FREIGHT AUSTRALIA'S ROLLINGSTOCK INITIATIVES

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Summary
Freight Australia purchased V/Line Freight, the formerly government owned rail freight business in Victoria on 1 May 1999. Since procuring the business, Freight Australia has sought every opportunity to expand and in particular grow the rail freight operations to most states in Australia.

To meet the ever increasing rollingstock requirements of Freight Australia, the Workshops Divisions, have responded with cost effective strategies and initiatives that have enabled the older and previously obsolete rollingstock to be reconfigured so they can operate for the new and expanded business requirements.

To demonstrate Freight Australia's rapid business expansion since, the distance traveled by Freight Australia's locomotive fleet has increased by 80% and wagons by 100%, with a 30% increase in the wagon numbers operating in traffic.

To increase the locomotive fleet capacity, efficiency and durability a large number of locomotive improvement projects have been implemented which include: -

- Installing 3800 horse power engines in Freight Australia's G class locomotives;
- Re-power the X Class locomotive with 3300 hp engines for 50% greater hauling capacity;
- Fitting traction enhancement kits;
- Re-gearing X & A class locomotives for better hauling capacity and Traction Motor durability;
- Hasler Speedo replacement with Loco-loggers;
- Inline fuelling to increase the locomotive range;
- Other Loco features include – Fuel Savers, Creep Crank, Self-Load, Pre-Lube Features and the fitment of cost effective air-conditioners.

The Wagon initiatives for increased effectiveness and efficiencies include: -

- Converting Briquette wagons of 76 tonne gross to 100 tonne gross Wheat wagons;
- Converting open wagons to container wagons;
- Creating broad gauge rice hoppers from surplus hoppers;
- Fitting air operated pneumatic top & bottom doors to grain hoppers;
- Building up a Log Traffic Fleet from wagons that were previously vans and open wagons;
- Raising the carrying capacity of wagons with the introduction of higher capacity 70 tonne bogies.

This paper will cover the many enhancements and initiatives that were investigated and are being undertaken to improve the productivity and performance of Freight Australia's current rollingstock fleet.

Figure 1: Freight Australia's G Class Locomotive

1. Introduction

Freight Australia's rollingstock initiatives have been driven by Freight Australia's need to turn around the previously inefficient and heavily subsidised government owned V/line Freight. To achieve this aim Freight Australia has had to continually be innovative with its processes and practices by looking for more cost effective ways to utilize and operate its rollingstock.

In May 1999, when Freight Australia commenced, it purchased a fleet of nearly 2700 wagons and 107 locomotives. Since starting, Freight Australia has nearly doubled the utilisation of its rollingstock.

2.0 Locomotive Strategies

The basis for a fully cost effective locomotive fleet is to ensure maximum utilization. Freight Australia has dramatically improved its rollingstock utilization by improving operational efficiency, better serving the rural sector of Victoria and reopening railway lines.

Developing new markets soon meant extending services to interstate operations with Freight Australia now running to Perth and operating in New South Wales. With this dramatic expansion and with a fleet of locomotives ranging in ages from 15 to over 40 years old, comprising of shunting locomotives through to 3300 hp locomotives, Freight Australia looked towards its Engineering team for solutions on how it could get more out of its current rollingstock. The option to purchase new rollingstock for a company in its first few years of business was not viable, so each of the locomotive classes was assessed to determine if there was potential to gain more from each of their specific configurations.

2.1 X Class Upgrades

The X Class locomotives were delivered in 3 series from 1966 through to 1975 and were fitted with 16 cylinder EMD 567/645 E blower driven engines that are rated at 1350 to 1640 Kw (1800 to 2200 hp) With the average age of the 24 X 's being 30 + years old and with most having traveled 4 million plus klm's, the fleet was ready for progressive upgrading.

Costs were reviewed for running and maintaining the X Class Fleet in their current configuration against the cost effectiveness of upgrading the locomotives to 3000 hp. The operating costs of the 567E/645E rootes blown power plant in the X class is high compared to the later turbo charged 645 E3B/C as the turbo charged engine has a 20 % improvement in brake specific fuel consumption.

In reviewing the fleet and with more cost-effective horsepower needed by Freight Australia to satisfy its expanding markets, the financial plans deemed it viable to raise the current power of the X Class to 3300 hp.

To initiate the project, each element of the locomotive was analysed and the appropriate upgrading to cater for the new engine was determined.

