

# A performance-based standards regime to regulate car-carriers in South Africa

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## ABSTRACT

Until recently, South African car-carriers operated under the abnormal load permit system allowing an additional 300 mm height and 500 mm length. Because car-carrier payloads are divisible and abnormal load permits are usually granted for indivisible loads, these permits were granted only as a special concession to the car-carrier industry. This practice is being phased out due to concerns over the stability of the over-height vehicles and a number of incidents of non-compliance by some car-carrier operators. The Abnormal Loads Technical Committee has stipulated two requirements should operators wish to operate car-carriers in excess of legislated dimensional limits. Firstly, the operator must be RTMS-certified (RTMS is the Road Transport Management System, a voluntary accreditation scheme addressing overloading, vehicle maintenance, driver training *etc.*); and secondly, the car-carrier should be shown to comply with the Performance-Based Standards (PBS) scheme. The PBS scheme is a detailed set of safety standards which regulate vehicle performance (such as vehicle rollover tendency) when conducting prescribed manoeuvres. A number of PBS demonstration projects are currently running in South Africa. This paper outlines the progress to date in developing and implementing PBS-compliant car-carrier designs, the regulatory challenges encountered, and the envisaged regulatory future for car-carriers in South Africa.

## 1 INTRODUCTION

### 1.1 Background

Until recently, it has been standard practice for South African car-carriers to operate under abnormal load permits, issued under Section 81 of the South African National Road Traffic Act (NRTA) (DoT, 2003). These permits allow the vehicles to exceed legislated height and length limits by 300 mm and 500 mm respectively. Generally speaking, abnormal load permits are granted for indivisible loads (e.g. large machinery components), and so the granting of these permits to car-carrier operators has been under a special concession of the TRH11 (Technical Recommendations for Highways: Dimensional and Mass Limitations and Other Requirements for Abnormal Load Vehicles) (DoT, 2000). This concession was granted in response to requests from the car-carrier industry so as to improve productivity and remain economically competitive.

In 2006, at a meeting of the South African Abnormal Loads Technical Committee (ALTC), it was decided that this practice would be phased out due to concerns of vehicle safety (due to increased height), the definition of “indivisible load”, and instances of non-compliance by some operators. This decision is currently enforced by the omission of any reference to car-carriers in the latest edition of the TRH11 (DoT, 2010). The committee has proposed that the granting of limited-period abnormal load permits will continue until 31 March 2013 for existing car-carriers registered before 1st April 2010; any car-carriers registered after this date will not be granted permits (including new vehicles of the same design as existing vehicles).

To maintain levels of productivity to which the industry is accustomed, the ALTC has proposed a replacement framework for over-length and over-height car-carriers. The proposal suggests that if an operator wishes to operate a car-carrier that exceeds prescribed height and length limits, two requirements must be met, namely:

1. the transport operator must be certified with the Road Transport Management System (RTMS), and
2. the vehicle design must comply with the Australian Performance-Based Standards or “PBS” scheme, which is currently the basis for a PBS demonstration project in South Africa.

## **1.2 Aim of paper**

This paper discusses the unique regulatory framework in which the South African car-carrier industry operates, the proposed changes to this framework, and the perceived future of the industry given these changes. The paper also summarises the research that has been conducted thus far in the context of the proposed new framework. Through doing so, the paper demonstrates how PBS, in conjunction with RTMS, can be used as a tool to improve vehicle safety and productivity.

## **1.3 Scope of paper**

The scope of this paper is limited to the regulatory framework of car-carriers in South Africa and the associated issues. Some technical aspects of the research conducted within this context are discussed, though only qualitatively.

The paper proceeds as follows:

1. An introduction to RTMS and PBS is provided.
2. An overview of car-carriers in South Africa and the outgoing framework within which they have operated is presented.
3. The proposed RTMS/PBS framework for car-carriers is discussed.
4. Progress towards the proposed new framework is summarised, covering the RTMS certification of the industry and the PBS assessment of three car-carrier designs.
5. A perceived future for car-carriers in South Africa is proposed.

