

Operating a Continuous Haulage System at United Colliery

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INTRODUCTION

United Collieries Pty Limited is an Australian mining company operating one underground coal mine, United Colliery at Warkworth in the Hunter Valley district of New South Wales. Centrally positioned, United Colliery is adjoined by other coal mining operations and is located 80km north - west of Newcastle and 20 kilometres south - west of Singleton. (Fig. 1) High standard road and rail links provide ready access to customers and suppliers.

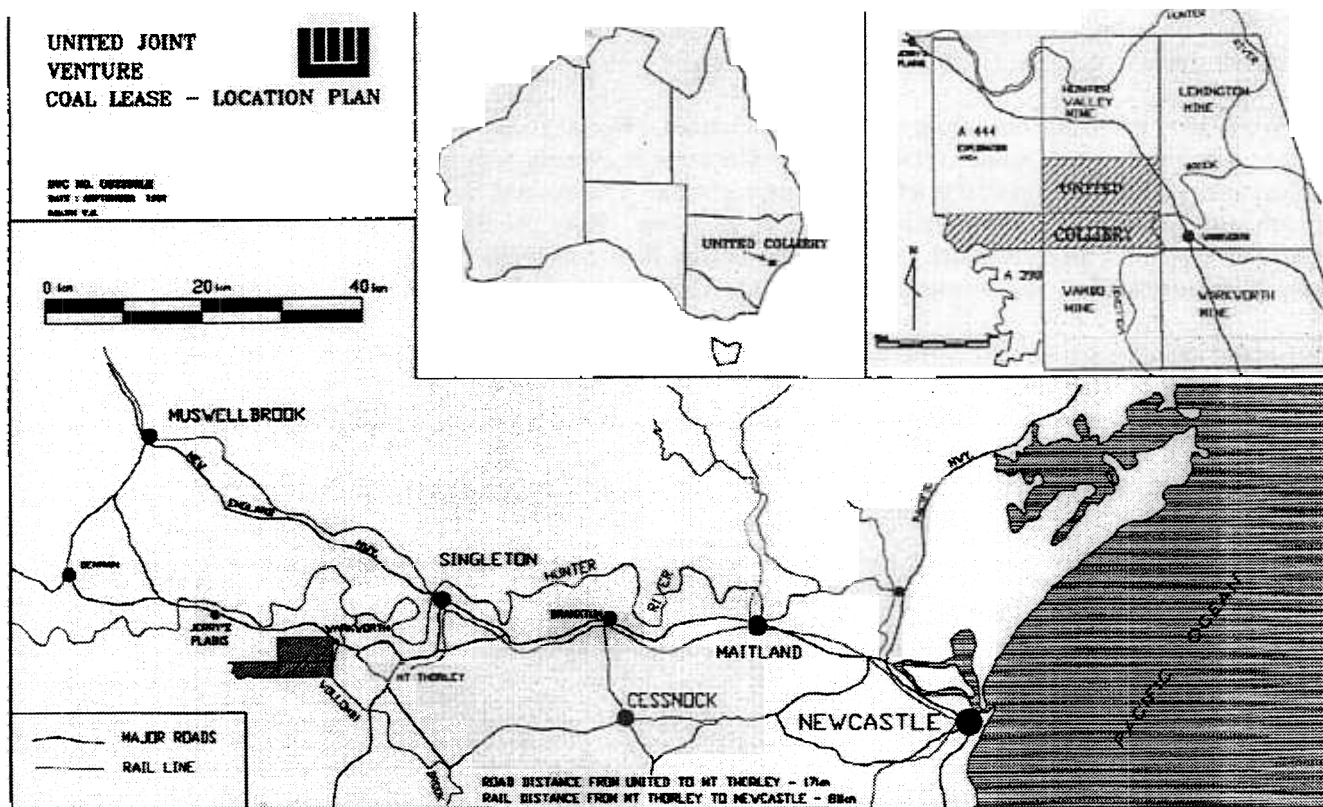


Fig.1 - Location plan

United Collieries Pty Limited is a joint venture between the United Mine Workers (CFMEU - Mining and Energy Division) and Abelshore Pty Ltd. The involvement of a union, in this instance the United Mine Workers, as a joint venture

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partner and shareholder in a mining operation is understood to be unique in the world. An exploration authorisation was granted to the Australian Coal and Oil Shale Employees Federation in 1979. This area was a replacement for the Nymboida colliery lease which had been worked by the union until reserves were exhausted. The authorisation covered an area of approximately 10 square kilometres and contained both open cut and underground reserves in many seams. Open cut reserves however were insufficient to warrant the development of a major opencut mine and the majority of reserves were accessible only by underground mining.

A resource rationalisation with the adjacent Wambo mine took place in April 1991. Wambo gained four of United's open cut coal seams and United gained access to an area of one seam within Wambo's lease, the Woodlands Hill. The reserve reallocation allowed Wambo to expand their existing open cut mine and United to develop a viable underground mine, initially in the Woodlands Hill seam, with potential to later mine other seams.

