

**THE DESIGN AND IMPLEMENTATION OF THE
LSL / TEKPRO DUAL CARRY OVERLAND CONVEYOR**

by

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INTRODUCTION

The main overland system feeding Run Of Mine sands to the Primary Concentrator Plant at the East mine of Anglo American's Namakwa Sands operations on the West Coast of South Africa, consisted of three flights of conveyors over a combined length of 3 km. Tailings from the plant were trucked over a similar distance, for deposition and rehabilitation of the mine site. It was realized however, that this distance would increase rapidly in the near future, and trucking costs were certain to escalate as a result.

Three options to reduce future operating costs were available to the mine:

- Move the Primary Concentrator Plant closer to the mine
- Install a return conveying system for the tails in parallel with the ROM feed conveyors
- Install a dual carry conveyor to replace the existing system

Despite the Primary Concentrator Plant being moveable in theory, in practice this would have been an extremely difficult and expensive exercise, and was no longer considered feasible. To install a separate return conveying system for the tails in parallel with the ROM feed conveyors would give rise to low availability and twice the amount of hardware.

The logical choice was therefore the Dual Carry Conveyor option. A search revealed that this type of conveyor is very rare throughout the world. Installations identified were

- A retro-fitted dual carry handling sulphur at the Indian Ocean fertilizer operation at Richards bay. This is a relatively short conveyor and has a complicated profile.
- The large declined system at Prosper Haniel in Germany
- The long overland dual carry system at Port Hedland, Western Australia, which handles incoming iron ore and outgoing iron briquettes.

The decision to proceed with the project at Namakwa Sands was made after Anglo American engineers and the author visited the system at Richards Bay and the 2-way conveyor at Port Hedland, Australia, in May 2001. This conveyor was seen to be operating satisfactorily despite being somewhat complicated.

This paper describes the design and implementation of the highly successful Dual Carry Conveyor (DCC) installed by Tekpro Projects at Namakwa Sands.

THE DUAL CARRY CONVEYOR

Criteria

Initial length	(one way)	3.5km	(6km initial conveying distance)
Final length	(one way)	7.5km	(14km final conveying distance)
Elevation change		28m	
Ground profile		Undulating	
ROM feed rate		1000 t/h	
Tails feed rate		991 t/h	
Belting specified		1050 mm wide St1250 8 x 5 (mine standard)	
Preferred speed		3.5 m/s	
Operation		Continuous for ROM & Tails simultaneously	
Selected idlers	overland modules	152 dia series 30 3 HDPE rolls for both strands	

Selected idlers	horizontal curves	127 dia series 25, 3 steel rolls (ROM) 2 steel rolls (empty)
Idler spacing	(Overland modules)	4.5m top and bottom on common free standing columns

Requirements to be met

In order to be a success, it was considered very important that the following requirements were met:

- The conveyor has to be extremely easy to maintain despite its length.
- The absolute minimum number of pulleys could be used.
- The (nominally dry) ROM has to be loaded on the top strand, but ideally thereafter be transported on the bottom strand for the majority of the conveyor's length, as this would be effectively protected from the wind, which would prevent or at least minimise the wind losses which were previously experienced.
- The highest availability is considered mandatory.
- The dual carry conveyor has to be operable in an overall system. For example, once the ROM and the Tails are both fed onto the conveyor, they cannot be isolated from each other, and they have to be handled downstream simultaneously. If either the ROM or Tails cannot be handled in the context of the entire system, then the whole system would stop which of course would be out of the question. The design of the overall system is therefore as important as the design of the DCC itself.
- The operating and control philosophy has not only be very simple for starting operating and stopping, but also had to be implemented without disruption to the operation of the plant.
- Good housekeeping was given as being mandatory despite transporting dry dusty ROM together with wet tails having 16% to 20% moisture content, which has a strong tendency to cling to the belt.
- The system has to be low risk
- To win on an open tender basis, the system had to be extremely competitively priced, but of the highest quality.
- The DCC is required to be easily extended, with the minimum of down-time during extensions.

