



BELTCON 4

Bulk Materials Handling by Belt Conveyors at New
Denmark Colliery

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Beltcon 4

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Content of Paper

Longwall and Rib Pillar Extraction mined coal is transported by belt conveyors underground, raised to the surface and discharged into 6000 ton concrete silos. The coal is drawn from the silos by variable speed belt feeders and fed to overland conveyors. The overland conveyors discharge run of mine coal into a central 12 000 ton silo. Coal, extracted from this silo, is conveyed to a crushing station where it is reduced to minus 50mm. Crushed coal is then routed to Tutuka Power Station or stockpiled for future use.

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1. Introduction

New Denmark Colliery is situated in the north eastern portion of the Anglo American Group's Standerton coalfield. It is set in the farmland area of the Southern Transvaal between the towns of Standerton, Bethal and Evander.

In this coalfield Amcoal has some 433 million sales ton reserves for the supply of coal to the 3 600 Megawatt Tutuka Power Station. The Mine is designed to produce in excess of 10 million tons of coal per annum, at full output from its central and North Mines and this will be on a continuous basis for the economic life of the Power Station.

The implementation of this major project commenced during the latter half of 1980 with the construction of the first leg of the Shaft System and Associated Infrastructure. This was followed by the Overland System and the Crushing Plant. Crushed coal can be routed to the Power Station or stacked for future use. The stockyard has a total capacity of 3 Million Tons. This stage, known as Phase 1, was commissioned during 1983.

The parallel Phase 2 system at the Central Mine was commissioned during 1985, doubling up the amount of coal to the Crushing Station.

The North Mine Shaft, Infrastructure and single Overland System was commissioned during 1986, thus increasing the tonnage of coal to the Power Station and Stockyard.

2. Synopsis

Almost 30km of belt conveyors have been installed at New Denmark to date for the transportation of a planned production of 833 000 tons per month of coal from New Denmark's Central and North Mines to Escom's Tutuka Stockyard and Power Station.

2.1. Underground

The Mine has planned to extract the maximum amount from the coal

seams, wherever possible, using Longwall; Continuous Miner and Rib-Pillar Extraction mining techniques. The mined coal is transported on standardised constant design parameter belt conveyors incorporating a "meccano set" analogy delivering run of mine coal to underground surge bins.

Variable speed Belt Feeders extract from these surge control bins and, via sacrificial belts, 16 degree Incline Shaft Conveyors elevate the coal 250 metres discharging into 6 000 ton concrete silos at both the Central and North Mines. These silos even out mining surges.

2.2. Surface

Coal, extracted from the 6000 ton silos by variable speed Belt Feeders, is conveyed, via sacrificial belts, to a common 12000 ton silo adjacent to the Crushing Station, by two parallel 3400m long Overland Conveyors from the Central Mine and a single 5700m flight from the North Mine.

Each Overland Conveyor incorporates a belt turn over device to ensure the dirty side of the return belt does not come into contact with the return idlers thus enhancing return belt training and idler life.

