

SMART TECHNOLOGIES AND POLICIES FOR THE EFFECTIVE MANAGEMENT OF HEAVY VEHICLES

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ABSTRACT

The management of the increasing demand on the road infrastructure placed by various road users is one of the most significant issues facing road authorities, network owners and road managers throughout Australia. Performance based standards (PBS) is an initiative of the National Transport Commission that provides a framework for the development and operation of safer and more efficient heavy vehicle combinations. The intelligent access program (IAP) is a unique application of intelligent transport systems (ITS) to heavy vehicle operations with the aim of providing tools that allow the better management of the transport task and the better management of the road assets. The IAP remotely monitors the operation of heavy vehicles to ensure that they are complying with their permitted operating conditions.

Queensland is leading Australia in the development of innovative (PBS) heavy vehicle combinations and the introduction of practical, IAP type management systems for the operation of these combinations. Prime mover and quad-axle semitrailer combinations are trialed in Queensland. These combinations meet the PBS requirements and fitted with an on-board mass monitoring system, global positioning systems (GPS) and their operation is monitored by a third party service provider. This project clearly illustrates the benefits of IAP and PBS.

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1 INTRODUCTION

Transport regulators in Australia are adopting a more effective approach to their legal and socio-economic duties and interests. A substantive reform agenda has been underway for close to a decade. The National Transport Commission (NTC) has facilitated the development of regulatory reforms aimed at increasing productivity, compliance and safety. The performance-based standards (PBS) and the intelligent access project (IAP) represent this fundamental shift in the management of heavy vehicle operations in Australia. This paper illustrates a practical example of how PBS and IAP can achieve these outcomes.

The transportation of heavy containers is an increasing problem for transport companies and the industry in general as due to existing mass and dimension limits there are no prescriptive vehicle options available to successfully complete this freight task. Queensland Transport has assessed a number of possible vehicle options under the principals of PBS and developed – in co-operation with Department of Main Roads and industry – new management methods that are based on the fundamentals of IAP. The trial operation of quad-axle semitrailers currently running in Queensland represents a good and practical example of the co-ordinated and sustained effort in the application of innovative road transport technologies that can provide significant economic benefits to particular segments of the road transport industry.

2 BACKGROUND

Australia is heavily dependent on the efficiency of the road freight sector. This reliance is expected to increase as the Bureau of Transport and Regional Economics (BTRE) predicts that the road freight task in Australia will increase by 118% between 2000 and 2020, a yearly increase of about 4%. With increasing pressure being placed on Australia's road network, the effective management of this growing demand is one of the major issues facing governments at all levels.

Mass and dimension limits have always been an issue for the transport industry, the jurisdictions/road authorities, and of course the public or road users. The regulation of heavy vehicle limits in Australia has traditionally been governed by the use of inflexible, highly prescriptive statutory and administrative instruments. This tendency to a 'one rule fits all' approach to network access has outlived its usefulness as a stand-alone strategy with its on-road policing techniques for non-conformance, and its cumbersome paper-based exemptions.

Transport operators see increased mass limits and larger heavy vehicles as the only way to increased efficiency. Jurisdictions see increases in mass and dimensions as a liability. They are also concerned about road safety and environmental implications and have over the years successfully resisted make significant changes to both.

Improving the efficiency of road transport may be possible by maximising heavy vehicle performance and achieving compliance with operating conditions. Remote verification of compliance with more flexible operating conditions will enhance economic gains while simultaneously achieving improved road safety and environmental outcomes for all parties.

3 PERFORMANCE BASED STANDARDS (PBS)

At its most basic, the performance based standards approach allows for vehicles or classes of vehicle - having met certain performance characteristics or measures – to be exempted from prescribed vehicle standards that apply to general access vehicles which have an 'as of right' use of the road network. The move towards performance based standards in Australia is intended to facilitate a shift towards tailoring classes of vehicle to specific operating environments and specific freight tasks. This is established by focusing on how the heavy vehicle combinations behave on the road and measured by a set of safety and infrastructure protection standards matched to four levels (Level 1-4) of the road network. The PBS project has developed technically-sound means of assessing vehicle performance. PBS will assist the road transport industry by allowing the operation of fewer, safer and more efficient heavy vehicles.