## **2 A REGIME CHANGE FOR CAR-CARRIERS IN SOUTH AFRICA**

### **2.1 RTMS and PBS in South Africa**

Published in 2004, the South African National Overload Strategy (Steyn et al., 2004) sought to address the problem of overloading facing South Africa. The report proposed the introduction of self-regulation as part of a comprehensive long-term solution: a scheme by which initiatives are implemented by industry to establish sound vehicle management practices. Such a scheme has materialised and is known as the Road Transport Management System (RTMS). The accreditation scheme is industry-led and certification is voluntary. It promotes sound vehicle management systems that address issues of road infrastructure protection, vehicle safety and logistics efficiency by prescribing requirements for vehicle maintenance, load management, driver training and driver wellness (Nordengen et al., 2008). Because RTMS certification is voluntary, incentives exist to promote industry participation. One such incentive is that RTMS-certified operators are eligible to participate in the South African PBS demonstration project or “Smart Truck” programme (Nordengen and Oberholtzer, 2006).

Performance-based standards offer an alternative regulatory framework to prescriptive standards for heavy vehicles. Prescriptive standards regulate vehicle parameters such as overall mass, length and axle loads which indirectly govern vehicle safety and road preservation. PBS directly governs these desired outputs, allowing more flexibility in the vehicle’s design (i.e. mass and dimensions). This flexibility allows for higher productivity vehicles that are able to meet a stringent set of minimum standards in terms of on-road performance. Higher productivity vehicles make economic sense, resulting in a reduction in vehicles on the road (and hence their risk exposure), fuel savings, emissions reduction and reduced road wear per ton of payload transported. When coupled with RTMS, PBS offers a safer, cleaner, more efficient, and more road-friendly transport solution.

For the implementation of the RTMS and PBS initiatives in South Africa, the Australian National Heavy Vehicle Accreditation Scheme (NHVAS) and PBS scheme respectively were chosen as the foundations upon which to develop the South African equivalents (Nordengen and Oberholtzer, 2006) (CSIR, 2010). A South African Smart Truck Review Panel was formed which meets approximately every two months to assess PBS applications and to regulate the implementation of PBS in South Africa. A Smart Truck Steering Committee was also formed which comprises representatives from industry, transport authorities and research entities.

The Australian PBS scheme (NTC, 2008), consists of a number of prescribed tests and manoeuvres designed to assess a vehicle’s safety in what are deemed to be the most critical circumstances. These include driveability tests which assess the ability of a vehicle to safely navigate steep grades, a low-speed turn test which assesses the amount of road-space required for a vehicle to perform a turn at an intersection, and various high-speed manoeuvres that assess a vehicles tendency to rollover, become unstable, or deviate into adjacent lanes in extreme scenarios. The pass/fail criteria of some of the standards are different for different road access levels, i.e. if a vehicle will require unrestricted road access it will have to meet the strictest criteria, whereas if it will only utilise main freight routes it will have to meet a set of slightly less stringent criteria but will be restricted to these routes. In South Africa, it is required that all PBS vehicles that exceed the 56 ton combination mass limit will have to undergo bridge-loading and road wear assessments.

Compliance with each of the performance standards may be assessed either by physical testing or by computer simulation. Computer simulation is the more popular option for obvious reasons, and various software packages exist for this purpose. Locally, such assessments have been conducted at the Council for Scientific and Industrial Research (CSIR) and at the University of the Witwatersrand (Wits) using the TruckSim<sup>®</sup> software package (“TruckSIM 8.1, Mechanical Simulation Corporation,” 2012).

## 2.2 Car-carriers and the outgoing regulatory framework

Car-carriers in South Africa typically exist in the form of one of two vehicle combinations: tractor and semitrailer combinations and truck and tag-trailer combinations. Illustrations of the vehicle types are shown in Figure 1. The truck and tag-trailer combinations can be further categorised into “short-long” and “fifty-fifty” configurations, referring to the relative lengths (and hence carrying capacities) of the truck and trailer respectively (see Figure 1 (b) and (c)).

The vehicles in Figure 1 are shown with the dimensions permitted by the outgoing abnormal load permit concession. The additional 300 mm allowance in height (from 4.3 to 4.6 m) is crucial for increased productivity. Without the allowance, the number of vehicles that may be carried is reduced and the possibility of an upper deck of vehicles is unlikely except when transporting low-profile vehicles. A similar point may be argued for the additional length (from 18.5 to 19 m for semitrailer configurations and from 22 to 22.5 m for truck-trailer configurations).