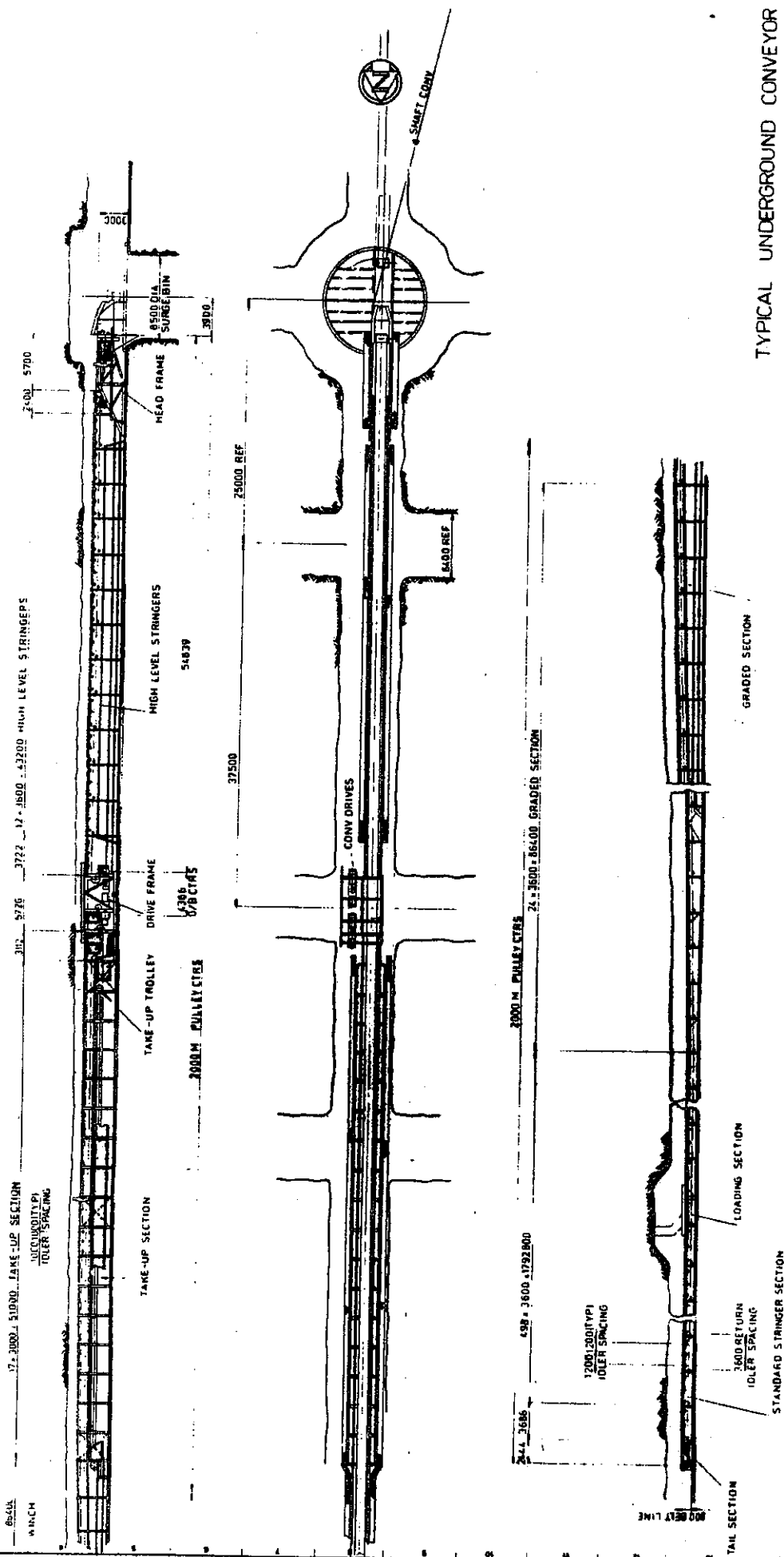
2.3. Crushing Station

Coal, extracted from the 12000 ton silo by Belt Feeders is transported, via Plant Conveyors, to concrete bins at the Crushing Station. Four Rolling Ring Crushers, fed by Belt Feeders reduce the run of mine coal to minus 50mm. The crushed coal is then conveyed directly to the Power Station or to the Tutuka Stockyard.

2.4. Belt Reeling Facility

A Belt Reeling facility, capable of storing 2km of spliced belt, is installed at the brow of each incline shaft and incorporate

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TYPICAL UNDERGROUND CONVEYOR

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the necessary mechanical belt handling equipment to assist in the installation of a new Shaft Conveyor Belt and/or the removal of an old belt from each Shaft Conveyor.

The facility at the North Mine can be adapted and used to perform similar functions at the Central, North and Tutuka Overland Conveyor systems. Permanent foundations and splicing houses are provided and the belt reeling equipment is easily removed from the shaft area and utilised to perform the same functions on the overland belts.