The introduction of performance based standards poses a number of unique challenges to regulators in terms of monitoring compliance and ensuring enforcement. This is because performance standards place an emphasis on meeting outcomes rather than processes. Consequently, performance standards require a greater level of technical expertise and understanding of vehicle impact and performance than do conventional prescriptive standards.

Government - in moving away from the social and economic inefficiency of standards based on 'one rule fits all', to a system that engages with operating conditions specific to mass,

dimension, configuration, time and location - demand a high level of veracity from information management systems which claim a capacity to verify compliant behaviour. The capacity to differentiate between prescription and performance compliance raises complex issues, be they engineering or regulatory in nature. Resolution of these issues hangs on mechanisms that can assure regulators of compliance with those aspects of operation that are prescription based, and those that are not.

4 THE INTELLIGENT ACCESS PROGRAM (IAP)

The Intelligent Access Project (IAP) was conceived in the late 90's by the various road authorities when they realised that an expanding population and economy needed a better system of data to both control this expansion and to protect the road infrastructure and the safety of all road users. This quickly proceeded to a set of objectives for the development and introduction of a system which can produce integrated information services to road users and road use data to the jurisdictions by a transparent methodology. The objective of IAP is the development and implementation of a voluntary system that can remotely monitor heavy vehicles in order to ensure that they are complying with their agreed operating conditions.

This compliance regime has to stand up as evidence to a regulatory standard and has to be capable of assuring regulators of compliance with specific conformance to mass, dimension, configuration, speed, location, and time of day activity. The IAP ushers in a new era of electronic compliance monitoring and paves the way for better targeted on-road enforcement as the heavy vehicle combinations operated under IAP are fitted with an In-Vehicle Unit (IVU) which enables monitoring and recording of various operating parameters. The system utilises a Global Positioning System (GPS) and on-board monitoring devices that can provide information on vehicle speed, time and position and vehicle and/or driver identification.

Under the IAP model, the transport operators engage certified IAP service providers on a commercial basis. The IAP service providers monitor the agreed IAP conditions (time and route restrictions, maximum speed etc.) of the transport operations and report any non-compliance event to the jurisdictions.

Guidelines have been developed with the assistance of the telematics industry ensuring that the end result was technically feasible, acceptable to industry, and had a positive net financial gain to all parties involved. Final stages of the IAP are almost complete with an IAP Business Case, Technical Guidelines, Performance Specifications, Administrative Guidelines, a national Policy Framework and a nationally agreed and supported Certification and Audit Program now in place.

5 DEVELOPMENT AND ASSESSMENT OF AN INTERMODAL PBS VEHICLE CONCEPT FOR CONTAINER TRANSPORT

The containerised freight segment of the road transport industry is developing significantly faster than road transport in general. The number of containers moving through the Port of Brisbane is growing by approximately 6-7% per year and it is expected that between 2004 and 2020, the TEU (20ft equivalent unit) numbers will increase from 0.612m to 2.8m, an increase of about 350%. In addition, there is a general trend towards the deployment of more 40ft

containers for export and import and there is an increasing number of heavy containers in the transport mix. The utilisation of heavy vehicles can be significantly influenced by these trends. B-doubles, for instance, can only carry 1 x 40 ft container and the larger number of heavy containers can increase the risk of overloading the combination or certain axle group of the combination. The existing heavy vehicle mass and dimension limits restrict the efficiency of these operations. Unless more freight efficient vehicles are encouraged, the number of trucks will continue to increase, to the detriment of port efficiency, road infrastructure and the environment.

In 2004, Queensland Transport (QT) received an application from a transport operator for the operation of non-standard, innovative heavy vehicle combination. The combination was developed for the transport of heavy 40ft containers and it included a single-steer tandem-drive prime towing a quad-axle semitrailer. The axle loads of the proposed combination were: 6t on the steer, 17t on the drive group and 27t on the quad-axle group. The proposed combination had an overall length of 17.5m and a Gross Combination Mass (GCM) of 50t. Both the axle loads and the GCM of the proposed combination were higher than maximum legal mass limits applying for this type of combination in Queensland. The combination is illustrated in Fig 1.



Fig. 1 the FCL quad-axle semitrailer combination

Queensland Transport (QT) supported this application as the quad-axle semitrailer was considered to offer considerable improvements in both productivity and safety when compared with conventional six-axle articulated combinations currently in operation. The proposal corresponded to QT's agenda of reducing the number of heavy vehicle movements undertaken, improving community amenity by reducing emissions, reduced truck presence in the community and increasing intermodal linkages. PBS assessment of the quad-axle semitrailer combination was carried out by RoadUser Systems Pty Ltd. The results of the desktop assessment are presented in Table 1.