GEOLOGY AND RESERVES

Coal seams within United's lease belong to the Permian Age Wittingham Coal Measures. They are overlain and interbedded with hard competent sediments consisting of mudstones, siltstones and sandstones. In-situ resources of 262Mt in 9 seams have been delineated within the lease including 106Mt in the Woodlands Hill Seam. An adjoining authorisation area is being explored for both underground and open cut development potential.

The Woodlands Hill is the only seam currently being mined. Working height ranges from 2.5m in the far north of the lease to 4.3m in the south west, averaging 3.6m. The seam is overlain with mudstone and to assist with roof control approximately 300mm of top coal is left against the mudstone. The working floor is composed of approximately 200mm of carbonaceous mudstone underlain by siltstone or sandstone. Floor conditions have generally been good due to the comparatively strong floor material. Occasionally broken floor conditions have resulted from loss of floor horizon, generally in intersections, and in faulted areas where the floor strength is usually lower.

OPERATIONS

Development of the underground mine commenced in 1991 with the drivage of entries to the Woodlands Hill seam, 80 metres below the surface, and construction of surface infrastructure including mine fan, administration and bathhouse complex.

Production started in January 1992 with one continuous miner unit. The mine was expanded in October 1995 with the introduction of a second unit extracting pillars using mobile roof supports. In November 1996 a third unit commenced operation and surface infrastructure was expanded including a new mine fan and extensions to administration, stores and bathhouse areas.

MINING METHODOLOGY

Mine development commenced in January 1992 utilising Joy 12CM12D continuous miners fitted with "on board" roofbolters loading into two shuttle cars. The continuous miner would cut out for 6 metres and then cutting would cease while the roof was supported. Average productivity was 540 tonnes per unit shift.

In pursuit of improved productivity the system was modified in October 1993 with the introduction of a "dual miner panel" system. This system utilised two continuous miners used alternately with roof support being erected in one face while production continued at an alternative face. Three shuttle cars were used in the section but only two on production at any time. Average production increased to 1,060 tonnes per unit shift.

In April 1994 the "cut and flit" system of mining was introduced with three shuttle cars used continually. Average productivity to date is approximately 1,200 tonnes per unit shift with a peak of 2,829 tonnes in an eight hour shift.

Current mining operations are based around three continuous miner sections. Two units, one on development using the cut and flit system and the other on pillar extraction, both utilise shuttle cars to load coal from the continuous miner onto the panel conveyor belt. The third unit operates in development using the cut and flit system but utilises a chain type continuous haulage system instead of shuttle cars. In 1998, run of mine output of two and a half million tonnes is planned off the three units.

CONTINUOUS HAULAGE

In 1997 United purchased a Chain Haulage System to be used in both cut and flit development and subsequent pillar extraction. The system is 103 metres long and will increase the productivity of both cut and flit development and pillar extraction to approximately 2,500 tonnes per unit shift.

Joy Mining Machinery was the successful tenderer from a group of three suppliers, all from the USA. The Joy system was selected after an exhaustive tender evaluation.

Tender specifications included the following requirements:

- Carrying capacity of 30 tonnes per minute (to match the rated capacity of the continuous miners);
- A minimum length of 100 metres;
- Ability to gain NSW approval which would include many safety requirements in excess of the American systems;
- Radio remote control of the inbye unit;
- PLC control;
- Visual display of the machine status in each operators cab;
- Ability to work on in 5 grades;
- Ability to operate in 5.0 m roadways with square (90 degree) intersections;
- Sound mechanical and electrical design;
- Tight delivery schedule;
- Strong support from the manufacturer; and
- Competitive price.

A representative working group consisting of a cross section of United employees visited six (6) high productivity mines using continuous haulage systems in the USA. The manufacturing plants of the three tenderers were also inspected. The experience gained by the visit not only assisted the working group in carrying out an extensive evaluation process, but it was also invaluable in customising a haulage system to United's requirements. Observations made in the American mines also assisted in the development of plans and procedures for safe and efficient operation of the system at United.

The continuous haulage system shown in Fig. 2 is made up of the following components.

1. 1 x breaker mobile bridge carrier
2. 4 x mobile bridge carriers.
3. 5 x bridges

- 4. 1 x belt dolly
- 5. 120 of metres of rigid belt frame.