3. Bulk Materials Handling

(Refer to Typical Underground Conveyor Drawing)

3.1. Underground System

The highly mechanised Central and North Mines utilise Continuous-Miner development and Rib-Pillar Extraction, as well as Longwall Retreat mining operations. These mining techniques ensure that the maximum extraction of coal will be achieved.

The sheared coal is crushed and transferred to the Mines' belt conveyor system. The flow of coal is initially carried on Longwall or Section Conveyors and transferred to Gathering Conveyors. Coal from the Gathering Conveyors is fed into surge bins to even out irregular mining peaks. Variable speed Belt Feeders extract coal from these surge bins and transfer to underground bunkers via main Trunk Conveying Systems. The coal is extracted from the underground bunkers and raised, by conveyors, to the surface plant.

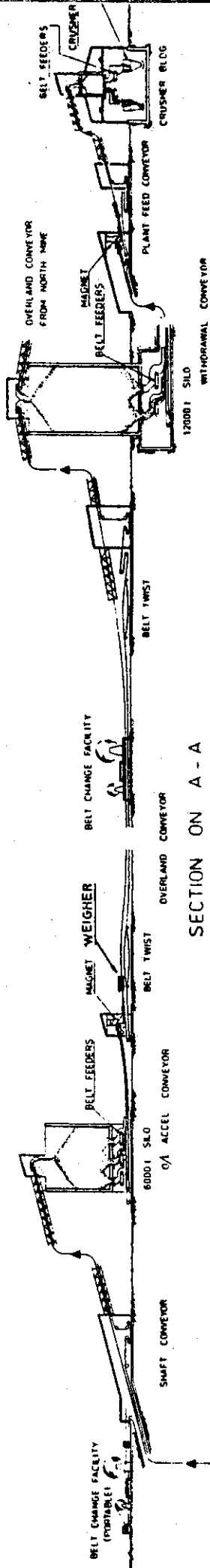
For maximum underground standardisation the various types of conveyors have been designed using the following parameters:

		Longwall & Section	Gathering	Trunk
Final Length	(m)	2 000	2000	2000
Rise	(m)	20	20	20
Capacity	(tph)	1 600	1 800	2 100
Belt Width	(mm)	1 200	1 200	1350
Belt Speed	(mps)	3,45	3,45	3,45
Standard Power Pack	(kW)	240	240	240

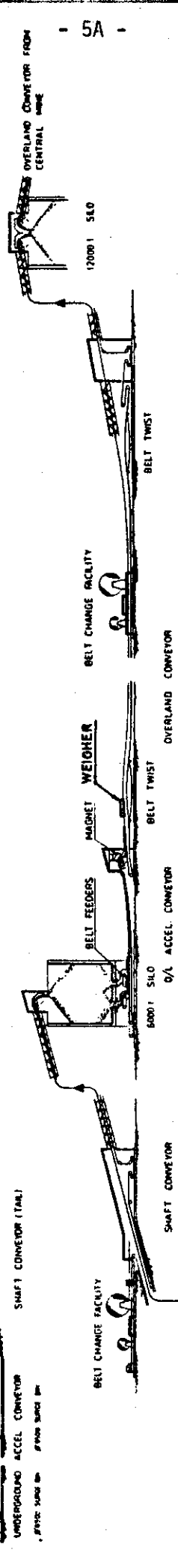
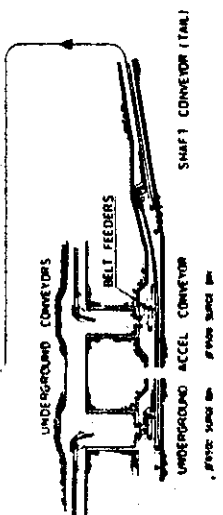
Using these design parameters the Mine has successfully standardised on its underground belt conveyor mechanicals and structures and, using a "meccano set" analogy, each conveyor is lengthened by installing extra standard modules and 240KW power packs to suit the mining activity.