This assessment was followed by an instrumented field testing program. The layout of the instrumentation as fitted to the test vehicle is illustrated in Fig 2. Only selected PBS measures were chosen for the instrumented field testing program as the primary objective of this testing program was to assess the lateral dynamics and the road space requirement of the quad-axle semitrailer combination. The assessed PBS measures included: Tracking Ability on a Strait Path (TASP), Low Speed Swept Path (LSSP), Frontal Swing (FS), Tail Swing (TS), Steer Tyre Friction Demand (STFD), Static Rollover Threshold (SRT), Rearward Amplification (RA), High Speed Transient Offtracking (HSTO) and Yaw Damping Coefficient (YDC).

The instrumented testing program was completed by using various testing methods. For instance, to determine the RA of the vehicle by measuring the lateral acceleration at the steer axle and rear trailer the lane change manoeuvres were executed at 88 km/h with frequencies of 0.3, 0.4, 0.5 Hz, and a peak lateral acceleration at the steer axle of 0.15 g. The various lane change paths are illustrated in Fig 3. The computer simulation model was calibrated by using the values obtained during the instrumented testing program and the performance of the proposed quad-axle semitrailer was reviewed. This review illustrated that the proposed quad-axle semitrailer satisfies all Level 1 PBS safety requirements.

| PBS Performance Measure | Performance Requirement | Proposed quad-axle combination | Pass/Fail (Level 1) |
|-------------------------------------|-------------------------|--------------------------------|---------------------|
| Startability | 20% | 25.6% | Pass |
| Gradeability | 80km/h on a 1%grade | 93.7 km/h | Pass |
| Acceleration Capability | As described by NTC | meets Level 1 | Pass |
| Tracking Ability on a Straight Path | Max. 2.9m | 2.71m | Pass |
| Low-Speed Swept Path | 7.4m | 6.70m | Pass |
| Frontal Swing | 0.7m | 0.34m | Pass |
| | 0.3m | 0.08m | Pass |
| Tail Swing | 0.3m | 0.08m | Pass |
| Steer Tyre Friction Demand | No greater than 80% | 49 % | Pass |
| Static Roll Threshold | At least 0.35g | 0.37g | Pass |
| Rearward Amplification | < 5.7 * SRT | 1.38 | Pass |
| Yaw Damping | Greater than 0.15 | 0.37 | Pass |
| High-Speed Transient Offtracking | Less than 0.6m | 0.26m | Pass |

Table 1 Computer simulation results

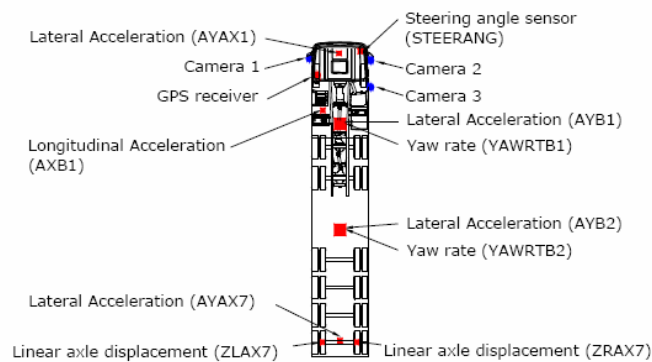


Figure 2 Vehicle instrumentation layout

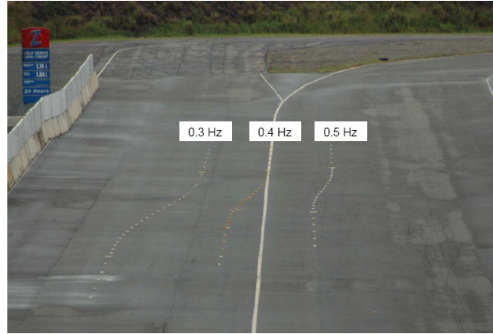


Figure 3 Lane Change paths (Source ARRB contact report VC71358-01-01)