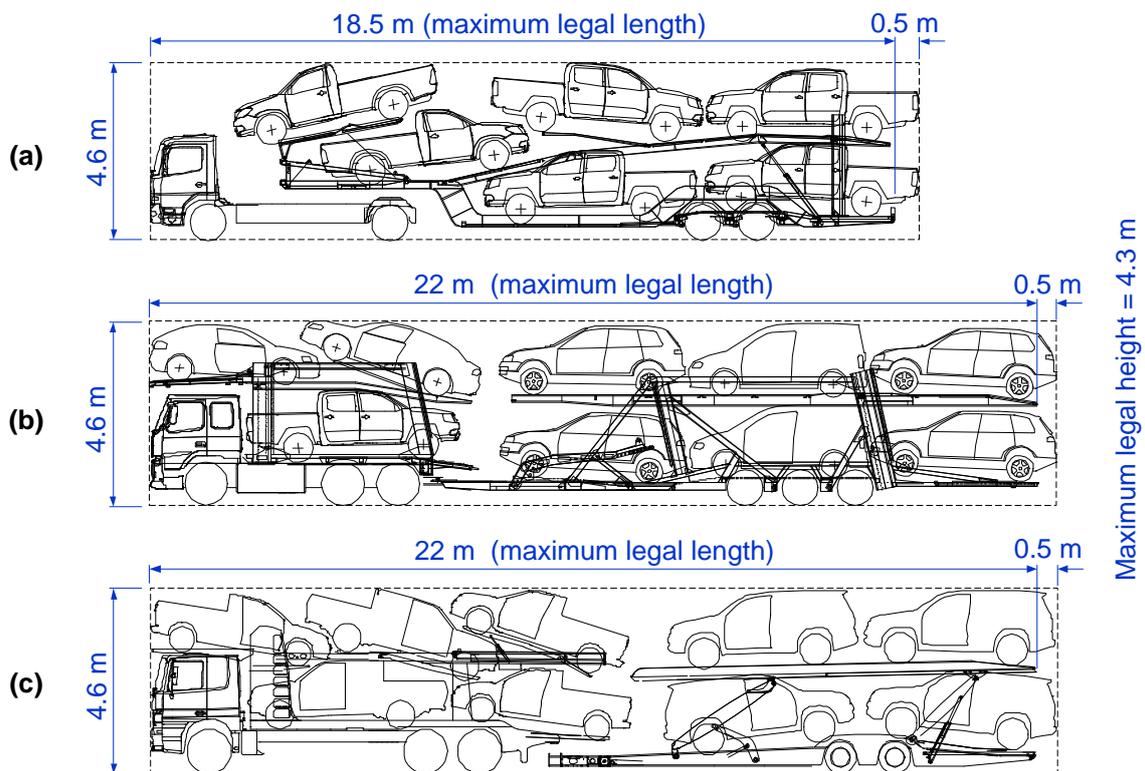


Figure 1: Typical South African car-carriers: (a) tractor and semitrailer, (b,c) truck and tag-trailer (short-long and fifty-fifty respectively) (Courtesy of Unipower (Natal) and Lohr)

### **2.3 The proposed RTMS/PBS framework for car-carriers**

Of the two options presented to the South African car-carrier industry by the ALTC (i.e. adhering to legal limits or obtaining RTMS and PBS approval), the option of adhering to the requirements of the NRTA was considered uneconomical. At present, car-carriers up to 23 m in length (22 m unladen) and 4.6 m in height (4.3 m unladen) would be considered for PBS car-carrier applications seeking unrestricted route access.

The process of gaining approval for a PBS car-carrier involves the following (CSIR, 2010):

1. Operators must obtain RTMS certification for the relevant vehicle fleets.
2. Operational approval must be obtained from the Abnormal Load Permit Offices in each of the provinces in which the vehicles are to operate.
3. Each vehicle combination design must be assessed in accordance with the Australian PBS scheme, and an assessment report must be submitted to the Smart Truck Review Panel for consideration.

In the context of the PBS demonstration project in South Africa, car-carriers are unique. Unlike typical Australian PBS vehicles, or any of the current operational PBS vehicles in South Africa, these vehicles do not exceed the legislated combination mass limit of 56 tons, and the vehicles themselves (excluding load projections) do not exceed the overall height or combination length allowances. It is the load of the laden vehicle that projects in excess of the legislated length and height limits. Because car-carriers do not at present exceed a combination mass of 56 tons, bridge-loading and road wear analyses are not required, though axle mass limits are enforced.

The following section presents the progress thus far in the RTMS/PBS initiative for car-carriers in South Africa.

## **3 PROGRESS TO DATE**

### **3.1 RTMS certification**

As of November 2012, four major car-carrier operators in South Africa had obtained RTMS certification, representing 740 vehicles on the road (including six from a smaller operator). These operators and their associated fleet sizes are shown in Table 1. This progress suggests a keenness of the industry to adopt the proposed new framework, and helps address the ALTC's concerns regarding previous instances of industry non-compliance.

