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BLACK COAL INDUSTRY INQUIRY

We had planned to provide a submission to the inquiry into the black coal industry but did not have it prepared in time for the original closing date. The latest list of submissions shows a number of others have made late submissions and it may not be too late for us to make some small contribution to the inquiry.

Recent events in NSW have shown that the black coal industry is not as strong as some might imagine and this poses a threat to jobs and export earnings. Papers presented at a conference that was held in Sydney in September of last year prompted some lively debate. This centred on the impact on the coal industry of the high transport costs and my own contribution was about ways to reduce some of the components of rail transport cost.

Coal exports from the Lithgow area of NSW make a small but valuable contribution to the total market. All of the coal from this area is mined underground and must be hauled across the Blue Mountains to reach the Eastern Seaboard. These two factors present significant technical challenges and have some influence on the FOB cost of the coal. The recent closure of a mine in the area suggests that it is difficult for this area to compete unless the total cost is reduced.

As most of the NSW coal is exported through Newcastle, the paper that I presented at the conference used the conditions in the Hunter Valley as the basis for specific examples of transport cost savings. However, the methods of increasing productivity and reducing costs are applicable to most railway transport operations and very large improvements could be made. In the specific case of the line across the Blue Mountains, an increase in productivity of more than 50% could be obtained from a change in locomotive technology.

At present there are no high productivity locomotives used to haul coal trains in Australia. Queensland Rail have announced plans to introduce some new locomotives on the Moura line in the next two years but there are no plans in place to introduce similar technology for any other coal hauls. The attachment provides a brief review of the subject of locomotive and crew productivity and further information is contained in the paper mentioned above.

Colin F G Butcher
Managing Director

INDUSTRY COMMISSION INQUIRY
INTO THE
BLACK COAL INDUSTRY

INTRODUCTION

An annual flow of more than 130 million tonnes of coal for export should make a substantial contribution to the Australian economy. This rate of coal exports is projected to grow and this will increase the importance of this source of foreign exchange. Recent events in South East Asia may influence the growth of the market for Australian coal and will certainly increase the emphasis on the cost of landing the coal at the relevant foreign ports. If the cost is not competitive the projected growth will not occur and is likely to become negative in the short to medium term future.

The cost of transport from the mine to the port is a significant part of the total cost and this part of the cost should be reduced by improved efficiency. It should be noted that the South Africans anticipate a continued demand for the real cost of transporting coal from the mine to the port to be reduced. In the USA the Association of American Railroads also expects a continued downward trend in the rates for the transport of coal. Whilst there have been significant efficiency gains in Australia, there will continued pressure for improvement to match the lowest cost of transport in other parts of the world.

Lower rail transport costs are generally linked to an increase in net tonnes of product moved for each employee. A comparison with the most efficient railways in other parts of the world suggests there is considerable scope for further improvement and increased locomotive and crew productivity should have a part to play.

A key performance parameter is the size of the train that a locomotive can haul up the ruling gradient under all weather conditions. There have been major improvements to the traction technology used in heavy haul locomotives and this has produced a significant increase in the hauling capacity of the most recent models of locomotive.

In Australia the diesel and electric locomotives that are currently used to haul coal trains do not use the most advanced traction technology and the hauling capacity of these locomotives does not match world best practice. Queensland Rail plan to introduce high capacity locomotives on the rebuilt Moura line in the next two years but there are no firm plans for similar locomotive and crew productivity gains to be made on other coal lines.

Increasing the size of the trains will reduce the speed and increase the time required to complete a journey. Steep gradients and speed limits on small radius curves also slow the trains and these factors have a negative impact on the productivity of both the locomotive and the *crew*.

Higher power output may have some benefits but changes to the infrastructure may have a much greater effect on both the maximum train size and the journey time on some routes. These points are covered in more detail to illustrate how each of them has an influence on locomotive and crew productivity.

INCREASED TRAIN SIZE

General

An efficient heavy haul railway requires trains that are as large as possible and this principle should be applied to the transport of coal. The maximum tractive effort that the locomotives can reliably produce and the ruling gradient on the line are the two critical factors that normally determine the train size.