5.1 Infrastructure issues

The PBS pavement vertical load measures requires that the average road wear per axle group (SARs/AG) shall not exceed the level calculated for a vehicle with the same number of rigid parts and the same number of axles on each rigid part as permitted by prescriptive (or equivalent) regulations. As there is only a limited knowledge on the damaging effects of this axle group on pavement performance, a supplementary prescriptive limit of 22.5t was adopted as a maximum quad axle load within the PBS pavement vertical load requirements. The axle loads of the proposed combination are detailed in Table 2. It illustrates that the quad axle group requested by industry was higher than the quad-axle loads that are permitted under PBS rules.

| | Steer Axle (t) | Drive Group (t) | Quad Axle Group (t) |
|--------------------------|----------------|---------------------|---|
| Current axle load limits | 6.0 | 16.5 17.0 (HML*) | 20.0 22.5 (PBS**) 24.0 (PBS – HML***) |
| Requested axle loads | 6.0 | 17.0 | 27.5 |

Table 2 Current and requested axle group load limits (*Higher Mass Limits routes, ** Under PBS rules on general access routes, *** Under PBS on HML routes)

The PBS bridge measure it specifies that bending moments and shear forces be no greater than the moments and forces induced in the bridge by reference vehicles with axle group loadings set as appropriate for the road class or route. This assessment has to be conducted for a range of bridge span lengths. Since the GCM of the proposed quad-axle combination was higher than the GCM of general access vehicles currently using the network and higher than the GCM of the reference vehicle, under the current PBS bridge assessment method it is difficult to meet the PBS bridge requirements and achieve any increase in mass. The assessment of the quad-axle semitrailer combination against the PBS infrastructure measures has indicated that the proposed combination does not meet all of the PBS infrastructure standards. Consequently, the operation of the quad-axle semitrailer was only approved under strict operating conditions.

Achieving compliance with mass limits and adherence to approved routes were essential elements of the proposal; therefore satellite tracking and on-board mass monitoring were also required. At this stage the evidentiary level security of on-board mass monitoring systems has not yet been reliably established. In addition, concerns have been raised for the accuracy and

operational characteristics of on-board mass measuring systems. A decision has been made nationally that Stage 1 of the IAP would only control heavy vehicle position, heavy vehicle time and speed compliance and would not include on-board mass monitoring until these technical issues resolved. As the legislative elements of IAP had not yet been established and implemented by the time of the commencement of the trial operation of the combination, an invention of a new legislative management framework was necessary. This framework covered issues related to the technology used, the access reporting process, mapping and non-compliance issues, provider certification and the development of the necessary audit criteria.

The specification and development of an on-board mass monitoring system was achieved by co-operation between the regulatory bodies (QT and Department of Main Roads (MR)), the transport operator (FCL), the potential service provider (NAVMAN) and the supplier of hardware (Tramanco). A legal framework was also developed that could regulate the relationships between the transport operator, the service provider and the jurisdiction. The arrangement was formalised in a Tri-Partite Agreement with signatories from FCL, QT/MR, and NAVMAN (FCL's service provider). This agreement detailed how each party will facilitate the operation of the combination under a QT issued permit.

Although the monitoring of route access by a GPS-based system is generally available these days, the available access of the proposed quad-axle semitrailer to the road network strongly depends on the loading conditions of the combination. There are limits placed on both the individual axle loads and the Gross Combination Mass (GCM) of the combination. Table 2 summarises these mass limits. Some of the approved routes are illustrated in Figure 4. The development of a more intelligent monitoring system was necessary which can assess the location information received from the vehicle's GPS system and the mass information gained from the on-board mass measuring system and can compare this data to the agreed access conditions.

| Steer Axle (t) | Drive Group (t) | Quad-axle group (t) | GCM (t) | Access |
|---------------------------|----------------------------|--------------------------------|----------------|--|
| < 6.0 | < 16.5 | < 20 | < 42.5 | General Access - No access restrictions apply |
| < 6.0 | < 17.0 | < 27.5 | < 50.0 | Restricted Access Operation of the combination is only allowed on the specified routes |

Table 2. Operating Mass limits

6 DEVELOPMENT AND ASSESSMENT OF AN INTERMODAL PBS VEHICLE CONCEPT

The main elements of the monitoring system used on the quad-axle combination are: the on-board mass measuring system supplied by Tramanco (using Check-Way® Electronic Weighing and Data Logging System®), the tracking system via GPS (using Navman GPS systems) and the reporting modules for providing Non Conformance Reports (NCRs) produced by a sub contract service provider (SmartTrans).