The design of the evolved system

The LSL/Tekpro Dual Carry Conveyor system met all of the design criteria as well as all the above additional requirements. As an indication of how this was achieved, the Process Flow Diagram, as well as a 3 dimensional sketch of the plant, are appended to this paper.

The arrangement of the Dual Carry Conveyor itself is as follows:

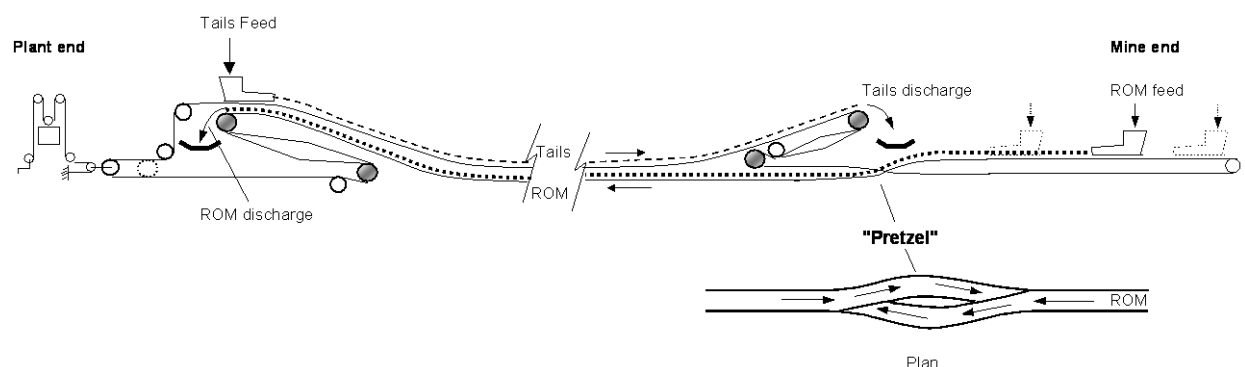


Figure 1. Dual Carry System features

The tails arrives at the DCC at a high level, as the feed conveyor has to cross an area frequented by haul trucks. The DCC therefore lends itself perfectly to the transport of tails on

its top strand. The ROM is mostly dry and dusty, and consequently lends itself perfectly to its transport on the lower strand, being more protected from the wind.

Computer models

Two computer models were set up in-house. One computer model determined the dynamic behavior of the conveyor itself for all load conditions for starting, running and stopping for the initial length of the conveyor as well as for the future extensions. The other computer model was for the simulation of the multiple horizontal curves in the “Pretzel” for all loading and weather conditions. Once the models provided proof that the conveyor would operate reliably under all conditions and had provided the required information for the detailing as well as equipment positioning and selection, the results obtained were then passed on to Professor Alex Harrison of Scientific Solutions Incorporated for him to audit. Professor Harrison set up his own independent computer simulations, and since the two independent sets of results concurred very well, the detail design was completed, and the conveyor system was implemented.

The “Pretzel”

One key element in the arrangement of the DCC is the area known as the “Pretzel”, where the top and bottom belts of the conveyor actually swop over through a series of four vertical and six horizontal compounded curves in a section less than 200m long. Because of this feature, the ROM, which is loaded in the normal way on the top belt, is actually transported for the majority of the conveyor’s length on the protected bottom belt, which is relatively protected from the wind. Also, the number of pulleys reduces dramatically from a typical value of 22 (for example at Port Hedland) to only 10.



Figure 2 The LSL /Tekpro “Pretzel” (The tail of the old one-way ROM system is on the left)



Figure 3 ROM in the Pretzel area

The idlers in the Pretzel section are series 25 steel roll type 127mm in diameter and spaced at 1.5m. They are super-elevated to nine degrees for both the two and three roll configurations. For flexibility, the super-elevation is adjustable via slots in the idler frames from eight up to ten degrees. As figure 3 indicates, the belt tracking through the horizontal curves of the Pretzel is extremely good, proving the accuracy of the theoretically calculated Pretzel idler frame super-elevation of 9° , as well as the forward tilt.

The overland section

The majority of the overland portion of the conveyor is made up of simple free-standing modules at 4.5m centers on concrete “dog-bone” sleepers, and are connected only by sheeting.