Increasing the number of locomotives at the head end of the train may allow the train size to be increased. This approach is limited by the strength of the couplers but additional locomotives may be used in the middle of the train to double the train size. In both cases the crew productivity will be increased and the number of train paths required for the task will be reduced. However, the fundamental productivity of each locomotive, in terms of tonnes hauled by the individual unit, remains unchanged.

An increase in the productivity of both the crew and the locomotive requires an increase in the hauling capacity of the individual locomotive. The main factors that influence the hauling capability are the locomotive mass, the traction technology and the ability to use the traction motor capacity under all normal operating conditions.

Locomotive Mass

Most locomotives used for heavy haul operations have six axles and the maximum axle load that may be applied to the track determines locomotive mass. In the US the axle load may be more than 31 tonnes and heavy haul locomotives may have a total mass of about 190 tonnes. In Australia the axle load for most standard gauge locomotives is limited to 22 tonnes and the latest narrow gauge locomotive for Queensland Rail are to have a maximum axle load of 20 tonnes.

As the mass has a direct bearing on the hauling capacity of a locomotive, Australian locomotives are inherently less capable than their counterparts in the USA.

On narrow gauge lines in Queensland the hauling capacity of a locomotive may be about 65% of the capacity of a heavy haul locomotive in North America. For the normal standard gauge locomotives the inherent limit is about 70% and these limits translate to a fundamental restriction to the Potential productivity of each locomotive.

In NSW there has been a move to heavier locomotives and special heavy haul locomotives are used on the line between the mines at Ulan and the port at Newcastle. However, the maximum mass is limited to about 87% of the mass of an equivalent locomotive in North America.

If heavier locomotives could be used to haul coal trains there would be a proportional increase in locomotive productivity.

Traction Technology

All of the existing locomotives used to haul coal trains have conventional d.c. motors that have been refined over several decades. In the past 25 years there has been a steady increase in the use of the a.c. traction motor for all types of railway traction including diesel and electric locomotives. This simple robust type of motor has a higher specific performance envelope and can provide a much greater tractive effort or hauling capacity.

The following chart shows the steady increase in the continuous rating of NSW classes of locomotive and compares these values with the rated tractive effort that is available by using a.c. traction motors as fitted to world best practice heavy haul diesel locomotives.

Refer to original submission for graph.

Adhesion

Higher capacity motors are of little use unless this performance capacity translates to tractive effort at the drawbar to haul heavier trains. Control systems have been developed to obtain the maximum effective use of the grip or adhesion at the point of contact between the wheels and the rails. With d.e. traction motors the starting tractive effort may be equivalent to 35% adhesion and the all weather running adhesion may be about 30%.

In 1991 in the US, four prototype locomotives were fitted with a.c. traction motors and these were trialed in heavy haul coal service by Burlington Northern. Three of these locomotives were able to start and haul 13,600 tonne trains that were normally hauled by five older diesel locomotives fitted with d.c. motors. The new locomotives also did not require additional locomotives to assist them to start the train on the steep hill out of the loading tard at the mine.

Burlington Northern subsequently ordered a fleet of 350 similar locomotives to replace 580 older locomotives that are used for coal and other heavy haul services. This provides a direct illustration of the advantages of the a.c traction motor system that has been developed for coal and similar heavy haul operations.

The following chart clearly shows the advantage of the a.c. traction system compared with the best available d c. motor performance in terms of the adhesion levels that are routinely obtained in service.

Refer to original submission for graph.

REDUCED JOURNEY TIME

Power Output

For heavy haul trains, the rated power output is normally less important than the hauling capacity. On lines that are relatively flat, a moderate power output is normally sufficient to haul a long train at the limited speed that applies to most heavy haul wagons. However, on lines that contain one or more long gradients that the train must climb in the loaded direction, a higher power will increase the speed of the train on the gradients and the journey time will be reduced.

Locomotives that can haul much heavier trains should have a higher rated power output to match the increased train size If the power does not match the greater train size, the gain in productivity from the increased hauling capacity will be partly lost due to the longer time to complete the journey.

Electric locomotives generally have access to an adequate source of power and increased output does not present major difficulties. Existing electric locomotives in NSW and Queensland have a rated power output of about 3000 kW, which is well above the power of the diesel locomotives that are used for similar operations.