Each conveyor includes the following standardised unit

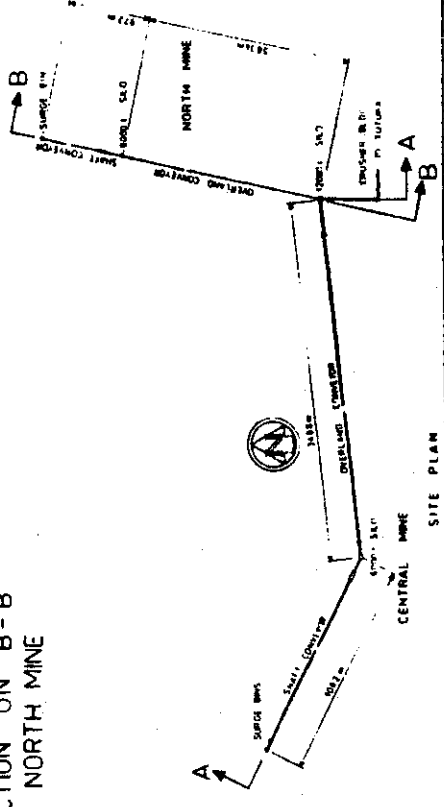
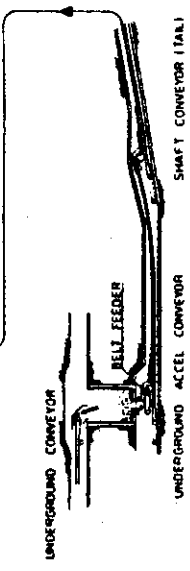
- Extended head end complete with mechanicals.
- High level stringers and idlers.
- Multiple drive frame and pulleys.
- 240KW standard Power Packs c/w fluid couplings.
- Electric winch take-up controlled by load cell.
- Grading section and idlers.
- Receiving hopper with impact idlers.
- Tail end frame and pulley.
- Standard Module and idlers.



SECTION ON A-A
CENTRAL MINE



SECTION ON B-B
NORTH MINE



BELT CONVEYOR SYSTEM
CENTRAL & NORTH MINE
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The coal, stored in the underground bunkers, is transferred to the main incline Shaft Conveyors via variable speed Belt Feeders and Acceleration/Sacrificial Belts, whose design characteristics are as follows:-

		Belt Feeders	Acceleration /Sacrificial
Length	(m)	5,5	130
Rise	(m)	nil	3
Capacity	(tph)	2 400	2 400
Belt Width	(mm)	1 500	1 500
Belt Speed	(mps)	0 to 0,5	4,0
Power Pack	(kW)	1 x 60 DC	1 x 110

The coal is then raised to the surface.

3.2. Surface System

(Refer to Belt Conveyor System Central and North Mine Drawing)

3.2.1. Incline Shaft Conveyor

In the design of the Main Incline Shaft System the following criteria were of paramount importance:

- Well proven, sound materials handling design principles had to be strictly adhered to.
- Structural design to cater for high belt tensions.
- Cost Effective solutions to be implemented.
- Investment in spare parts to be minimal.
- Downtime, repair and maintenance costs to be minimal.
- Avoid massive tension fluctuations in the system thus reducing potential problem areas.
- System to be adaptable to ensure continual operation.

These sound fundamentals were basically achieved by :

Multiple Drives

A multiple drive arrangement was selected with 4 x 600kW power packs driving each shaft belt. This arrangement:-

- Resulted in lower operating tensions.
- Smaller and less expensive spare components could be stocked eg 1 set of bearings for 12 Shaft Conveyor Power Packs.
- Should one drive unit become unserviceable the system would still operate at a reduced capacity.
- Maintenance facilities would be smaller to cope with the reduced mass of equipment.
- Spares for smaller units more readily available.