2.1.1 The Engine

The engine chosen for the X Class was the turbo charged 645 E3C, this was dimensionally the same as the engine it was replacing and would deliver the required 3300 hp. Sources for the supply of 16 – 645 E3C engines were considered along with the option of cascading the engines from the G class. The G class would in turn be retrofitted with the larger and more powerful 645F3B Engine. This proved be the most cost effective option as well as being beneficial for both locomotive classes. (Figure 2)

Figure 2: The X class with the turbo-charged engine being fitted.

2.1.2 The Under-frame

The under-frame of the X was modeled and analysed to determine if: (a) it could handle the extra 50 % horsepower and (b) ensure its long term durability, especially when each under-frame is now 30 + years old.

An FEA was carried out to determine if there would be any critical areas arising due to the increased power and extensive crack detecting was performed to determine the current state of the under-frame.

The main increase in loads on the under-frame from the new engine arose from the increase of maximum engine torque and the increase of tractive effort by up to 50%. This tractive effort is realised by the increase in the locomotive weight and the enhanced traction control system that is fitted.

The analyses through the model showed high peak stresses in the area of the engine transoms. These stresses, which exceeded the allowable, occurred at the engine transom web between the engine mounts and the side sills. The model highlighted that the engine is very stiff as compared to the side sills which in-turn causes excessive relative rotation between the sills and the engine mounts. This combined with the torsionally stiff closed box section of the transoms cause excessive stresses in the transom webs and would induce cracking.

Initially it was considered to tackle the problem by adding more material to the engine transoms, this however only added more stiffness to each transom and simply caused more torsional resistance to exacerbate the problem. The engineering solution was to make torsionally flexible transoms that are in effect "I" beams and effectively removed the highly stressed areas. (Figure 3)

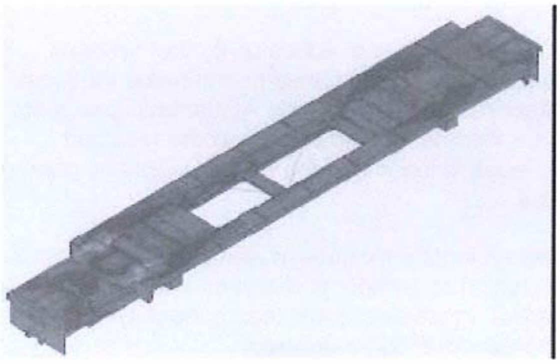

Figure 3: The FEA model of the underframe

2.1.3 The Electrical System

The original D32 Generator has been replaced with the G Class AR 10 Alternator as the D32 was not capable of delivering 3300 hp.

The control system chosen to replace the older Electric-Pneumatic System is the Q Tron QES 3 Locomotive System. This Microprocessor system was chosen after successful testing of a simpler Qtron system that is now being fitted to the A class. The system consists of a microprocessor-based electronic control unit, an operator interface panel and data logger.

The dynamic braking capacity of the X class has been upgraded to 700amps to match the traction output of 3000hp.
Other features of the re-powered X include: -

- The fitting of 26L Brake Gear fitted against the original B7 equipment;
- The cooling system being upgraded with larger radiator banks;
- The air-compressor being converted to a water-cooled WBO type;
- A more ergonomic laid out drivers cab, this is based on the G Class locomotive cab which is suitable for driver only operation;
- A unique toilet being fitted that requires less servicing.

2.1.4 Performance and Conclusion

From the first testing of X38 it was evident that this upgrade had produced a locomotive of greater hauling capacity by at least 50 % as against the original X Class. The tractive effort is now in the order of 330 kN compared to its original 212 kN and detailed testing has shown that the upgraded X can operate similar loads as Freight Australia's current G Class. The traction control equipment now fitted compensates for the fact this locomotive is still fitted with the original X class Flexicoil non-high adhesion bogies.

Other Details of the higher horsepower X are listed below in Chart 1: -

	Original X	**Re-Powered X**
Tractive Effort	212 kN	331 kN
Adhesion	20 %	27 %
Mass	114 tonnes	118 tonnes
Gear Ratio	59:18	61:16
Power	1450/1340 kW -Series 1 1640/1490 kW -Series 2&3	2460/2240 kW

Chart 1: Specifications of a Standard vs Re-powered X

The X class build program is now being streamlined with the electrical cabinet, cooling group and other critical sections being built as separate modules that can be readily installed. This process has allowed the program to be incorporated into what is essentially a running maintenance shop and a re-powered X to be produced at a small % of the cost of a new locomotive.