The power output from most diesel locomotives used for coal transport is less than 2000 kW and heavy haul trains that are hauled by diesel locomotives tend to be relatively slow. The increased hauling capacity available from a.c. traction motors has prompted a major increase in diesel locomotive power output. To obtain the required power, the two main suppliers of heavy haul locomotives in the US have developed new engines that provide a power output that is more than the capacity of the existing electric locomotives.

Operating Speed

The maximum speed of most heavy haul trains is 80 km/hr and this is unlikely to change. In Queensland the maximum speed was only 65 km/hr but it has been raised to 80 km/hr on most lines to cut the cycle time and to gain extra capacity from the existing fleet. Gradients, speed limits on curves and the waiting time in passing loops all have an impact on the average speed.

A higher power output may reduce the effect of the gradients but changes to the infrastructure may be required to allow the trains to operate at maximum speed for a larger part of the journey. This subject is covered in a subsequent section of this submission.

Loading and Unloading

The journey time is not confined to the actual running time between the mine and the port. It also includes the time to load the train at the mine and may also include the time to unload the train

Most of the loading facilities at coalmines require the train to pass slowly under the loading bins. A long train will take more than an hour to load all of the wagons and increasing the length of the train will extend this time. As the time will increase in proportion to the train size, it does not have an effect on the locomotive or crew productivity. However, a greater loading rate will have some benefit on the operating efficiency.

At port facilities where the locomotives are used during the unloading cycle, a faster unloading system will have some benefits. If the locomotives are released from the train during the unloading cycle, the time to unload the wagons will not have a direct influence on the locomotive and crew productivity.

SELECTIVE INFRASTRUCTURE IMPROVEMENTS

Gradients

The ideal railway line for heavy haul operations would run in a direct line from the mine to the port and would have minimal gradients. In South Africa the line to the coal port of Richards Bay was rebuilt to ease the ruling gradient from 1.5% to 0.625%. The trains that operate over this line are 200 wagons long and only have locomotives at the head end.

In the US most of the lines that are used for coal transport have gradients that do not exceed 1%. On these routes, a small number of locomotives at the head end can haul trains that have a gross mass of more than 12,000 tonnes.

Most of the lines that carry coal to the ports along the East coast of Australia must cross part of the Great Dividing Range and have an alignment that is far from ideal. Many of the original lines were built at low cost and follow the natural terrain up and down steep hills.

Gradients of 3.3% were used for the construction of some sections of track in NSW and some of these sections are still used today. Other parts of the system have gradients of 2.5% and most lines have a ruling gradient of 1.33% or more.

As traffic increased and the steep hills on the early alignments became an impediment, some deviations were built to increase line capacity. The original main line between Picton and Mittagong had steep gradients in both directions but a deviation between Hill Top and Colo Vale eased the gradient to 1.5% for the loaded trains that were used to carry produce to Sydney.

The old line was replaced by the current alignment in 1919 and the gradient in both directions was reduced to 1.33%. To avoid the Sydney suburban area, some coal is transported over this scenic alignment through Mittagong. The gradient places a significant limit on the number of coal wagons that a locomotive may haul over this route.

On the line between Muswellbrook and Werris Creek the original steep section that was built in 1878 to cross the Liverpool Range is still used today. On the approach to the top of the hill at Ardglen the gradient is 2 5% in both directions. The chart below shows the effect of the gradient on the train size that a FreightCorp 82 class locomotive with an a.c. traction system can haul.

This indicates the extent of the gain in locomotive hauling capacity that could be obtained from changes to the ruling gradient on heavy haul lines.

Refer to original submission for graph.

Curves

Some of the original alignments contained steep gradients that followed the natural terrain and contained small radius curves. The line across the Blue Mountains and the climb to Ardglen are two typical examples where steep hills are combined with small radius curves.

Many of the track deviations that were built to reduce the ruling gradients contain a larger number of small radius curves than the original line. These curves increase the train resistance to motion and place an additional restriction on locomotive productivity.

