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THE USE OF CASE STUDIES IN THE DEVELOPMENT OF A PERFORMANCE-BASED APPROACH TO HEAVY VEHICLE REGULATION



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Abstract

Australia has embarked on an ambitious project to develop and implement a performance-based approach to regulation of heavy vehicles. This project is being managed by the National Road Transport Commission, which was established in 1991 to develop a consistent regulatory approach for heavy vehicles within the Australian federal system.

The Performance- Based Standards (PBS) project has four components, one of which is to undertake relevant case studies within a PBS framework. These case studies have been chosen from current reform priorities but also needed to cover the field of nominated 'standard' vehicles and prescriptive standards currently in operation. In addition to delivering the actual reforms, they will provide early demonstrations of the effectiveness of a PBS approach in existing applications and support the analysis and development of key performance measures and their respective standards.

The paper will outline the range of case studies being undertaken and how these studies will assist the development of the overall PBS approach.

1.0 INTRODUCTION

The National Road Transport Commission (NRTC) and Austroads (the association of Australian and New Zealand road transport and traffic authorities) have commenced a major project to develop a performance-based standards (PBS) approach to the regulation of heavy vehicles. A more complete description of the project is given by Peters and Stevenson, 2000.

The expected outputs of a PBS approach are enhanced productivity, improved road safety and decreased environmental impacts, achieved through comprehensive reform of the approach to heavy vehicle regulation within Australia. The initial step is to allow augmentation of the current prescriptive approach with an optional PBS approach, based on agreed performance measures and standards for innovative vehicles on routes assessed as suitable. In the longer term, it is envisaged that the experiences derived from this augmentation process will drive developments in the prescriptive regimes such that PBS approaches will become more dominant.

The Australian/New Zealand project is a major undertaking, building upon previous international work, with a particular focus on an integrated approach through:

- Policy analysis
- Sustainable transport development
- Regulation reform
- Macro and micro economic evaluation
- Specialist technical analysis of the productivity/road safety interface
- The application of new technology/ITS.

The PBS project will be implemented progressively, with significant outputs expected to be available in 2002/3. It will provide a transparent and more rational process, which better addresses “dimensional creep”, provides a positive approach to projected road transport demand and allows deliberative evaluation of safety and environmental reforms and impacts.

A critical phase of the development process is the early consideration of illustrative ‘case study’ applications of PBS for a wide range of industry sectors.

2.0 PBS TERMS OF REFERENCE

The project is proceeding in accordance with the approved Terms of Reference, which specify four interrelated phases:

- A. Identification of appropriate performance measures and standards and a survey of the existing Australian fleet.
- B. Preparation of Guidelines for the consistent application of PBS.
- C. Regulations, Compliance and Enforcement – the arrangements for PBS to operate as an alternative to prescriptive regulations.
- D. Case Studies – Assembly of work previously conducted and the practical application of PBS to nationally agreed priorities.

The objectives of PBS will be met by the development of a new regulatory approach which:

- regulates for critical road safety and higher productivity performance
- optimises the vehicle/road design interface, particularly pavement and bridge wear
- accelerates the 'take-up' of new vehicle technology and Intelligent Transport Systems technology
- improves compliance with transport regulations
- ensures a consistent approach to the performance-based assessment of innovative vehicles
- assists a consistent approach to enabling local and specific use vehicles
- provides the opportunity for industry to enter into partnership with governments to finance infrastructure to support PBS operations.

Safety will be far more important when innovative vehicle designs are assessed transparently under a PBS approach, and new vehicles will, on average, be safer to operate than Australia's current heavy vehicle fleet. It is anticipated also that current heavy vehicle types that have poor safety performance would be phased out over time.

The general limit for vehicle width is currently 2.5m and for height 4.3m. These standards have not been subject to such intensive and regular reviews as mass and length limits. However, some vehicles are allowed to operate at greater heights or widths on restricted routes, carrying specific commodities or under permit/exemption arrangements. Individual States and Territories have for many years been permitting some vehicles that fall outside the prescriptive standards to use parts of the road system, where the operators have been able to demonstrate that the vehicles can operate satisfactorily. This activity has now reached a stage where there is a need for a nationally consistent approach. In addition, most prescriptive limits are only surrogates for addressing the fundamental operational performance concerns such as dynamic stability and efficient and safe access for heavy vehicles.