2.2 G Class

The objective of re-powering the G Class was to provide engines for the X Class while adding horsepower to the G Class Fleet at minimal cost. To ensure the project is cost effective, it was necessary that minimal changes were carried out to the G.
A risk analysis was carried out to determine the critical items that had to be reviewed which included the following: -

- The fit-ment of the 645F Engine;
- The electrical and structural adequacy of the G class;
- The cooling capacity;
- The control system;
- Any reliability issues.

The engine is the same physical dimension as the current 645E3 engine type as it derives its extra horsepower from increasing the rpm and boost. The cooling group and control system was analysed and compared to EMD's SD50, a similar engined US locomotive. The resultant analysis determined that the cooling capacity of the G class was adequate and to make the control system compatible only one module had to be upgraded.

One of the major concerns identified and investigated was the reliability of the F type engine. Information indicated that this engine suffered "A" Frame cracking due to the extra horsepower it generates against the E3C engine it superceded. The Freight Australia "F" engines are manufactured with the new blocks and stronger A frames that are now supplied to major U.S. railroads.

The first locomotive converted with the F engine was G529, being released during 2000. Freight Australia staff at South Dynon undertook the conversion in conjunction with the overhauling of this locomotive.

The ability to integrate this project into the overhaul cycle of the G class fleet, obtain engines at a very attractive price and operate these locomotives to Perth (where horsepower dictates train loads), makes this a very cost-effective project.

The upgraded G's are now averaging over 300,000 klm's per year and returning figures in excess of 200,000+ klm's between failures. This compares to the previous Public Transport Corporations G Class figures that indicated an average of 80,000 klm's between failures.

2.3 A Class

The A class locomotives procured by Freight Australia were originally converted during the mid-eighties and fitted with 12 Cylinder turbo-charged engines. This raised their power to 1680 kW (2107 hp) from their original build in the early 50's when they were 1120 kW (1500 hp). Their revised excitation and power control system was EMD'S Dash 2 system and the locomotives were fitted with D57 type traction motors, these were the original 1950's D27 traction motors upgraded. The A classes were geared to 59:18 gearing to allow them to operate at higher speeds for passenger operation.

A review of the A class showed that its body and underframe didn't lend itself to upgrading or more horsepower, however, for very little outlay, its load hauling capacity could be increased as much as 35%. The way to achieve the increase hauling capacity was to: -

1) Fit D77 traction motors to the fleet – Because of the 825 amp D57 traction motor current rating limitations the A Class couldn't exert enough tractive effort to match the locomotives 20% adhesion potential. The higher current rated 1050 amp D77 traction motors allows this adhesion level to be attained.
2) Re-gear from 59:18 to 61:16 gearing – The lower gearing ensures any higher adhesion levels will match the continuous current rating of the traction motors.
3) Fit an adhesion control system to achieve 25% + adhesion levels.

Initially a number of adhesion control systems were assessed and tested to determine the most effective adhesion system. Actual train load tests were then conducted to confirm the resultant increase in loads that the A class would be able to haul.

The system finally chosen was the Qtron QTRAC system. This system is designed to allow older GM locomotives to have their control systems upgraded for higher adhesion.

2.4 Y Class

The Y class is the smallest locomotive in Freight Australia's fleet, it is 488 Kwatts (650hp) and is primarily used for shunting. Seventy-five of these locomotives were originally built between 1963 to 1968 by Clyde Engineering P/L to specifications that included bogies and traction motors from the 1920 Tait Electrical Multiple Units (EMU'S). The Taits were introduced when Victoria first electrified its system. This initiative saved money, but left this workhorse that carried the 6 Cylinder EMD 567 & 645E with 2 achilles heels. The first was the GE247A traction motors, although upgraded for the Y class they are now not economically viable to recondition and secondly, the plain axle bearings that are reliant on wicking by wool pads to provide lubrication to the journal.

Because of these factors the Y Class has always been tied to yards for shunting, can only move under speed restrictions as their traction motors are limited to 64 kph and have their plain bearing axle boxes serviced twice monthly.

Flexibility to support mainline trains, permit transit between locations and the ability to operate in an area for extended time without servicing meant there was an economic need to upgrade the Y class for their long term viability. To upgrade these locomotives economically, it was decided to cascade the D67 & D57 traction motors and wheelsets with the 59-18 gearing surplus from the A & X upgrading program.