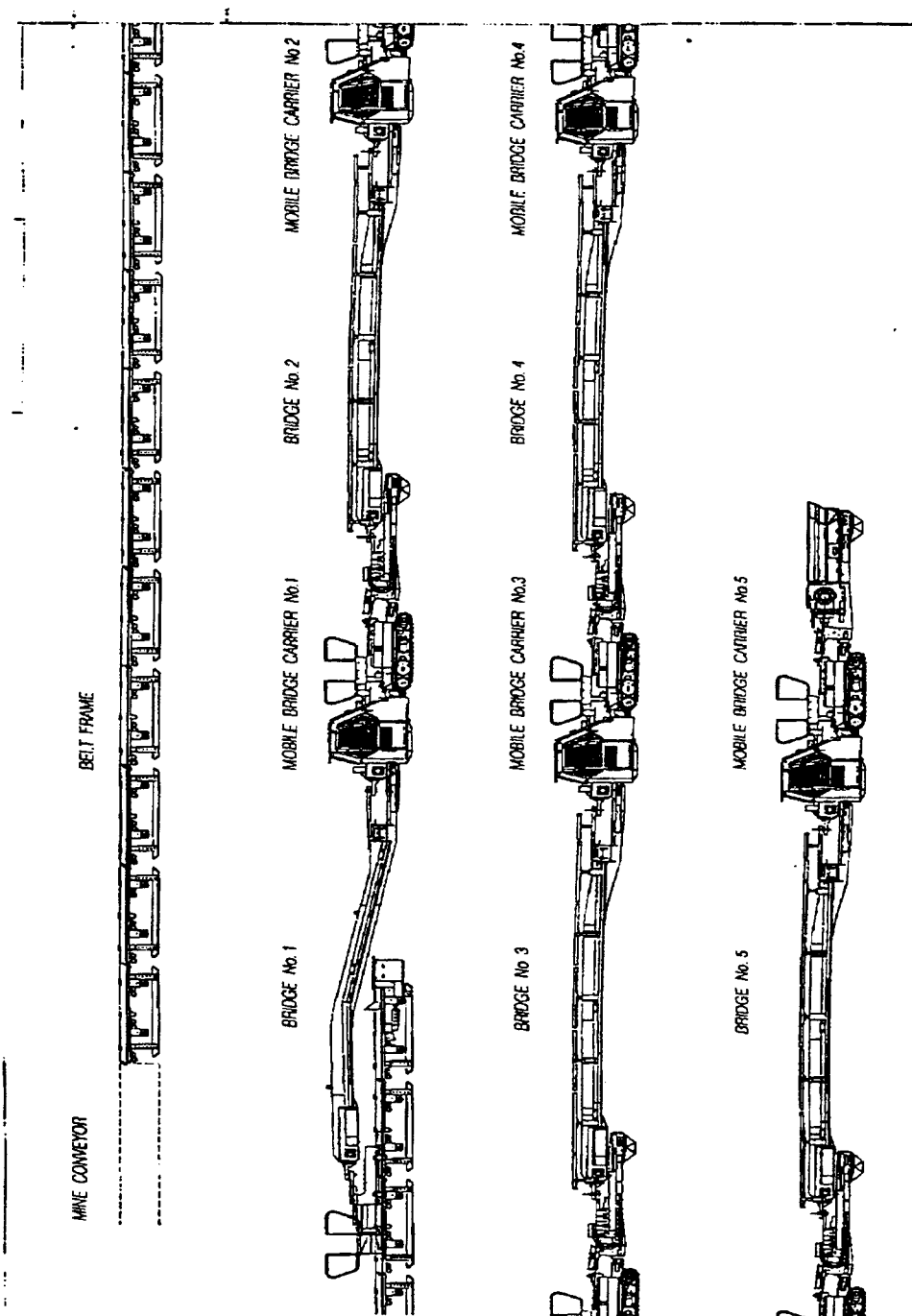


Fig.2 - Chain haulage system general arrangement

United's continuous haulage system is the first equipped with a sophisticated Joy JNA computer control system, providing onboard computer control of overload levels, start-up sequences and various safety features. The computer system also

provides each operator with information on the operational status of the whole machine and assists in diagnosing system faults. United's continuous haulage is fitted with a voice communications system linking each haulage operator to the continuous miner operator, other crew members and section visitors.

The inbye unit is equipped with radio remote control which enables that unit to operate beyond the last roof support. This feature allows the current maximum seventeen (17) metres cut to be achieved with the inbye unit operator remaining in his cab under supported roof, and provides the potential to increase the depth of cut to as much as thirty six (36) metres as experience is gained with the system.

Successfully extending the depth of cut significantly beyond the current seventeen (17) metres will require issues such as directional guidance and horizon control of the miner to be addressed.

Technology addressing some of the issues of deep cut mining is currently being developed by Joy Manufacturing for highwall mining, and United is working with Joy in assessing the applicability of that technology in the continuous haulage operation. Installation of television cameras on board the continuous miner is being considered as a means of enhancing driver vision when deeper cuts are used.

Panel design

The first panel (five heading layout) as shown in Fig. 3 has been designed to maximise production from the continuous haulage system. Design factors considered included the maximum reach of the haulage unit, optimum pillar size to ensure pillar stability and to satisfy statutory requirements, and the need for a safe and efficient method of pillar extraction utilising the continuous haulage system.