The idlers are 152mm diameter HDPE 3- roll series 30, mounted in belt friendly idler frames.

Figure 4 shows the overland modules before sheeting was installed:



Figure 4. Typical Line Stand and Sleepers

Belt turn-overs and Drives

For convenience, and to reduce the number of high tension bend pulleys, the position of the belt turn-overs was also selected to be in between the two drive units at each discharge point of the conveyor. Because of this, there are actually no high tension bend pulleys at all required to serve the drives, despite there ultimately being four 400kW drive units fitted. The two belt turn-overs are each 25m long.



Figure 5. Plant end Structure.

The tailings load onto the belt is shown on top, with the ROM strand underneath and above the turn-over. The counterweight tower is in the background.

Other key design aspects

The main take-up for the DCC is at the plant-end only, as illustrated in figure 5. Because of this, when the conveyor reaches its full length, two of the four 400 kW drive units will be nearly 7,5 km away from the take-up. This gave rise to the following design aspects:

- 1) How can the correct slack-side tension be guaranteed on the mine end drives nearly 7,5 km away from the take-up?
- 2) How can the effective tension from the two 400 kW mine-end drives be prevented from lifting the counterweight during starting and running when the top tails strand is empty?
- 3) How can load sharing be guaranteed between all four drives?
- 4) How can the “Pretzel” be guaranteed to operate correctly and properly track the belt for varying tensions, weather conditions, number of drives installed, for all the different load cases.

The answers to all the above aspects relate to two considerations, namely the results of the simulation of the conveyor for all the lengths and load cases for which it will operate, together with the variable speed drive (VSD) system installed with its control. It became apparent during the design and simulation that the use of a state of the art electrical variable speed system would be highly beneficial. As a result, the speed of each drive is kept identical, and the drive torque is proportioned as required.

The control system is such that the mine-end drives will always produce 80% of the torque that the plant-end drives produce. In other words, the mine end drives always do 44% of the total work required, and the Plant end drives adjacent to the take-up always do 56% of the total work required. In this way, it is not possible to over-stress the belt or lift the counterweight through an adverse belt tension distribution.

The start-up time has been set to 300 seconds. This gives an exceptionally smooth start-up, and ensures good counterweight behaviour even during an aborted start. The VSD is also used to ramp down the conveyor during normal stopping. This has been set to 18 seconds, and not only produces a very smooth stop, but also ensures that the discharge chutes are never overfilled. The volume of the two DCC discharge chutes is such that they are also never overfilled even during a power failure or emergency stop, in which case, the stopping time is interestingly enough, actually *longer* than for a normal controlled stop.

With the above design, there has never been any evidence of any dynamic transient tensions propagating through the belt.



Figure 6. The Plant end with feed to ROM Stockpile

Pulley maintenance

When the counterweight is lowered by means of the manually operated electric winch in the counterweight tower, the slack in the belt enables the plant end pulleys to be maintained. This slackness in the belt extends for approximately one kilometer, which means that the belt remains very taught thereafter. For ease of maintenance of the pulleys situated towards the far mine end of the conveyor, (which is a great distance from the take-up at the plant end), the terminal pulley has been mounted on a sliding frame. When the locating pins are removed from this frame, it simply slides along a pair of rails providing the necessary slack in the belt where it is required.

Commissioning

The variable speed drives were commissioned prior to the conveyor start-up by simply disconnecting the high-speed couplings.

The idlers and pulleys were all lined up using LSL/Tekpro's aligning device which incorporates a telescopic gun-sight and which has proven to be so accurate, that no belt training was necessary. The gun-sight is mounted on a stand, which in turn is mounted on a short length of angle iron, and finely adjusted such that the gun site is at exactly 90° to the angle iron. The device is placed on top of, and in the middle of a central idler roll. By sighting through the scope, one can see far into the distance down the conveyor.