To achieve this, adapter boxes had to be sourced so packaged bearings could be fitted to the Y class bogie. This was originally done by scalloping the original axle box and fitting the "C" type packaged bearing, however, we have now designed a new axle box housing that will allow the bigger D Type axle package that is more cost effective.

The electrical side of the locomotive was also revisited to accommodate an improved adhesion system, the larger traction motors and the new gearing.

The Y class locomotive, after these and other modifications, including the fitting of air conditioning, has resulted in a locomotive that can operate in a remote location, can be easily relocated, does not require fortnightly lubrication and can support the mainline fleet by hauling loads at 80+kph.

3. Wagon Strategies

3.1 Initiatives to Improve the Grain Fleet

Freight Australia hauls millions of tonnes of grain per year. The Grain business is expanding and Freight Australia is responding with initiatives like the "Waratah" train. This is a customer contract train has been created to move on demand from region to region dependant on the customer's requirements.
With the extra business arising and the utilisation of the current fleet of grain hopper wagons being near its maximum, cost effective means had to be developed to increase the size of Freight Australia's grain carrying capacity.

The engineering initiatives to increase both the total fleet size and hauling capacity of the current fleet was to: -

1) Refurbish surplus hopper wagons that were acquired, modified to broad gauge and introduced into the rice traffic.

2) Increase the carrying capacity of the current wagons. Surplus wagons that previously carried briquettes were converted to carry grain as well as having their capacities increased.
3) Build new hopper wagons of increased capacity.

3.2 The VHBF Story

More wagons were needed for grain traffic and when surplus hoppers became available, Freight Australia looked at ways of introducing them into revenue earning traffic.

It became viable to introduce these heavier, older surplus hoppers in order to release the aluminium VHGF wagons from the branch lines that convey rice from the silos to the processing plant at Echuca. This traffic only works on short hauls and the wagons are often used as a storage facility.

Before embarking on this project there was detailed consultation with both the business groups and the customer. The customer did have initial concerns utilising these older wagons, but each issue was examined and worked through by Freight Australia Workshop's staff.

The following modifications were carried out to each wagon to enable them to operate the rice traffic on broad gauge (Figure 4):-

- The wagons were re-engineered to accommodate the Victorian XC three piece bogie;
- The top of each wagon, including the lids were modified to ensure the wagons are suitable for each of the current loading docks and able to be easily handled by 1 operator;
- The lower discharge doors were modified as they were heavy and originally opened and locked by an over-center lever mechanism on a cam arrangement. The discharge doors can now be operated by current portable-opening devices.
- Other enhancements to these wagons include fitting steps and handrails to meet our operating requirements, fitting internal deflector plates to ensure the rice discharges between the rail and into the pits and adding extra walkways to the top of each wagon for safety.

The resultant wagon is now designated VHBF and it has more than proven itself in service. The customer and operators were involved thoughout its development and the wagon has been accepted despite its lesser payloads.

Figure 4: A VHBF wagon during re-manufacture

3.3 The 100 Tonne Grain Wagons

The 100 tonne grain wagons were conceived by engineering when the operating parameters were revisited and it was deemed we should take full advantage of the outline diagram and tracks that allowed for the higher axle loads.

The VHEF's open wagons, the old briquette wagons which were out of service, were based on a original grain hopper design that when analysed proved to be suitable for extended sides and increased capacity.

Initially, a finite element model was created for the original design of the hopper wagon and strength load cases were analysed and critical overstressed locations were identified. Strengthening modifications were added as required using an interactive process to determine the optimum strength requirements.

It was calculated that the final wagons produced are adequate to sustain a fatigue life of at least a further 20 years based on each wagon travelling 100,000 km per year.

Twenty-two VHEF wagons have now been manufactured with a further 18 being prepared for conversion. The resultant wagons, re-classified VHNY's can operate to 115 kph and are rated at 100 gross tonnes, however they are restricted to 92 gross tonnes due to track limitations.

3.4 New Higher Capacity Wagons – VHKY's

New 100 tonne grain wagons were conceived after a derailment that caused unrepairable damage to a number of grain hopper wagons.