Development mining

The continuous haulage unit is used in a cut and flit development mining system. The depth of cut is initially a maximum seventeen (17) metres, however it is proposed to incrementally increase the depth of cut to a maximum of thirty six (36) metres as operational experience is gained and suitable controls are developed. Fig. 4 shows the mining sequence for development of the first panel using the continuous haulage system.

metre wide cutter head and an on-board airborne dust scrubber unit. For increased productivity the continuous miner has been designed to shear up and down and an automatic cutting cycle (auto cycle) has been incorporated to allow for some degree of automation.

The continuous miner power supply cable is run along the full length of the chain haulage system minimising the need to manhandle the cable when flitting.

Roof and rib support

The roof is supported with 2.1 metre fully encapsulated AVH roof bolts with 150 mm steel plates. Rib bolts are not normally installed but have been occasionally used in faulted areas. Two (2) Fletcher CDDR-17 roof bolting machines, each equipped with two bolting masts are used to install the supports.

Roof support for 5.5 metre wide roadways consists of rows of roofbolts installed 1.4 metres apart and roof support for the conveyor belt roadway, which has a maximum width of 6.5 metres, consists of rows of roofbolts installed 1.0 metre apart in accordance with the mine support rules.

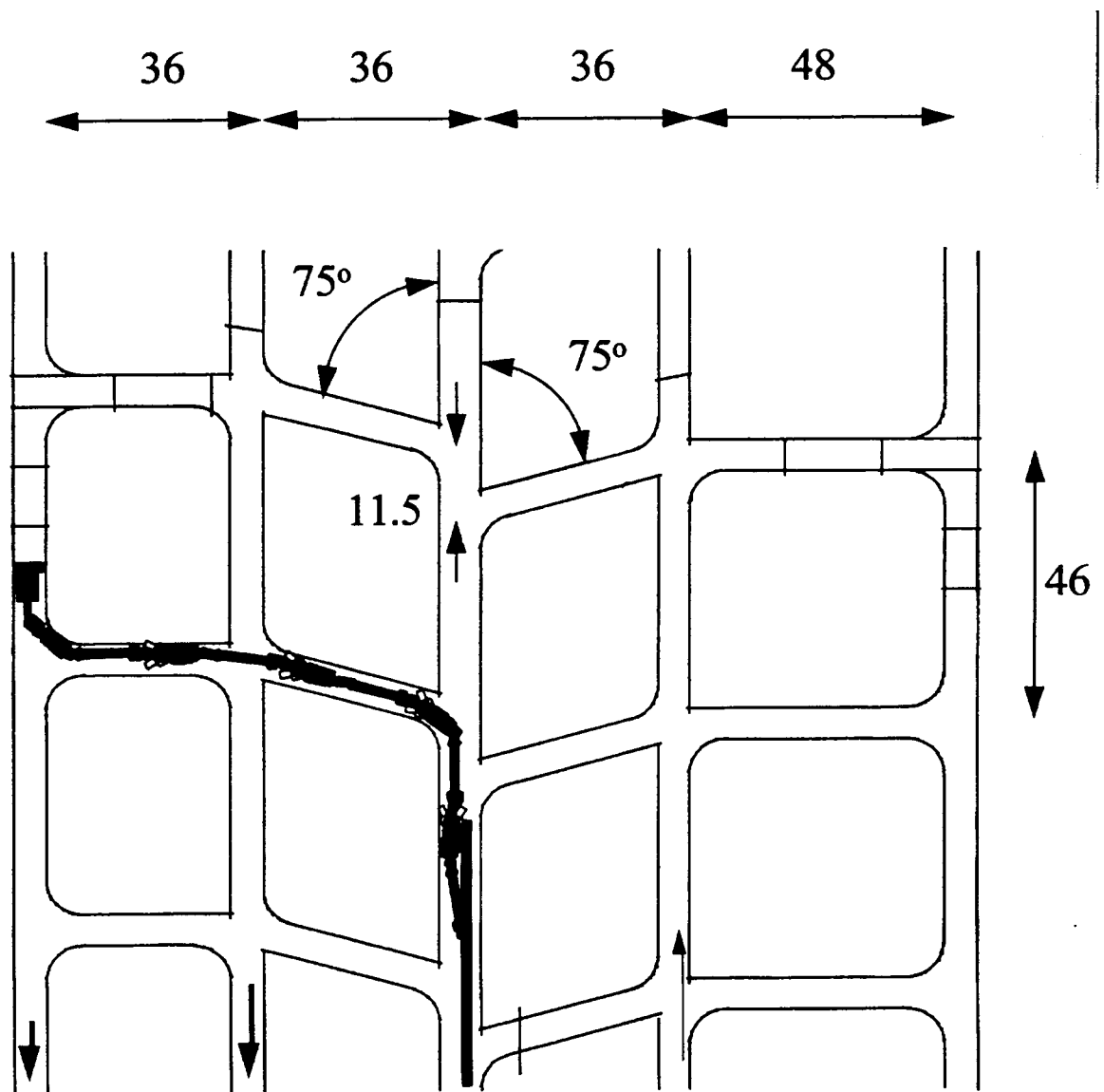


Fig.3 - Typical panel layout CM in final sequence

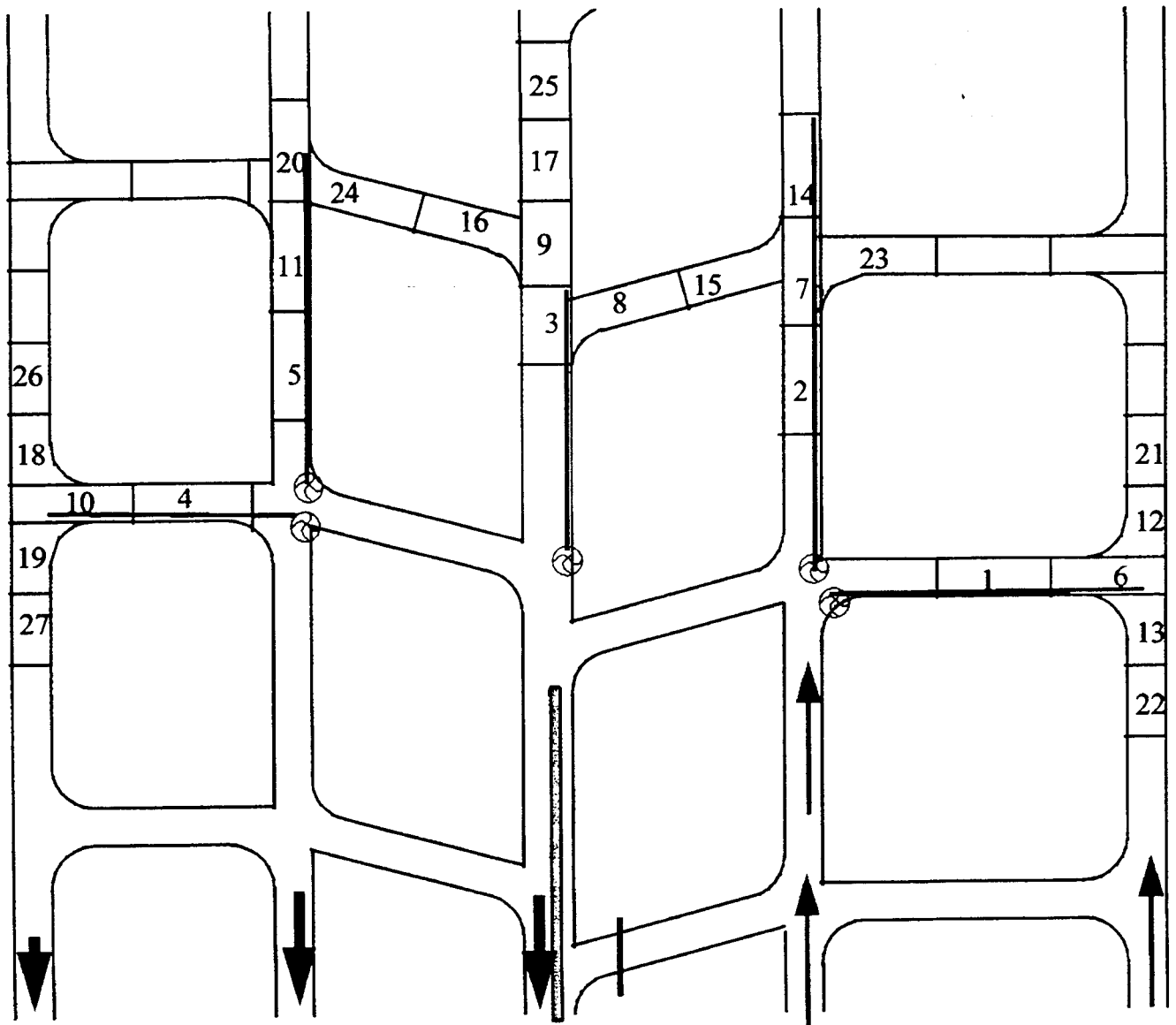


Fig.4 - Current sequence plan with compressed air fan locations

The continuous haulage system is used in conjunction with a radio remote controlled Joy 12CM12D fitted with a 5.4

Ventilation

The ventilation system in the chain haulage panel has been designed with the following features in mind.

- The requirement for relatively narrow roadways;
- The requirement for large pillars designed for subsequent extraction at depth;
- The need to cope with higher levels of dust and gas production;
- The higher advance rates reducing the ability to efficiently install ventilation;

- The use of single pass continuous miners at United Colliery; and
- The future requirements to cut out in excess of thirty metres.

The first continuous haulage panel has been designed as a five (5) heading layout with the conveyor belt heading being the centre heading. Intake air is directed along the two (2) right hand roadways of the panel and returned via the remaining three (3) roadways, one of which is the belt roadway (ie. homotropical ventilation). Fig. 5 shows a general layout of the panel ventilation.