**Table 1: RTMS-certified car-carrier operators, November 2012 (Source: JC Auditors)**

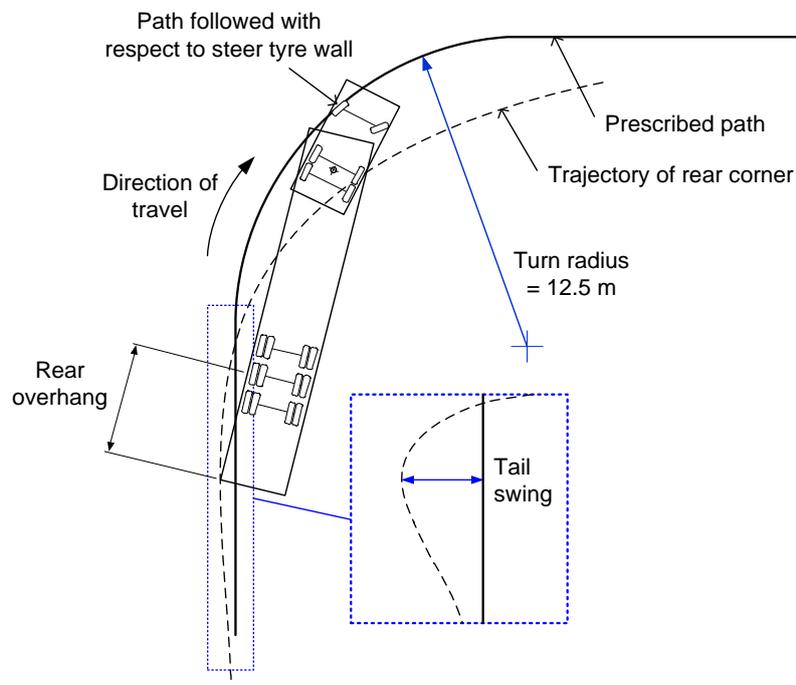
<b>Operator</b>	<b>No. of vehicles (Nov 2012)</b>
Motorvia	292
Grindrod Logistics	149
Vehicle Delivery Services (VDS)	173
To Anywhere Carriers (TAC)	120
Toyota Tshusho Africa (TTAF)	6

## 3.2 PBS assessments

To date, one of each of the typical configurations shown in Figure 1 has undergone a PBS assessment, conducted locally at the CSIR and Wits University using TruckSim®. These assessments are the first of their kind in South Africa and have provided hitherto unavailable insight into the performance of these types of vehicle. Note that none of the vehicle designs have yet obtained approval to operate as PBS vehicles. They may however operate without approval provided they comply with all the regulations in the NRTA. Selected aspects of the assessments are summarised in the sections that follow.

### 3.2.1 *Tail swing*

Tail swing is one of the low-speed standards governing road-space usage during a ninety-degree turn. It is a measure of how much the outer rear corner of a truck or trailer swings out into an adjacent lane during a turn at an intersection. The prescribed manoeuvre is a ninety-degree turn of radius 12.5 m with straight entry and exit tangents, which must be followed with respect to the outer steer tyre wall. This is illustrated in Figure 2 for the example of a generic tractor and semitrailer combination. The region in which tail swing is determined is enlarged for clarity (the enlargement is not to scale).



**Figure 2: Tail swing definition and measurement**

The amount of tail swing exhibited by a vehicle is primarily dependent on the vehicle's rear overhang (defined in the figure) (Prem et al., 2002). South African car-carriers possess very large rear overhangs compared with other types of heavy vehicle (with the exception of buses), and so it was anticipated that the tail swing standard would be critical for these vehicles. Through an assessment of the existing car-carrier fleet (De Saxe et al., 2012), it was calculated that only about 20% of the fleet could meet the requirement for unrestricted road access (maximum tail swing of 300 mm). Tail swing is therefore likely to be a limiting factor in the early stages of future car-carrier design, and rear overhangs will be restricted to values significantly less than what is allowed by the NRTA. For the short-long combination, a Unipower (Natal) Maxiporter, design modifications were required in order to meet the tail swing standard (and to address other short-comings), and the final design underwent field-testing to confirm the effect of the modifications on the low-speed turn standards (see Figure 3).