Drive Stations

Drive Stations are located at ground level thus ensuring:

- Easier maintenance of drive units.
- Reduction in loads to be carried by cantilever head and boom above concrete silo.
- Elimination of any induced belt tensions being transferred to concrete silo.

Drive Components

Drive Components were selected using 4 pole squirrel cage motors each driving a right angled helical gear unit via scoop controlled variable speed turbo couplings fitted with extra oil cooling. This type of variable fill fluid coupling is particularly relevant to conveyors requiring very protracted start up times, having high installed power or requiring close control of the starting torque.

The couplings were selected to meet various design criteria with the three most important being:

- Gradual and controlled torque build up to "breakaway" in both the empty and loaded condition.
- Adjustable peak torque limitation during the acceleration sequence.
- Belt inspection is easily achieved by controlling the slip of the scoop trim type coupling. This allows the empty belt to be run at a reduced speed (0.5mps) for visual inspection of the belt.

Other notable advantages in the use of such couplings include:-

- No load start up of motors.
- Load sharing during conveyor start up and continuous running.
- High thermal capacity thus allowing long start up times.
- Overloaded conveyors can be started by adjusting the peak torque limitation.
- Low speed belt pulling.

Since the Shaft Conveyor discharges into a 6000 ton concrete silo brakes were not fitted to the power packs.

The design characteristics of the Shaft Conveyors are:

		Central Mine Shaft Conveyor	North Mine Shaft Conveyor
Length	(m)	988	925
Rise	(m)	252	244
Capacity	(tph)	2 400	2 400
Belt Width	(mm)	1 350	1 350
Belt Speed	(mps)	4,29	4,29
Power Pack	(kW)	4 x 600	4 x 600

The coal stored in the 6000 ton concrete silos, at Central and North Mines, is transferred to the twin 3400m Central Mine Overland Conveyors and the single 5700m North Mine Overland Conveyors via variable speed Belt Feeders and Accelerator/Sacrificial Belts, whose design characteristics are as follows:-

		Belt Feeders	Acceleration /Sacrificial
Length	(m)	5,0	62
Rise	(m)	nil	2,5
Capacity	(tph)	1 000	1 500
Belt Width	(mm)	1 500	1 350
Belt Speed	(mps)	0 to 0,5	3.25
Power Pack	(kW)	1 x 30 DC	1 x 55

NB Two feeders in tandem supply 1500 tph to Accelerator/Sacrificial Belts.

The coal is transferred to the Overland System via chutework. Overhead magnets remove tramp iron from the system.

3.2.2. Overland Conveyors

In the planning of the Overland System the design criteria, multiple drives, drive station and drive components as fully discussed under Incline Shaft Conveyor were strictly adhered to .

Behind the electric winch take-up controlled by a load cell, a belt turn over device has been incorporated. This simple device incorporates mangle rolls and sets of idlers in frames which can be rotated through 360 degrees. The belt leaving the take-up is turned over to ensure the dirty side of the return belt does not come into contact with the return idlers thus enhancing return belt training and idler life. Immediately before the tail pulley the reverse procedure takes place.

Due to the underground mining, where the maximum amount of coal is extracted, there is the continual problem that the overland route may subside. Each stringer support structure is designed to easily overcome this potential hazard.

A weighing machine is installed near the tail end to monitor the tonnage of coal transferred to the 12000 ton silo. This silo is common to both the Central and North Mines.

The design characteristics of Overland Conveyors are:

		Central Mine Overland Conveyor	North Mine Overland Conveyor
Length	(m)	3 400	5 700
Rise	(m)	27	27
Capacity	(tph)	1 500	1 500
Belt Width	(mm)	1 050	1 050
Belt Speed	(mps)	4,7	4,7
Power Pack	(kW)	2 x 500	3 x 500

3.2.3. Crushing Plant

The coal stored in the 12000 ton silo is transferred to the Crushing Plant concrete bins via variable speed Belt Feeders; Withdrawal Conveyors and Plant Feed Conveyors whose design characteristics are as follows:-