Ventilation of the continuous miner working place is by exhaust ducting mounted onto the continuous haulage system. It runs from the coal receiving hopper at the rear of the continuous miner to the auxiliary fan in the conveyor belt heading. The ducting is a mixture of 700 mm diameter fibreglass and 720 mm diameter semi rigid spiral wound tube. This tube provides the flexibility required at pivot points and accommodates the 1.2 metre compression on the MBC dollies.

The fan is mounted on wheels and is located on the section conveyor belt frame. It is towed in and out along the conveyor by the chain haulage system. The fan, which is fitted with an attenuator, exhausts into the belt roadway.

Ventilation to all other places is currently via a forcing fan (17.5m³/s open circuit capacity) located in the intake airway with 725mm diameter lay flat ducting directing air to each face. The air quantity at each face is regulated by a fibreglass butterfly valve located in a Tee piece on each intersection. The forcing ventilation system provides excellent ventilation for the roof bolters and diesels.

Due to the working height being lower than expected, we are currently experimenting with compressed air auxiliary fans positioned at the entry of each heading. Air is directed to each face via 500mm diameter layflat ducting. With this arrangement the chain haulage system will no longer have to pass under the layflat tubing and the excellent ventilation of the faces being bolted and cleaned will be maintained.

Pillar extraction

It is proposed to utilise the continuous haulage system to extract the pillars formed during development. The panel layout has been designed to take into account a proposed pillar extraction sequence as shown on Fig. 6 and mobile roof supports will be used in conjunction with the haulage. Details of the proposed pillar extraction method will be finalised after continuous haulage operational experience is gained and geological features in the mining area are taken into account.

Panel services

At full production it is anticipated that the panel services will be advanced every second day. To ensure these service moves are completed efficiently and on schedule, intensive planning and design work involving many United personnel was required.

Some of the results included:

- A redesigned panel conveyor structure for speedier extensions;
- An integrated transformer / DCB, track mounted for speedier power supply moves;
- Flexible high voltage cable loaded in to a purpose built trailer which allows the cable to be quickly installed and retrieved;
- Power supply cables in custom made lengths;
- The on board exhausting ventilation system and forcing ventilation layflat ducting which requires less labour to move; and
- A flexible fire line is used in the area of the belt frame and can be quickly advanced. It is later replaced by a steel fire line once the belt frame is inbye that location. This fire line was originally mounted to the belt frame.