Terms of Reference for the PBS project and relevant reports can be sourced from the NRTC's Web site (www.nrtc.gov.au).

3.0 CASE STUDY PHILOSOPHY

Performance-based standards specify in precise terms the objectives to be achieved, but leave the means unspecified. A wide variety of heavy vehicle configurations are in use to match the different freight tasks and prevailing road and traffic conditions.

A key part of the project, Phase D, is the progressive completion of case studies which draw together the innovation, technology, productivity, safety and compliance and enforcement implications of PBS. The focus on case studies will provide:

- experience with utilisation of a PBS framework
- early delivery of benefits for specific applications
- identification and resolution of policy and implementation issues
- coverage across all aspects of the PBS project.

Traditionally, regulatory reforms have been concentrated on vehicle productivity and enhanced prescriptive standards. PBS case studies are expected to cover mass and dimension issues and also innovative vehicle combinations, safety improvements, environmental initiatives, access controls, alternative compliance and regulatory approaches and specific commodity or transport tasks.

Through these case studies, many of the potential hurdles to the overall PBS approach are expected to be encountered. These might include:

- the need to demonstrate to governments the integrity of a PBS approach
- verification of alternative simulation models for dynamic performance
- clarification of commercial confidentiality issues
- demonstration of integrated compliance approaches
- resolution of operational or jurisdictional border operation
- demonstration of operational advantages to operators
- effective processes for assessing vehicles against the road network
- confirmation of the potential scope of PBS approaches.

4.0 PREVIOUS CASE STUDIES

The NRTC commissioned a collation of relevant heavy vehicle investigations, which in part utilised elements of a PBS approach, and required this information to be put into a format useful for prospective PBS guidelines (ARRB Transport Research, 1999). It assisted with the determination of standards based on current best practice and provided an example of fleet performance. This work was used also as an input into a separate project, which identified possible performance measures (Roaduser International and ARRB Transport Research, 1999).

This work demonstrated in part that considerable experience was available across Australasia already on the use of a “PBS-like” approach, where innovations were assessed by investigation of aspects such as dynamic performance and infrastructure impacts. These case studies were largely productivity-driven, with the initiative taken primarily by transport operators. There was a wide range of performance standards and measures chosen and assessed, but considerable overlap on basic safety and performance characteristics, such as turning, acceleration, braking, handling and stability. The significance of individual standards in particular jurisdictions varied, possibly reflecting the different nature of the transport task and there was no general agreement on the numerical value (measure) for each standard.

In addition, the methods employed by jurisdictional agencies to make assessments varied (eg desktop studies, basic inspections and on-road trials, off-road full scale testing, short- or long-duration on road trials, computer modelling and simulation, reference to work by others).

5.0 CURRENT CASE STUDIES

5.1 B Doubles

The B Double configuration, which originated in Canada in the 1970s, has proved very popular in Australia, with access constraints easing considerably in the 1990s. The maximum overall length was set originally at 23 metres, but increased to 25 metres (with a tri-tri combination) in 1995, following a successful 12 month on-road trial. Because only overall length (and minimum axle spacing criteria) apply, there has been a trend for transporters of palletised freight to extend the load area (deck length) at the expense of reducing the length available for the tractor unit. This led to:

- introduction of very short wheelbase tractors, to provide for 36 1.2 m x 1.2m pallets
- implementation of a fixed deck length of 22 m and increased overall length of 27.5 m in one jurisdiction as a consequence of industry lobbying
- anecdotal evidence of operational and design problems with very short tractor units.

A review was commissioned by the Victorian State Road Agency (VicRoads) on behalf of the NRTC and draft recommendations have been made (Pearson, 1999). The draft report summarised the issues raised in public submissions and investigated options within a performance-based framework. It examined primarily ride quality, vehicle handling and low speed offtracking and recommended that the maximum length be increased to 26 metres and that an additional control be implemented to restrict the distance between the front trailer king pin and the rear of the combination to not exceed 20.5 metres. The report identified the implications for low speed offtracking but did not quantify any potential infrastructure implications. It also suggested that any decision might need to be deferred until the PBS project was more advanced and standards and measures agreed.