Any proposed new alignment should be checked using a simulation program to determine the effect of the curves on the locomotive hauling capacity. In general the deviation should avoid the use of small radius curves.

In addition to the effect on the train size that may be hauled up the ruling gradient, curves can impose speed limits. Coal trains are normally limited to a maximum speed of 80 km/hr and the curves should have a radius large enough to allow the trains to run at this speed.

Curves that limit the speed have an effect on journey time and this reduces the locomotive and crew productivity.

SPECIFIC CASE STUDIES

Blue Mountains

Electric locomotives that are used to haul coal trains over the Blue Mountains have a relatively low tractive effort and modest power output. European locomotives that were built at about the same time have double the power output and a similar tractive effort rating. Simulation studies have been used to compare the performance of these two types of locomotive and have confirmed there would be very little difference in the hauling capacity of the two types but the latest traction technology would provide a small energy saving.

A heavier version of the European locomotive could haul a larger number of coal wagons over this difficult track profile. The power output could be increased in proportion to the train size to allow the new locomotive to match the journey time of the existing trains. The increase in the train size would represent a direct gain in the productivity of the locomotive.

The existing coal trains have up to four locomotives at the head end and the same running time and hauling capacity would be well within the performance envelope of three modern units.

With four new locomotives at the head end the crew productivity could be increased by over 50%.

This technical feasibility study was limited to an investigation of the potential locomotive performance. Other factors may have a significant impact on the size of the coal trains that could be hauled over this route. However, the study did identify the significant improvement in locomotive productivity that is available from the latest traction technology.

Ardglen

The line over the Liverpool Range at Ardglen follows the original alignment and the gradient is 2.5% in both directions. Coal traffic that originates from the mines at Gunnedah and Curlewis must use this line to reach the port at Newcastle. Other coal deposits in the area could be developed and this would substantially increase the heavy haul traffic over this route.

A 1990 study investigated several alignments to avoid the steep climb to the summit at Ardglen. In all cases the change to the alignment was limited to easing the gradient between Willow Tree and Ardglen to match the ruling gradient of 1.33% on other parts of the line.

The lowest cost option retained the existing tunnel on the descent from the summit. A deviation for about 19 km increasing the length of the climb to the portal at 632 metres above sea level. The easier gradient would have eliminated the need to use banking locomotives but an increase in the size of the train required heavier or more advanced locomotives.

A recent review of the line identified an alternative alignment that would reduce the gradient to 1.0% on the climb up the Liverpool Range. To take full advantage of this alignment, the ruling gradient on other parts of the line would need to be eased. The new alignment would have a number of significant advantages that would reduce operating costs. The base case for this study was taken to be a train hauled by a pair of 82 class locomotives on the easier alignment proposed in 1990.

A modified alignment with a ruling gradient of 1.0% would allow the number of wagons to be increased by at least 28%, A change to the traction system would allow the number of wagons to be increased by almost 43% compared with the base case.

Increasing the number of wagons would slightly increase the journey time but an increase in power output to match the 90 class would reverse this trend. A heavier locomotive could haul even more wagons but would be the slowest option. The lowest journey time would be obtained by increasing the power to the maximum that is now available in a heavy haul locomotive.

To allow a direct comparison between the various options, the journey times and the total fuel consumptions have been divided by the number of wagons. This data is presented in the table on the next page and indicates the advantage of a reduced gradient and higher capacity locomotives.

The highest productivity is obtained by hauling the largest number of coal wagons the highest performance locomotive.

The lowest specific fuel consumption is obtained a slower train but the saving is small compared with the heaviest train hauled by a 3000 kW locomotive. As this has a large advantage in terms of the time per wagon, it is likely to be the most cost effective solution for the operating conditions used for this study.

COMPARISON OF OPTIONS FOR ARDGLEN DEVIATION

Refer to original submission for chart.

CONCLUSIONS

There are significant opportunities to increase locomotive and crew productivity.

To match world best practice there is a need for investment in locomotives or changes to the infrastructure or a combination of both.

In the case of the existing line over the Blue Mountains, an increase of more than 50% is technically feasible.

A new alignment to replace the steep climb at Ardglen combined with increased locomotive mass and modern technology could double locomotive utilisation and save fuel.