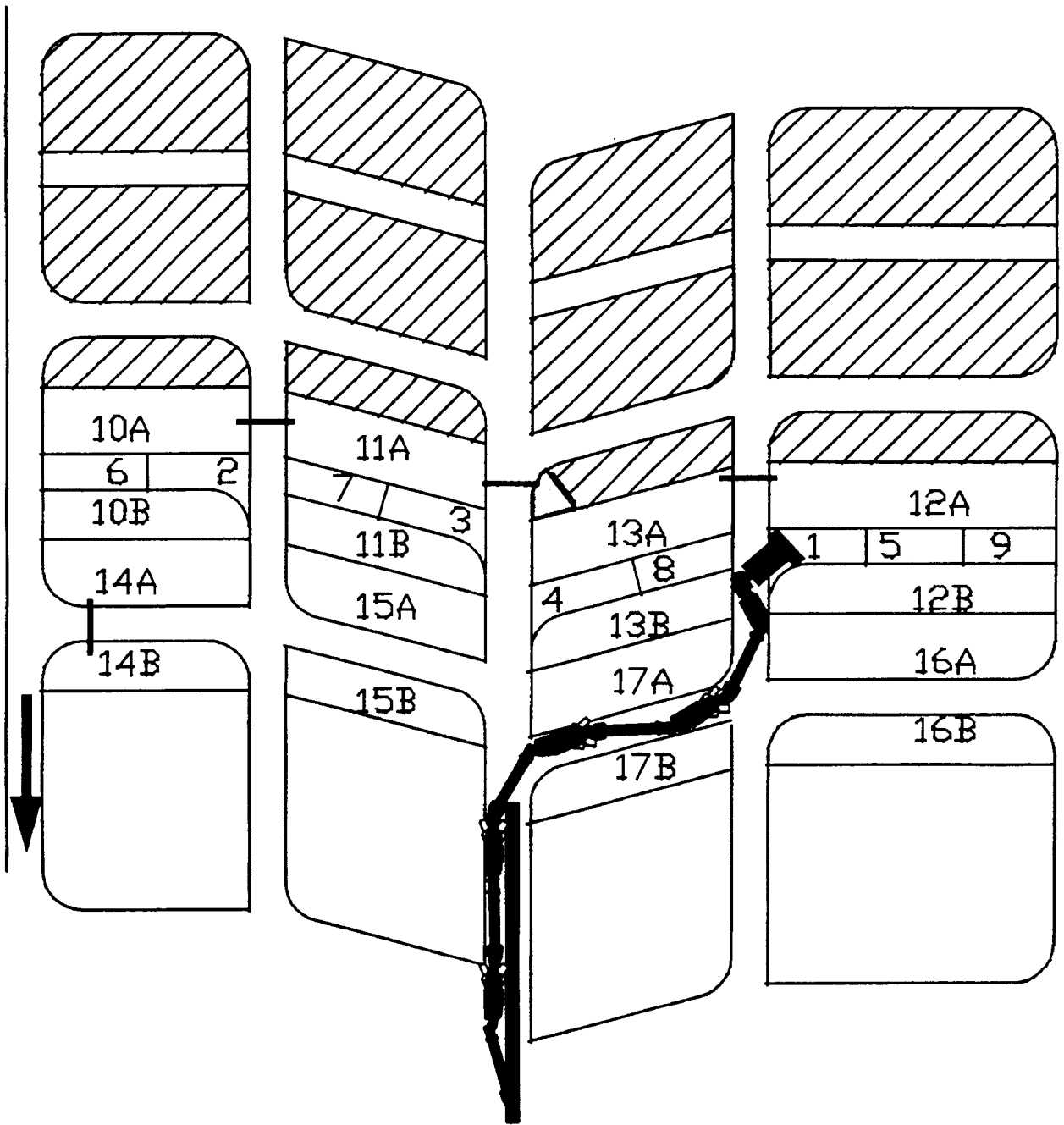


Fig.5 - Original ventilation layout

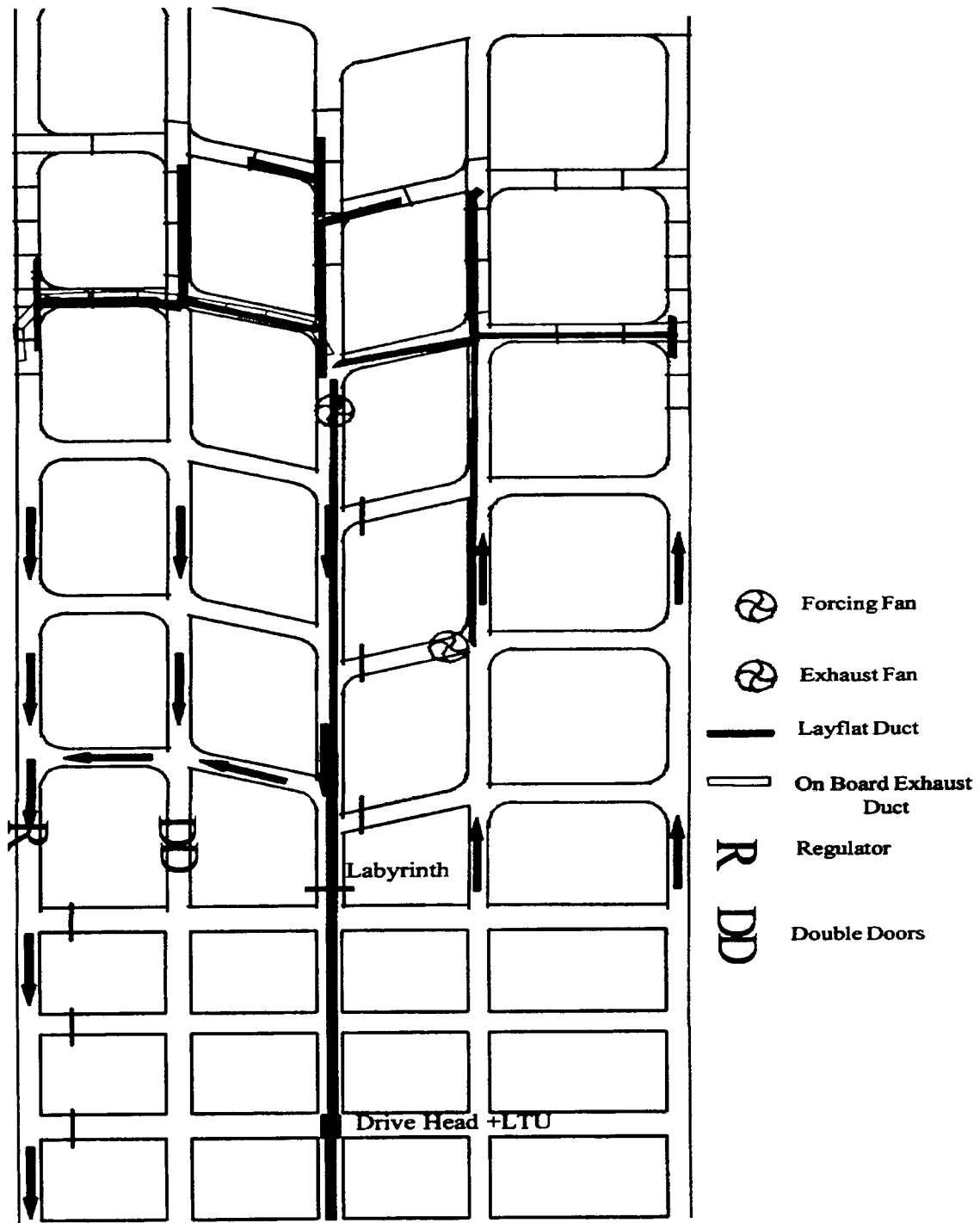


Fig.6 - Typical extraction sequence

Manning

The continuous haulage system development crew is twelve (12) production mineworkers and one (1) supervising production mineworker. The production functions are generally as follows:

- 1 production supervising mineworker (deputy);
- 1 continuous miner operator;
- 5 continuous haulage operators;
- 4 roof bolter operators (when required); and
- 2 utility men

The inbye MBC operator also performs the function of miner cable hand if required. All crew members are fully trained and authorised to operate the continuous haulage system.

Electrical and mechanical mine workers are called into the panel on an as needed basis.

Procedures.

A number of risk assessments were held before the introduction of the chain haulage system. These were:

- Design Risk Assessment;
- Operational Risk Assessment; and
- Ventilation Risk Assessment

The Design and Operational Risk Assessments for the continuous haulage system were conducted by a team consisting of members of the haulage working group, mine management and Joy personnel, and were important in the development of many of the machine safety features.

All of the risk assessments identified the need for management procedures to ensure the safe and efficient operation of the system. As part of their training all operators were fully instructed in these procedures prior to their being authorised to operate the continuous haulage system.

Operational experience

It is early days in the use of the Chain Haulage System.

By the end of December the system performance was starting to come together with one shift exceeding 1,700 tonnes and many shifts exceeding 1,000 tonnes. Current average productivity though is still only around 900 tonnes per shift. As problems are identified they are worked on until remedied.

A summary of problems to date includes:

1. Onboard ventilation system.
 - Collapse of flexible ducting in the area near the exhausting fan;
 - Damage of components;
 - Seized wheel bearings on exhausting fan;

- Vibration trips on exhausting fan;
 - Broken coupling between exhausting fan and CHS dolly; and
 - Blockage of coal receival hopper ductwork with coal, causing collapse of tubing along the system.
2. Layflat ventilation.
- Layflat tubina torn down due to insufficient seam working height
 - Coupling joints coming apart
 - Vibration trips and low current trips on forcing fan
3. Water in the panel
- Excessive slurry on roads
 - Excessive slurry on belt
 - Excessive material carry back
 - Soft floor
4. Soft floor and chain haulage digging up floor.
- CHS bogged and “stuck” in holes;
 - Undulations in conveyor belt structure;
 - Difficulty advancing conveyor belt frame;
 - Broken connecting pins.
5. Damaged and tangled power supply cables to CHS
6. Trapping shoes of CHS and exhausting fan damaged belt signalling system
7. Inexperienced operators
- Slower flitting;
 - MBC's getting bogged and stuck;
 - MBC's tearing up floor; and
 - Not working as a cohesive 5 person machine.
8. Chain Haulage System
- Broken connecting pins;
 - Broken support for connecting pin;

- Area lighting incorrectly located resulting in damage;
- Unreliable voice communications hardware;
- Radio remote control problems;
- Excessive water usage adding to panel water problems; and
- Damaged cab support rams.

9. Hydraulic and electrical problems on the CHS

10. Continuous miner drivers adapting to cut coal continuously instead of the stop / start technique used with shuttle cars

11. Initial high downtime on the continuous miner

A limiting feature of the chain haulage system is that in general one problem stops the total system and the movement of coal.

Noticeable improvements came about after the groundwater make in the panel and water discharge from the CHS and miner was controlled and reduced.

Unfortunately, as many of the problems with the continuous chain haulage and ventilation systems were being solved, the panel advanced into a zone of seam faulting. The associated strata dislocation and weak roof necessitates a reduction in cut out distances, thus requiring the CHS to be flitted more often, consequently reducing productivity. The faults are accompanied by an increased methane make causing the continuous miner cutter heads to automatically stop when the sensor detects 1.8 % methane. To overcome the increased methane make, further improvements of the on board ventilation system are being directed at achieving higher air quantities and advancing the exhausting air ducting closer to the face. The final design may have the ventilation ducting directly connected onto the continuous miner.

United is also looking at the processes of cutting and flitting to identify areas for performance increases so that the available time is used more productively. The cutting cycle will be analysed so that the continuous miners are operated closer to their peak cutting rate of 30 tonnes per minute rather than the 6 to 10 tonnes per minute rates (over a 5 minute cycle) being now achieved.

CONCLUSION

The introduction of the Chain Haulage System at United Colliery has shown the productive potential of this type of system in Australian mines. The productivity of the Chain Haulage System will continue to improve as overall panel downtime is reduced and operator experience increases. Further improvements in productivity will occur when areas relatively free of geological disturbances are mined and the implementation of deeper cuts (up to 36 metres) will enable a higher proportion of the available time to be spent cutting.