The case study raised a number of important issues, including the risks of prescriptive standards (creep, unforeseen consequences, and irrelevance to operational performance) and some of the difficulties in PBS assessments (lack of agreed standards and measures, infrastructure assessment). One potential approach to assessment of infrastructure impacts might be to initiate a sampling/demonstration process, utilising the current B-Double fleet variations and the recommended configuration. The final report is awaited.

5.2 Truck Trailers

Previous national mass limits for a truck-trailer combination restrict the total mass of a combination (other than a road train or B-double) and any load to 42.5 tonnes. In addition, the loaded mass of the dog or pig trailer must not exceed the loaded mass of the towing vehicle (ie 1:1 mass ratio). These limits appeared to unreasonably restrict the productivity of these vehicles (ie considerably less than possible if maximum axle mass limits and axle spacing were the sole criteria). Operators in a variety of industry sectors (including quarry operations, sand, gravel, grain cartage and brick cartage) have expressed strong interest in using truck and trailer combinations at higher gross mass limits to improve their productivity.

In 1996, ARRB Transport Research was commissioned to investigate the issue and conducted tests covering dynamic stability, braking, high speed off-tracking and other criteria for vehicles with different wheelbases, axles and suspensions and on-road trials under permit conditions were also conducted. The results indicated that increasing the mass ratio from 1:1 to 1:1.4 is unlikely to compromise road safety for vehicles fitted with air suspensions. (ARRB Transport Research, 1997). Based on this work, a preliminary set of operating conditions, covering suspension type, axle spacing and vehicle capability, was adopted by most jurisdictions (with some permutations), in advance of formal national agreement.

However in 1998, concerns were raised by the road transport industry regarding these Truck-Trailer operations at higher mass, ie:

- anecdotal reports were being received of some stability problems, with these higher mass combinations in both Australia and New Zealand
- recent simulation work indicated stability problems for certain truck-trailer combinations (particularly with high Centres of Gravity (CoG) and short wheelbases)
- there was potential for fleet conversion from more stable 6 axle articulated vehicles to truck-trailer combinations.

As a result, further work was commissioned to research and assess the application of performance criteria for on-road stability, based on computer simulations. The consultant's report (Roaduser International, 1999) indicated that:

- the stability performance of truck-trailer combinations is dependent on the CoG of the trailer (predominantly), longitudinal dimensions and the tow coupling rear overhang
- truck-trailer combinations with high CoG remain of concern
- acceptable stability can be achieved by adjusting critical design dimensions
- accident data involving truck-trailers at the higher mass limits were limited
- appropriate performance formulae can be developed to facilitate safe design
- there is no evidence at this stage of significant fleet conversion.

The poorer safety performance of these vehicles for some tasks and the critical trade-off between increased productivity and improved road safety was important in examining these issues.

The effects of truck and dog mass and dimensions on dynamic stability have proven to be complex and difficult to generalise. However, for combinations operating above 42.5 tonnes GCM and up to 50 tonnes GCM, a three level approach for approval of general access operation has been proposed as follows:

Level 1	Meet specific dimensional limits and a general set of control conditions, derived from the performance-based simulation analysis (eg CoG < 1.8 m).
Level 2	If outside the proposed performance-based controls in Level 1, an assessment against the performance formulae developed as part of this review is required (eg as shown in Eq 1)
Level 3	If performance formulae in Level 2 are not met, a full performance-based assessment is required.

As an example, the most general form of the performance formula under Level 2 for the truck and dog with 4-axle dog trailer at 50 tonnes GCM is given by:

[Eq.1]
$$\text{TrWB} + 1.24 \text{ TkWB} - 3 \text{ CROH} - 14.1 \text{ TrCOG} > - 25.0$$

where

CROH

=

coupling rear overhang (m)

TrCOG

=

trailer centre of gravity height (m)

TrWB

=

trailer wheelbase (m)

TkWB

=

truck wheelbase (m)

This case study raised several issues relevant to a PBS approach, including the need for staged approaches, the difficulty in removing productivity gains on the grounds of safety risk, the potential complexity of PBS approaches, debate over the numerical measure to be adopted and the dearth of reliable accident data with which to correlate simulation results. A final recommendation on this issue has not been made at this stage.