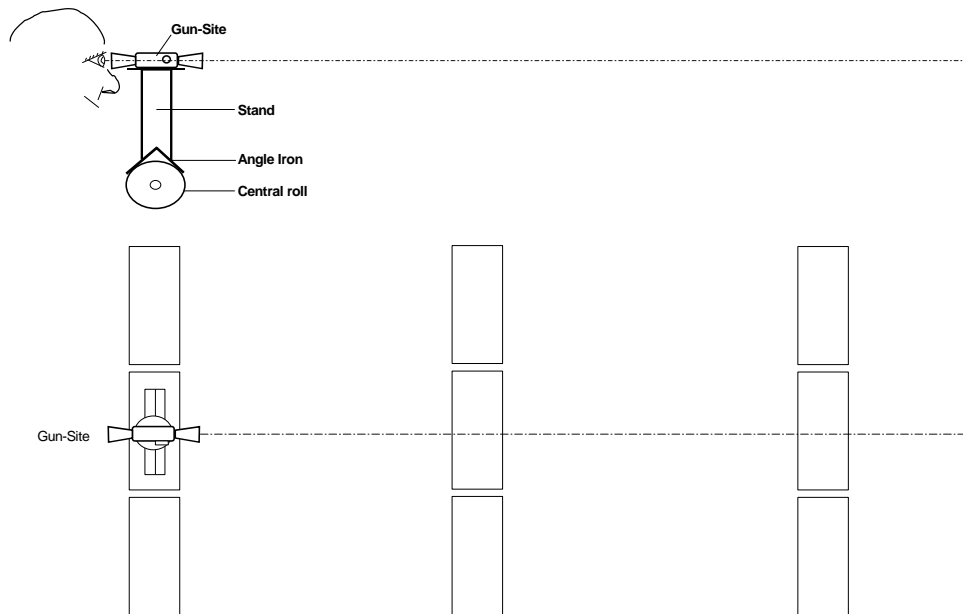


Figure 7. Gun-sight alignment tool

The idler frame carrying the roll on which the gun-site is mounted is simply adjusted until the vertical cross wire is on the center-line of the conveyor in the far distance. The idler is therefore now set in exactly the correct alignment. The same device was used to align the pulleys as well.

Because of the attention to the detail that went into the design, installation and alignment of all the conveyor elements, commissioning the conveyor was a case of simply starting it up and ironing out a few bugs in the intelligent on-board belt protection and safety system.

The “Pretzel” behaved exactly as designed and required no adjustment.

Operation

At the time of writing this paper, the conveyor has run for five months, and the following aspects are now apparent:

- 1) The conveyor has a high availability.
- 2) It is easy to operate.
- 3) The wet tailings on the upper strand takes on a large amount of water when it is raining. In addition, the high moisture content of the tailings results in the moisture puddling to the surface of the burden, as the material traverses over the idlers.
- 4) The Pretzel operates well under all weather conditions.
- 5) Primary belt scrapers are not suitable on wet tailings, especially when there are lumps of rock present. These can jam between the scraper and the belt and are a potential source of belt damage.
- 6) Due to its location, the conveyor is susceptible to being buried in windblown sand.
- 7) At one location along the conveyor the idler seals and subsequently the idler bearings are suffering due to the presence of a considerable amount of extremely fine and very abrasive wind blown sand.

CONCLUSION

The LSL Tekpro Dual Carry Conveyor has taken several proven design principles, and incorporated them into one highly successful conveyor. By thoroughly simulating the conveyor on the computer, whilst at the same time simplifying the arrangement to the absolute maximum, the result is a totally unique conveyor with high availability, low capital and operating costs and low risk.

There can be no question that well designed and properly implemented Dual Carry Conveyors of this type have a significant role to play in the future of materials handling.

THE AUTHORS

Graham Spriggs is the Chief Mechanical Engineer of the materials handling consultancy LSL Consulting (Inc.) which he joined in 1982. He is also the Chief Mechanical Engineer of Tekpro Projects (Pty) Ltd., which was formed in 1986 as the contracting division of the parent consultancy.

His experience in major conveying installations is world wide, and is a specialist in conveyor dynamics and the design of long and horizontally curved conveyors.

He has presented numerous papers relating to the loadings on structures brought about by major conveying systems, and lectures in South Africa for the Masters Design Course in belt conveyor design initiated by TUNRA from the University of Newcastle in Australia.

Graham Shortt is quite tall really.