BRISBANE MAP A
MAP CREATED: 19/1/2006

FISHERMAN ISLANDS

Access to all roads in Port of Brisbane area
or Fishermans Islands

- Port One
- Shelton One
- Lutcliffe One
- Edgely Farmhouse One
- Edgely One
- Edgely Two
- Edgely Three
- Edgely Four
- Edgely Five
- Edgely Six
- Edgely Seven
- Edgely Eight
- Edgely Nine
- Edgely Ten
- Edgely Eleven
- Edgely Twelve
- Edgely Thirteen
- Edgely Fourteen
- Edgely Fifteen
- Edgely Sixteen
- Edgely Seventeen
- Edgely Eighteen
- Edgely Nineteen
- Edgely Twenty
- Edgely Twenty One
- Edgely Twenty Two
- Edgely Twenty Three
- Edgely Twenty Four
- Edgely Twenty Five
- Edgely Twenty Six
- Edgely Twenty Seven
- Edgely Twenty Eight
- Edgely Twenty Nine
- Edgely Thirty
- Edgely Thirty One
- Edgely Thirty Two
- Edgely Thirty Three
- Edgely Thirty Four
- Edgely Thirty Five
- Edgely Thirty Six
- Edgely Thirty Seven
- Edgely Thirty Eight
- Edgely Thirty Nine
- Edgely Forty
- Edgely Forty One
- Edgely Forty Two
- Edgely Forty Three
- Edgely Forty Four
- Edgely Forty Five
- Edgely Forty Six
- Edgely Forty Seven
- Edgely Forty Eight
- Edgely Forty Nine
- Edgely Fifty

BRISBANE MAP B
MAP CREATED: 19/1/2006

At right turn from Lytton Rd to Hemmant Rd

BRISBANE MAP C
MAP CREATED: 19/1/2006

BRISBANE MAP D
MAP CREATED: 19/1/2006

In this monitoring model, both the location and mass information is channeled to the service provider that assesses the information and makes a decision if the vehicle can legally travel on the routes in question under the loading conditions. If the vehicle does not comply with any of the operational conditions -being mass or route compliance, a non-compliance report is issued and sent to QT and MR. The validity of the NCR is investigated by QT before any action is initiated against the transport operator. Following the investigation, if QT and MR are satisfied that the NCR requires further action, based on the severity of the breach or risk to the infrastructure, the jurisdiction will either issue a Penalty Infringement Notice or initiate a judicial briefing.

The Smart-Amps® have their own unique identifiers which allow each vehicle unit to be clearly identified individually in a combination regardless of the size of the combination. This system has been successfully used on various heavy vehicle combinations ranging from a prime mover semitrailer up to a six-trailer road train combination. Tramanco has developed various software programs for different applications including gross/net weight, axle lift, mass monitoring and suspension performance monitoring. The system also has a driver identification (ID) feature that requires the driver to enter a four key strokes to record his ID.

Navman designs, develops, manufactures and delivers a complete end-to-end fleet management solution. The Navman Online AVL service offering is a web based vehicle tracking and communications services. The hardware contains a GPS receiver, which provides accurate positioning, using the GPS satellites, a cellular modem and a microprocessor board which continuously analyses position and cellular network status to decide when and how to report position. A private connection is in place between the cellular network and the Navman Servers so traffic is sent directly from the cellular network to Navman's Servers without transiting any public network. All communications, events and user information is stored in a database on the Navman Server. The server is only accessible across the internet using the Navman provided customer desktop application. Through these customer desktop applications, users are able to view where any tracked vehicle is or has been. Real-time updates are shown both on maps and as a textual description.

To achieve the objectives required under the IAP the mass data from the monitored vehicle is sent every 2.0 minutes (which can be varied) to the Navman GPS system which pairs this mass data with the vehicles position and speed to meet the other requirements of the IAP. All data is sent in an encrypted format with check sums, data identifiers, transmission sequence numbers and an eight character block of data which monitors any tampering with the Chek-Way® system. This data is sent out over the mobile phone network at minimum cost and monitored by the service provider who provides access to the data to the operator (password protected) and also sends NCR's (automatically and autonomously to the road authorities).