5.3 Bus Mass & Dimensions

Current bus and coach limits in Australia have been developed incrementally through a traditional process of periodic review based on economic and engineering principles. While regulatory authorities have attempted to apply the same principles to trucks and buses, there has been increasing industry pressure to treat buses differently. Arguments have been developed in relation to the additional tare weight required to meet safety standards in buses and coaches, and to respond better to the comfort, security and travel needs of passengers. The current "prescriptive" limits applied to buses and coaches are often based on considerations of performance, although this has not been made explicit in the past. The NRTC is currently carrying out a review of bus and coach mass and dimensions.

The application of PBS regulation to buses and coaches is following the principles being developed by NRTC and Austroads for heavy vehicle PBS to take account of:

- Underlying performance implications of current limits
- PBS methods currently under development for heavy vehicles in general
- Current safety and infrastructure issues identified for buses and coaches.

Some performance implications of current bus and coach limits are as follows:

- Steering axle load limits have been relaxed only slightly over the years, and very large-section tyres are needed for the higher weights. Road managers have been concerned about increased pavement wear and tyre safety for the steer axle.
- Drive axle load limits have been relaxed specifically for some buses (from 9 tonne to 10 tonne) in recognition of mass increases related to an accessibility reform, the use of road-friendly air suspensions, and the absence of significant concerns about roll stability for buses, with road managers concerned about increased pavement wear.
- The rear overhang limitation reflects generalised concerns about vehicle instability (if rear overhang is large relative to the wheelbase), and about tail swing in low-speed turns.
- The overall length limit has been relaxed, in some cases, specifically for buses (from 12.5m to 14.5m). Road managers are concerned about the ability of longer vehicles to turn at intersections (particularly in urban areas). Concerns have also been expressed about encroachment and protrusion of vehicles when accessing bus bays.

This project is currently in its final stages. The outcome is expected to combine changes to prescriptive limits for mass, length, and width for general access buses and coaches, together with a PBS framework for assessing other combinations of mass, length, and width for particular routes and regional applications.

5.4 Access to Local Roads

The focus on meeting critical safety standards is likely to be a compelling argument for achieving greater access by heavy vehicles to Australia's local road system (around 70

percent of the total network), a more effective strategic road network overall and, possibly, greater community acceptance of heavy vehicles generally. Present heavy vehicle access in urban and regional Australia is constrained by the local road network, and local community decisions will continue to be made to limit access on various grounds including amenity. However, the PBS approach will introduce for the first time an objective framework for decision-making, based on explicit vehicle, infrastructure and other performance criteria. This is likely to be highly appealing to local government authorities that have to reconcile economic development objectives with residential amenity, infrastructure protection and safety issues.

There is a tension between industry and the community over the use of larger heavy vehicles, particularly on roads which are not of arterial or higher function or design standard. Historically communities have been accused of being intolerant of larger vehicles, particularly in the local street system, whereas industry has been accused of being dismissive of community concerns. The absence of appropriate access assessment tools has resulted in an inadequate recognition of the role and classification of some roads and a mismatch between the vehicle and the road function and the vehicle task. The establishment of national vehicle access guidelines over the next 18 months aims to provide assessment tools, processes and procedures for both road authorities and industry to determine road network access with a high degree of consistency and transparency.

A number of specific case studies will be identified to enable rigorous testing of the guidelines with the different combinations of road and vehicle types.

5.5 Load Restraint Guide

In 1994, the NRTC implemented a different approach to load securement, which was based upon regulating the performance standards to be met (in terms of deceleration forces), rather than specifying minimum prescriptive requirements. A similar approach has been adopted in Canada. This approach recognised the very large range of cargoes being transported and the multiplicity of securement techniques, which made prescription inefficient. It provided a substantial improvement in industry restraint practices, but also demonstrated some potential risks for PBS approaches in general.

The Regulations were supplemented by a Load Restraint Guide, which outlined the performance standards and also provided examples of "best practice" for particular commodities. The perceived failures of the approach included the technical complexity of parts of the Guide for many users, inadequate communication and training of enforcement officers (some of whom considered the Guide as mandatory) and the lack of a national process to endorse and promulgate acceptable innovative restraint techniques.