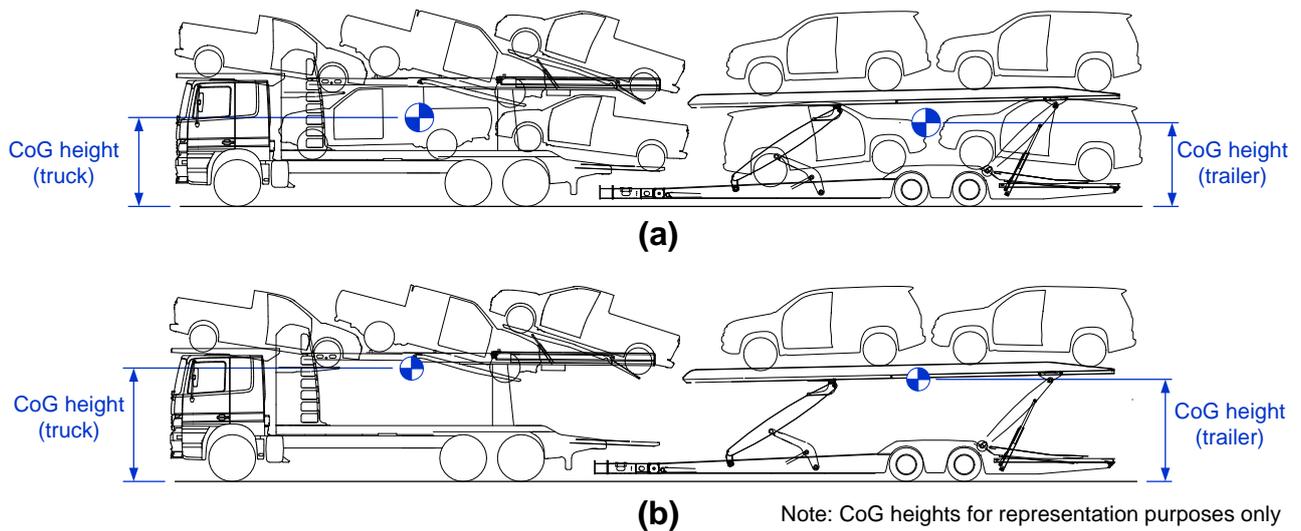
**Figure 3: The modified Unipower Maxiporter undergoing low-speed turn testing**

### 3.2.2 *Dynamic safety performance*

One of the ALTC's concerns relating to car-carriers was the increased rollover risk due to the vehicles' increased height. In a PBS context, rollover tendency is quantified using the "static rollover threshold" or "SRT" standard. SRT is determined either by a tilt-table test, or by setting the vehicle on a circular road of fixed radius and slowly increasing speed until rollover occurs. SRT is the maximum lateral acceleration reached by the vehicle at the point of rollover. For each of the three vehicle combinations assessed, with each at maximum payload capacity, it was calculated that SRT performance was acceptable.