		Belt Feeders	With-drawal	Plant Feed
Length	(m)	5,0	124	195
Rise	(m)	nil	26	15
Capacity	(tph)	1 800	1 800	1 800
Belt Width	(mm)	1 500	1 500	1 500
Belt Speed	(mps)	0 to 0,5	2,79	2,79
Power Pack	(kW)	1 x 30DC	1 x 220	1 x 220

Coal is extracted from the concrete bins by variable speed Belt Feeders and fed at 1500tph into four Rolling Ring Crushers. The run of mine coal is reduced to minus 50mm and the crushed coal can be conveyed directly to the Power Station or the Tutuka Stockyard.

Belt Feeder design characteristics are as follows:

		Belt Feeders
Length	(m)	3,0
Rise	(m)	nil
Capacity	(tph)	1 500
Belt Width	(mm)	1 500
Belt Speed	(mps)	0 to 0,5
Power Pack	(kW)	1 x 30DC

3.2.4. Belt Changing Facility

In order to reduce down time for belt replacement a belt changing facility has been installed at the shaft brow of the Central and North Mines. The facility consists of a splicing table and belt storage drums. The advantages of this system are that the individual rolls of belting are spliced together forming one continuous length. The new belt is securely attached to the old belt and run into position. The system is fitted with a dual braking system and easily handles a total belt length of over 2000 metres and weighing in excess of 100 tons. One operator controls the belt drum and strategically placed observers provide progress feed back during belt installation. As the new belt is pulled on the old belt is fed onto wooden drums.

This facility was also used to pull on the initial belt and it is noteworthy that it took a total of 10 days from start to finish including 8 splices.

The facility designed for the North Mine is demountable and can easily be transported, adapted and used to perform similar functions at the Central, North and Tutuka Overland Conveyors.

4. Notable Design Features

4.1. Civil Engineering Design Aspects For Silos and Overland Conveyor

Due to the geology at New Denmark, some special design features had to be adopted.

- The black soil in most parts of the area made the passage of vehicular traffic impossible in wet weather. Access roads and hard standing areas had to be built on all construction sites.
- The Overland Conveyor stringer steelwork had to be piled every 3 metres and the conveyor stringer support structures designed with flanged connections to facilitate re-alignment of the conveyor after surface subsidence has taken place due to coal extraction by Longwall mining methods.

Silos

- In order to find the best practical and most cost effective solutions it was essential that the design concepts for the Civil Engineering Structures, such as the silos, remained flexible and easily adaptable to unforeseen changes due to ground conditions.
- The 6000 ton silo cylindrical shell was built on a very heavy raft foundation. A novel feature was incorporated with vertical columns supporting the internal floor slab and the floor support columns were

split in order to reduce the stiffness so that no unduly heavy moments would be induced into the slab. The silo floor is also free of the cylindrical shell sections to allow for unforeseen movements.

- The 12000 ton silo was eventually founded at a level 15 metres below natural ground level. It was originally intended to build a 12 000 ton open conical stockpile with an under tunnel founded at minus 17 metres. During construction, however, unforeseen ground conditions, such as a major geological fault running through the excavation site, dictated a change in design from an open stockpile to a concrete cylindrical silo concept. A 25m diameter silo by 49 metres high and founded 15m below natural ground level presented the best solution under the circumstances.
- An unique feature in the design of this very large silo was the necessity to design for outside pressure on the silo walls below natural ground level. A design concept to support the floor slab on columns independently of the cylinder wall was adopted to facilitate sliding construction from the foundations upward without interference of an internal slab.

4.2. Shaft Conveyor Structure

The Incline Shaft Conveyor emerges from underground into a Drive House on the surface and continues upwards through a series of gantry bridges to the top of a circular concrete silo into which the run of mine coal discharges.

The major structural steel elements supporting the belt are stringers, head frame, drive frame, take up frame and gantries supported by trestles.