Valuable work carried out to increase the payload of the VHEF wagons was critical in the design work for a replacement wagon build program. The new wagon being designated VHKY. (Figure 5)

Fundamental design elements of the VHNY were used; principally the underframe and the bottom curved plates. A new design was established for the top curved panels and the top cant rail. In order to optimise the construction of these new hopper wagons, a number of doubling plates, which were segmented in the VHEF conversion, were combined for this new wagon.

All the higher capacity grain wagons, either the modified or the new, have been designed and fitted with pneumatic doors, both top and bottom, to increase the productivity and operator safety of these wagons.

Figure 5: The new 100 tonne VHKY Wagon

3.5 Log Wagons

Freight Australia found a new emerging market in transporting plantation logs and to capitalise, the Sale to Bairnsdale line had to be reopened. To enabled Freight Australia to establish this new business, the line had to be initially operated by the lighter Road Transferable Locomotive till the track was reinstated to a level that would enable higher axle load locomotives to operate. For the log business to expand, wagons that could carry logs were in urgent demand.

In order to satisfy this demand, older disused container flats, open wagons and louvre vans were all identified as having the potential to be converted into log wagons by having their sides and canopies removed. Further checks were undertaken to determine the suitability of each wagon to support the load where the stanchion cradles were to be attached.

The container flats and the open wagons proved straight forward, however, the VLEX louvre van design had to be analysed as its canopy needed to be fully removed. The analysis revealed, as with many of the original PTC wagons, that the center sill on the vans actually took 95+ % of the load.

The cradle frames for the logs were then designed so that they could be huck bolted onto the various wagon classes, this allowed for easy replacement if damaged and the ability to convert these wagons back to container flats if the need arose. (Figure 6)

Flexibility and the ability to convert wagons readily for any commodity was a bonus for these wagons however, unlike previous log wagons built, these wagons were not fitted with bulkheads. To fit bulkheads to these wagons would mean excessive extra costs, shorten their effective carrying load length and reduce their flexibility. To enable these wagons to be accredited for operation in Victoria, Freight Australia had to demonstrate the safe securing of the logs namely in the longitudinal direction without bulkheads being fitted.

The ROA Manual of Engineering Standards and Practices requires an overall load sustaining minimum capacity in the longitudinal direction equal to the gravity force of the load multiplied by 4. i.e. survive a 4G de-acceleration.

Freight Australia demonstrated the safety of these wagons, loaded with logs and why bulkheads were not required by: -

- Carrying out impact trials of Log wagons to determine the load movements at speeds between 8kph to 15kph. These dramatic test could not replicate 4G as to do so would have meant destroying a wagon however, it did demonstrate the controlled way the load shifted. The mass of the logs tied down and jammed between the stanchions and the friction between the logs meant the log movements were contained within the outline diagram and none of the logs broke away from their total mass;
- Modeling the forces and the loads required to move the loaded logs between the stanchions and calculating the sufficiency of the log restraining systems;
- Reviewing other Log Transporters and their practices. This included the American Railroads, who are governed by the AAR guidelines, and more importantly our competitors in the road industry who follow the Department of Transport Guidelines. Both operations aren't required to operate their vehicles with bulkheads.

Figure 6: Converted log wagons

3.6 The Container 2-Slot Wagons –VQOF's

Freight Australia business has been growing in all sectors including its container traffic. To service the growing demand and with the container fleet fully committed, more container wagons had to be sourced.

For years, the general purpose open wagons had supported the container wagons, however, these wagons built principally throughout the 1960's and 70's, needed increasing maintenance. Years of transporting products including gypsum and logs lead to massive deterioration and corrosion of their bodies. Inspections of the general purpose open wagons that had been removed from traffic due to their condition, showed the floors and more importantly the underframes of each were intact and it was only their sides and doors that were badly deteriorated.

To quickly satisfy the demand for container wagons the Workshops Group drew up the scope of work to convert these wagons into flat-topped container wagons that can transport either 20ft or 40ft containers.

The modification involved: -

- Cutting off the 1.2 metre sides and doors;
- Welding on escutcheon plates at the container loading points;
- Fitting marine style twistlocks.

These newly modified wagons, classified VQOF's, have proved to be a very cost effective solution to a market demanding more container flats and as at mid-2002, 90+ have been produced. (Figure 7)

Figure 7: Converted VQOF 2 Slot Container Wagons

4. Other Rollingstock Initiatives

4.1 The Automatic Continuous Re-Fuelling System

The Automatic Continuous Re-Fuelling project stemmed from Freight Australia winning a contract to haul freight between Melbourne Perth, a route distance of 3,450 km each way. To operate this service one of the challenges was to provide fuel for the transcontinental operation.