A review of the Guide and development of appropriate supporting processes is underway, but the PBS approach will be retained. This case study has been useful in demonstrating both the strengths and potential weaknesses of such a PBS approach.

5.6 Cranes

The NRTC in October 1999 commissioned a study of concerns identified by the crane industry on their operation as Special Purpose Vehicles. The prime focus of this study was to:

- consider the application of Performance Based Standards (PBS) to the operation of cranes
- review tyre technologies in respect of the relevant regulations
- develop conditions for the towing of trailers by cranes
- document route assessment methods
- collate route information by State Road Authorities

A PBS approach should reduce the need for importers to carry out expensive modification of indivisible cranes, which could be imported in the appropriate configuration to meet an established set of national standards.

Performance Based Standards (PBS) will be an alternative to the current prescriptive approach to regulation and will allow vehicle movement to be managed according to how they perform, are driven and operated and match the characteristics of the road network. Under this approach, the size and mass of the vehicle may no longer be the primary factors determining the operation of vehicles, but rather their operational performance, effect on other users and impact on pavements and structures.

PBS will encourage a much more productive and safer range of vehicles and operators. Vehicles could be authorised to operate if it can be demonstrated that they can deliver net benefits to the community including safe operation on the road system.

The draft recommendations include:

- identification of tyre research needs regarding load distribution at the tyre contact
- a proposal for trailer towing under PBS conditions on suitable routes
- investigation of the possibility of developing a nationally agreed mobile crane assessment computer model for use with all overmass vehicles and loads
- development of a common national vehicle assessment process and application form
- continuation of work towards defining networks suitable for a range of overmass and oversize vehicles and suitable communication processes
- development of a suitable monitoring scheme to ensure a high level of compliance with travel conditions during vehicle movements
- specific technical initiatives covering improved access for oversize and overmass cranes.

This project only affects a small sectional interest group directly, but has significant broader implications if more productive cranes can be utilised efficiently. The PBS approach allows such sectional interests to be addressed objectively, with less risk of an undesirable precedent being set.

5.7 Other Case Studies

A range of other case studies are also proposed, underway or being assessed, including coverage of:

- specific applications for higher mass limits (eg. for twin-steer axles, single drive axles, super single tyres, single steer axle)
- general dimension limits (eg height limits of 4.3 m, vehicle width at 2.5 m)
- rigid vehicle controls, (recognising the contribution of these vehicles and the dissimilar transport patterns in comparison with long haul freight)
- commodity-specific transport (eg width of refrigerated vans carrying both frozen and chilled cargo and length generally).

Each project requires specific Terms of Reference and is expected to contribute to the overall PBS project.

6.0 PROJECT RISKS

The risks in adoption of a PBS approach are well recognised (Peters and Stevenson, 2000), eg disadvantage for small operators, technical complexity, diversity of solutions and corresponding enforcement difficulties, overly onerous controls imposed for whole trip based on origin/destination constraints, surety in setting standards, cost effectiveness. In addition, care is needed to ensure that PBS is not over-sold as an immediate panacea to all road reform issues. There is also a significant demand to communicate with the range of interest groups that will be part of the decision making process or affected by this new approach to heavy vehicle regulation. There are clearly considerable challenges ahead of the widespread implementation of a PBS approach, even as augmentation of conventional approaches.

However, retention of a traditional prescriptive approach does not appear sustainable, if the transport demands over the next 10 –15 years are to be met. For example, in Australia, it is projected that the road freight task will double in the next 15 years. In addition, it is anticipated that governments will demand road safety objectives drive operational controls on heavy vehicles. In responding to the laudable innovative skills of the Australian transport industry, better tools and regulatory frameworks are essential to ensure transparent and comprehensive assessments are possible, as well as government goals delivered.

7.0 CONCLUSIONS

The PBS project has commenced, with a major commitment to the use of case studies to help build the overall PBS approach. The range of case studies is extensive and this PBS approach is expected to be adopted in examination of similar issues in future. The other Phases of the project are also well advanced, eg the field of measures is currently being refined and evaluated and the standards are being developed.

The use of case studies is seen as an essential element of this development process, providing both early implementation and adding to the overall project integrity. It will provide a demonstration that the risks can be overcome, as well as an opportunity to effectively communicate with both transport operators, relevant government agencies and other community groups.

8.0 REFERENCES

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