Design work was fully in accordance with SABS 0162 - 1984 "Code of Practice for the Structural Use of Steel" and loadings fully in accordance with SABS 0160 - 1980 and Anglo American specified design requirements.

Allowances were made for temperature effects, but of prime significance is the considerable forces induced into the structure from the belt tensions. It is worthy of note that the head pulley frame was designed to cater for 1 400kN.

This load was considered too large to impose on the concrete silo and it was decided to provide the necessary resistance, via the inclined gantry stringers, linking to the drive frame at ground level. The total length of the high tensions stringers are in excess of 100 metres. Braced universal columns were used for stability reasons and supported on hinged posts at 3 metre intervals, thus catering for the longitudinal shortening from high compressive stresses.

4.3. Control and Instrumentation

The mine supplied power at 11kV to the Drive Houses where it was transformed to 3.3kV for the conveyor drive motors and crushers and 550V for all auxiliary motors. Underground all drives greater than 5.5kW were run off a 950V supply and the smaller motors off a 380V supply.

The Incline Shaft and Overland Conveyor drives comprise multi-drive units using scoop couplings. The entire control and supervision was effected via Programmable Logic Controllers (PLC) having a Master Visual Display Unit in the Main Control Room.

Prior to start up the Central Control Room Operator would check the condition of the conveyor system and, on initiating a start command, a prestart warning sounds along the full length of the conveyors after which all the relevant auxiliary motors start up followed by the controlled run in of the main drives via scoop couplings.

The system is designed such that it has full electronic back up for manual operation should the PLC's fail. All safety devices and stop circuits are hard wired for additional safety.

4.4. Belt Rip Detection

Built into the bottom covers of the Shaft and Overland Conveyor belts are relatively small figure eight conductive loops known as Sensors. These Sensors are at 50 metre pitch on the Shaft Conveyors, 100 metre pitch on the Overland Conveyors and are installed across the width of the belt from edge to edge.

A pair of Detector Heads are mounted on the conveyor structure immediately following the high risk damage areas. These Heads are positioned about 100mm below the belt's non carrying surface and are aligned with the Sensors loops at each edge. A cable connects the detector to the conveniently located Control Unit.

As a good Sensor passes over the Detector an output pulse is generated. A continuous series of good Sensors passing over a Detector causes a continuous series of Detector impulses. Each Detector pulse resets a timer in the Control Unit. If a Sensor is cut (open circuited), due to belt damage, the timer will not reset and the Control Unit will issue a belt stop command immediately to the Conveyor Controls.

For maintenance purposes a belt rip can be simulated by placing a metal plate between the Detector Head and the surface of the belt. This prevents an output pulse from being generated and shuts the belt down.

4.5. Removal of High Tension Pulleys

The removal of drive or high tension pulleys from any belt conveying system for maintenance or repair is a time consuming and tedious process and this is particularly so in the confined space of a inclined shaft belt. The Shaft Conveyor head and drive pulleys at New Denmark have a resultant belt tension of 1400kN and a system has been developed and patented in which these high tension pulleys can be relatively easily removed. The method of removing the drive or head pulley includes the steps of clamping the belt in strategic places and removing the tension

from the conveyor belt. This allows the relevant terminal pulley to be disconnected from its mounting, easily removed and another pulley quickly installed. This simple solution is now being implemented at New Denmark.

5. Concluding Remarks

Almost 60km of South African manufactured conveyor belting moving over 25000 locally produced conveyor idlers efficiently transports coal, at a rate in excess of 800 000 ton per month, to Tutuka Power Station. The Material Handling Contract, which included design, manufacture and installation, is one of the largest of its kind awarded to a single Contractor in South Africa. It proves conclusively that our local industry has the necessary expertise and engineering dedication to tackle every discipline associated with the Bulk Handling of material on belt conveyors. This plant shall transport coal, to Tutuka Power Station, well into the 21st century, and New Denmark Colliery shall justifiably be remembered and referred to as "THE COAL MINE OF THE EIGHTIES".

6. Acknowledgement

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