Freight Australia's solution to this issue was to provide the locomotives with an additional 60,000 litres of fuel capacity by attaching a bulk fuel rail tanker to the locomotive consist. (Figure 8) This system eliminated the need for re-fuelling stops at remote locations and the associated risks, downtime and costs of wayside re-fuelling.

The fuelling system developed allows for the gravity feeding of fuel from the tank wagon to the locomotives through a connecting fuel line. Fuel levels in the locomotive tanks are monitored by the system and supply is controlled by valves. Supply is boosted when required by an air powered fuel pump mounted on the tank wagon. Control of the whole system is by programmable logic controllers (PLCs) on each of the locomotives and the tank.

The locomotives and tank wagons have been fitted out, tested and commissioned at Freight Australia's South Dynon Maintenance Centre.

Due to time constraints required by the customer, the system was conceived and delivered in a remarkably short time frame with the fast tracking of all project management processes.

The automatic continuous re-fuelling system, engineered by Freight Australia's Workshops Group has more than exceeded the expectations of the Operations and Business groups by achieving commercial benefits and improving the transit times of this service.

Figure 8: Tanker fitted with the Automati Continuous Fuelling Equipment.

4.2 Longer Trains

Freight Australia had a desire to increase the length of their trains for more cost effective freight operations. The aim was to initiate longer trains with the current rollingstock in a safe and structured manner.

From the start the operators worked with the Engineering Group to determine the requirements for the operation of bulk grain trains of 80 + vehicles in length and 6400 tonnes gross mass over their major grain corridors, i.e. Murtoa – Portland and Maryborough – Geelong.

The risks identified in the operation of longer freight trains included: -

- Draft gear failure;
- Wagon cracking and failure;
- Ability to maintain brake pipe pressure;
- Brake application and release and train handling techniques;
- Ability to stop within required limits;
- Ability to maintain low speed;
- Ability to hold train on grade;
- Brakes leaking off prematurely;
- Use of obsolete brake equipment.

Each of these risks was analysed and a series of tests involving operating trains at up to 97 vehicles long, approximately 6500 tonnes mass and 1.5 klm's in length, were carried out under the guidance of Freight Australia's Engineering section.

Other tests carried out that led to recommendations for long train operation included, the trains ability to maintain brake pipe pressure, brake application and release times and the adequacy of Freight Australia's End of Train Air Monitoring System.

Typically, for a 65 vehicle train, a minimum service application (50 kPa brake pipe reduction) took 20 to 25 seconds to transmit to the end of the train as compared to a 97 vehicle train that took 80-90 seconds. A further 100 kPa reduction (to full service application) took approximately 90 seconds to transmit for the 65 vehicle train and 150 seconds for the 97 vehicle train. Release times were longer, and were dependent on throttle notch setting.

Stopping tests were also conducted, the requirement is for a train to be able to stop from maximum operating speed within 2500 metres. The tests conducted between Maryborough to North Geelong demonstrated that the longer trains took in the order of one kilometre to stop after a minimum reduction was made.

The issue that a long train could not always be held on a grade using the independent brake of the locomotive did cause some discussion. The solution was to amend the procedures so that the driver would apply an emergency brake application to exhaust the brake pipe. This will hold the train stationary for at least three hours. Testing of a series of wagons showed that brake cylinder pressure is maintained at approx. 94% of full brake cylinder pressure (350 kPa) for 3 hours, and after six hours, 74% is maintained.

The engineering section has worked closely with the drivers and the operators to ensure the safe implementation of longer trains. All the tests indicated that driver handling techniques and training is critical to operating safer and longer trains. Effectively using the full capability of the dynamic brake and prudent use of the air brake is necessary, as is an understanding by the crews of the times it takes for the pressure signal for the application and release of the brakes throughout the train.

5. Conclusion

Freight Australia has now been in existence for just over 3 years and in order for it to remain competitive it must use every opportunity to maximize the use of its rollingstock and optimise costs. The Workshops Engineering Group works closely with the Operating and Business Divisions to consistently look for innovative and more advanced ways to meet our customers needs. The initiatives listed in this paper have been successfully implemented and have enabled Freight Australia to operate a more efficient and cost effective transport operation.

6. Acknowledgements

The Authors wish to acknowledge the permission of Freight Australia for the production of this paper.