7 IN-SERVICE ASSESSMENT OF THE ON-BOARD MASS MONITORING SYSTEM

As concerns had been raised about the reliability and operation of the monitoring system used on the combination, QT has conducted an extensive but practical in-service test program for the assessment of the on-board mass monitoring system and QT's capability of enforcing the agreed operating conditions. The object of this testing was not to establish or certify if the on-board mass measuring and reporting system meets the requirements for in-service accuracy and tamper security, but to evaluate and the practical and operational limitations related to the operation of such a system. A number of non-compliance events were created under strictly controlled conditions and the monitoring service was tested to report the non-compliance events simulated and to demonstrate that compliance can be achieved through the monitoring system. These scenarios included: overloading the vehicle; overloading various axle groups; tampering with the on-board mass monitoring equipment (changing the calibration); tampering with the GPS equipment; exceeding the speed limits and operating the combination outside of the approved routes.

The on-board mass monitoring system was calibrated against weighbridge measurements. The initial calibration of the on-board system was very important as the load on the steer axle is not directly measured. A constant steer axle weight is added to the measured drive group load. The approved routes were mapped and geofenced. A geofence is an active area that can be drawn on a map. The vehicle monitors this area in comparison to its current GPS position. If the vehicle enters or exits this area, an immediate update is sent through the server to the customer desktop application. The test vehicle consisted of a Mack 6 x 4 cab-over prime mover coupled with a quad axle skeletal semi-trailer. The container was loaded with palletized load. The operational permit

allows for variations of +/- 1.5% of total mass on each vehicle unit and on the GCM of the combination i.e. 750kg maximum tolerance. During the testing, the axle loads were measured on a certified weight bridge and compared with the on-board system. Table 3 illustrates the results that all tolerances were within the stated objective of +/- 1.5%. The on-board system can monitor the position of the liftable axle of the quad-axle group (UP or DOWN) or if the turntable position is changed (UP or DOWN).

| | Load on steer axle + drive group (prime mover) (kg) | Load on the quad axle group (kg) | Total weight (kg) |
|-----------------|---|----------------------------------|-------------------|
| Weighbridge | 21,440.00 | 25,600.00 | 47,040.00 |
| On-board system | 21,240.00 | 25,260.00 | 46,500.00 |
| Variation | -200.00 | -300.00 | -540.00 |
| | -0.93% | -1.13% | -1.14% |

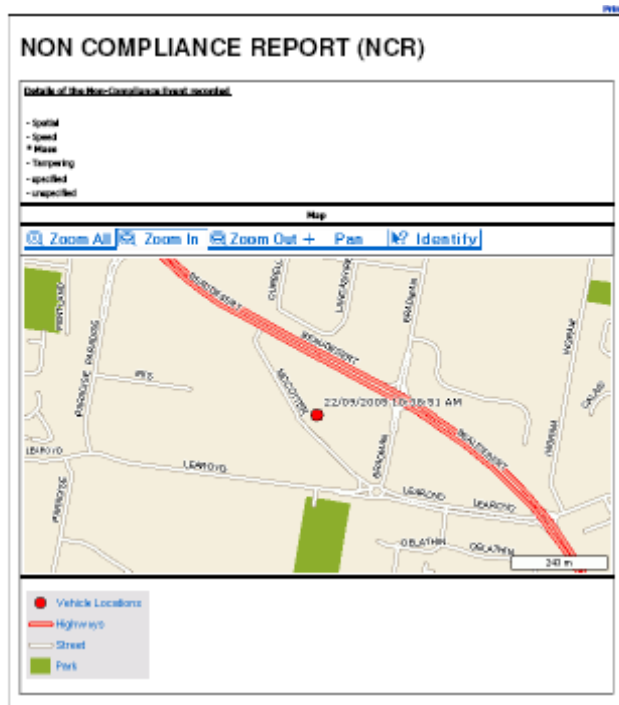
Table 3 Measured axle loads

Additional testing of the Tramanco system conducted by the MR indicated that the accuracy of the on-board monitoring system is within the tolerances of Class 2 of the *National Measurement Regulation* 1999.

During the "overloading test" the Gross Combination Mass of the combination exceeded the maximum 50.00 t limit. The Check-Way® meter displayed the following loaded weights: CH A (prime mover): 20,600kg, CH B (quad trailer): 31,720kg and TOTAL: 52,320kgs. Under this loading condition the weight display on the trailer (CH B) was flashing to warn the driver that an overload is present. A sample of a NCR is illustrated in Fig 5.

