In general, overland conveyors can be installed to a tighter schedule.

For the CABLE BELT conveyor at Selby it was agreed that underground installation would be a flexible process to be carried out as and when sections of the drift were made available by the National Coal Board. Surface installation was carried out to a much tighter schedule.

In March, 1983, a Cable Belt site office was set up at Gascoigne Wood. Initially work concentrated on installation in the drive area with the erection of steelwork and preparation of foundations.

At the same time manufacture of the drive unit was being completed in the subcontractors and was being prepared for gear meshing tests. By June, 1983, the drive unit base frame was being aligned on the foundations.

On completion of tests in the subcontractor's works, the drive unit was dismantled, re-protected and delivered to site during July, 1983. Once on site the main components of the drive unit were re-assembled on cradles in the drive house. Prior to assembly of the drive unit, its non load bearing casing had been installed - this allowed installation of ancillary equipment, such as disc brakes and spragging gear, which was completed in August.

It was not until August that the first underground area was made available by the National Coal Board when the tension area foundations were laid.

In September, 1983, electrical work in the drive area was commenced with the installation of the control room panels and associated by cabling. After delivery of the drive motors in November, they were assembled, installed and interfaced with the drive unit by January, 1984.

By the time of the miners' strike in March, 1984, the majority of the surface work had been carried out and plans were being drawn up for cable and belt installation. During the 12 months of the National miners' strike, it was not possible to install equipment underground. Work continued, whenever possible, in the drive area. Periodically, the drive unit motors would be run and preventative maintenance was carried out as required.

The remainder of the underground work was completed in March-April 1985. Drive cable installation commenced on 22 April with the pulling on of the pilot rope. It took approximately 18 hours to install the first 5 Km of drive cable and splice it into the second length. This length was pulled on and spliced to form the endless loop in 14 hours. It took approximately the same amount of time to install the second drive cable. The cables were completely installed by 3 May. Although the cables were installed over a period of 12 days, the real time spent on cable installation over that period was approximately 5 working days.

Between the 3rd and 5th May, the conveyor was run to check the functioning of all equipment prior to the installation of belt. This commenced on the 15 May, over five working days to the 22 May the complete belt length of 10 200 m was installed. On the 24 May, the conveyor was run up to 100% speed for 2 half hour periods.

6. COMMISSIONINC

The final stage of the commissioning period was to run the conveyor and check all the line equipment for alignment etc. Tests were then carried out on all monitoring devices to ensure they would operate within the specified tolerances. At the same time the motor control gear was being commissioned. Once these tests were completed, the conveyor was run empty using one or two drive motors.

Once material was available, the conveyor was run under various loading and running conditions, ultimately running at 100% speed with a full load. During the commissioning period the conveyor was run for some 65 hours while checks were being carried out.

Tests confirmed that meshing on the drive unit gears were comparable to the figures obtained when the drive unit was originally assembled in our subcontractor's works prior to being delivered to site. There is 90% meshing on the left-hand final shaft assembly and 100% on the right-hand assembly. Cable Belt specification called for a minimum 75% meshing.

Due to National Coal Board production requirements, they requested that the conveyor be used to carry production material as soon as possible. To date (end of June) the conveyor has operated for 200 hours and over that period carried approximately 200 000 tonnes. Initial readings show that power draw is less than anticipated for the conveyor at this length.

During this period the only significant problem to occur was a brake pad binding on a drive wheel. As a result of inadequate safety monitoring in the main control and a defective smoke detection system, the heat generated caused the brake paths on the Koepe wheel to distort slightly, requiring the brake faces to be re-machined.

7. CONCLUSION

The Selby CABLE BELT conveyor system demonstrates that conveyors are the only practical solution for long distance transport systems due to the high reliability and low operating and maintenance costs of conveyors. As mining operations, both overland and underground, move into more remote areas and (as with Selby), more environmentally sensitive areas, conveyors will have a major role to play in the infrastructure of these operations.

Cable Belt is responding to this demand with a continuous development programme, improving equipment to meet the challenges of these longer and larger applications. The contribution of the National Coal Board to these developments has been significant.