A single test was also conducted to try to "blind" the GPS antenna and to see what effect this had on the data. This was accomplished by putting an alfoil shield in the form of an "envelope" which covered entirely the GPS antenna. The vehicle was moved from the northern end of the depot to the southern end of the depot. As a result, the GPS system confirmed that the vehicle moved from the Northern end and had "popped up" 500 metres away at the southern end some 15 minutes later.

During the on-road testing the driver was requested to stop and disconnect the trailer scales, then drive for some distance, find another safe place and stop and re-connect them. These actions were recorded by the monitoring system and it reported that the truck was traveling without a trailer for a certain distance and provided details of the times and locations where these events occurred. All attempts to fake the results or to tamper with the system were recorded. The assessment of the speed monitoring function of the system was conducted by lowering the "approved speed limit" for the combination from 100 km/h to 40 km/h on an approved segment of the freeway. It was done by using the Navman's's desktop application that can link specific speed limits to specific geo-fences or operating areas. During its travel when the speed of the quad-axle combination exceeded this "new" speed limit a non-compliance report was generated.



| IVU# | IVU# | Date | Time | Longitude | Latitude | Direction of travel | Speed | Tamper alarm | Location | MassA | MassB | MassC | MassD | MassE |
|---------|---------------|------------|----------|-----------|----------|---------------------|-------|--------------|-----------|-------|-------|-------|-------|-------|
| Unknown | 4-9-E-63-0001 | 22/09/2005 | 10:38 AM | 153.03409 | 27.59637 | 313 | 0 | | Fcl Depot | 20960 | 31540 | | | |

Figure 5 Non compliance report (Mass)

When the combination entered into the Port of Brisbane area the driver was instructed to drive in and out of the permitted zones, which it did, and NCR's have been generated accordingly for the respective geo-fences.

Supplementary tests have been conducted on other heavy vehicle combinations which indicate that in addition to monitoring the mass on heavy vehicle combinations the Chek-Way® system might be suitable to monitor the performance of heavy vehicle suspensions characteristics and plot a histogram of longevity by taking a series of data readings from the system whilst the vehicle is actually in service. This test is called Axle Test® and can be a standard feature of any Chek-Way® system with recording the performance of the suspension for a known input that can be repeated. The "Trip Test®" feature of the system can monitor the peak dynamic loads on the axle groups of a heavy vehicle combination traveling on any route at any time. The measured peak dynamic forces can be linked to road condition (apart of other factors such as loading conditions, speed etc). By collecting and analyzing this data might lead to using the GPS information for the location of critical sections of the trip where road impacts on the vehicle might require further investigation.

8 CONCLUSIONS AND BENEFITS

There is little argument that the capability of Australia's road network varies markedly and that there are opportunities waiting where higher masses, different dimensions and innovative

combinations could be accommodated with minimal risk to safety and infrastructure. Road agencies and industry will both need to have a common understanding and acceptance of the potential benefits from the introduction of performance based access arrangements.

QT and the National Transport Commission (NTC) strongly support the development of road transport policy options that are based on scientific information and assessment and progress initiatives for the most effective use of the road system. This process could lead to the development of more diverse heavy vehicles that are designed for specific freight task. The quad-axle semitrailer combination meets the PBS safety standards and could enhance the efficiency of the container transport operation. This project demonstrated that the PBS can provide a tool for the development and assessment of innovative proposals that offer safety benefits, productivity improvements and operational flexibility for fleet operators.

Since the introduction of the first combination in 2005, the transport operator now has 8 quad-axle trailers in operation. It has been reported that around 80-90% of the operation would include the transport of heavy containers. The new trailers have been designed to carry both heavy 40ft and 20ft containers which can improve the efficiency of the operation even more. The testing of the monitoring system has clearly demonstrated that it complies with the conditions and requirements of the existing operational permit and the Tri-Partite Agreement. It would also comply with most of the proposed requirements of the Intelligent Access Program. This trial achieved a simple yet accurate system which monitors and controls: mass compliance, spacial compliance and speed compliance. A small number of non-compliance reports has been received by QT and MR and these instances have been investigated. No major breach of the operating conditions was established.

IAP offers a means by which compliance with a PBS environment can be monitored using a portable paperless interface. The PBS and IAP framework can be cost effective and could provide significant benefits to the transport operators by achieving major efficiencies in the transport operations.