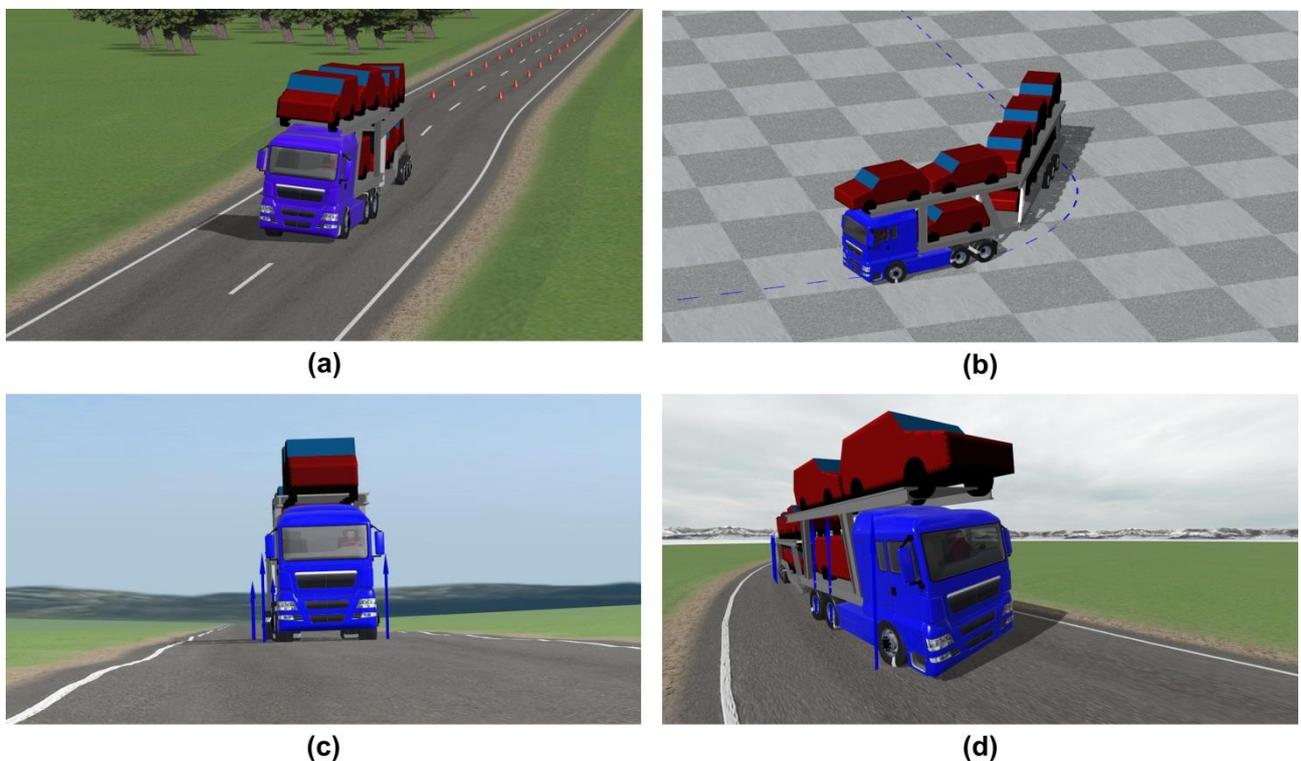
Unlike bulk goods vehicles however, car-carriers have highly variable payloads in terms of load distribution, and maximum capacity is not necessarily the worst-case scenario in terms of safety performance. Due to the nature of car transport logistics, it is not uncommon for a car-carrier to operate with cars on the upper loading platform while the lower loading platform is empty. This presents a situation where the mass of the payload is less than that of a full load, but the overall centre of gravity (CoG) height is significantly higher (see Figure 4). SRT is negatively affected by increases in both mass and centre of gravity height, and so it may or may not be the case that such a load scenario deteriorates SRT performance, depending on a number of other variables.

For the fifty-fifty combination, it was calculated that the SRT standard was not met when only the upper loading platforms were loaded. SRT performance of a fifty-fifty combination is expected to be inferior to that of a short-long due to the increased mass supported by the same number of axles on the truck (assuming that the truck has a lower rollover threshold than the trailer in each case). For assessment purposes however, no lowering of the upper loading platforms was taken into account for the "top laden" scenario, whereas in practice car-carrier trucks and trailers can lower the upper loading platform in such a case, reducing the overall centre of gravity height. Based on these findings it was proposed that the lowering of upper loading platforms when the lower platforms are empty be a condition of PBS approval for such vehicles.



**Figure 4: A comparison between the mass and centre of gravity (CoG) height of a car-carrier that is (a) fully laden and (b) has only its upper loading platforms loaded.**

Other performance standards that were found to be of importance for typical car-carrier designs are “yaw damping” and “high-speed transient offtracking”. Yaw damping is a measure of the rate at which yaw oscillations decay after a severe steering input at speed. High-speed transient offtracking is a measure of how much the rearmost trailer of a vehicle deviates into an adjacent lane during a high-speed lane-change manoeuvre. The short-long car-carrier assessed was calculated to have substandard performance in these standards and design modifications were required to obtain compliance. The fifty-fifty car-carrier assessed had acceptable performance in these respects. Calculated results for the tractor and semitrailer combination showed acceptable performance in all dynamic standards. Figure 5 illustrates an example of a car-carrier simulation using TruckSim®.



**Figure 5: PBS simulations of a car-carrier using TruckSim®. (a) High-speed lane-change, (b) low-speed turn, (c) tracking ability on an uneven road, (d) rollover test**

### *3.2.3 Startability and gradeability performance of 6x2 combinations*

The Australian PBS scheme addresses the drivetrain capabilities of a vehicle to ensure that it has suitable torque and traction to navigate steep grades and to maintain certain speeds so as to minimise obstruction to free-flowing traffic. Because their mass is typically well below the allowable legal limit of 56 tons, most truck and tag-trailer car-carrier combinations make use of a 6x2 drivetrain configuration. This means that only one of the two rear axles of the truck is driven, unlike a 6x4 in which both axles are driven. A 6x2 is generally more economical, but has lower traction capabilities than a 6x4. As a result of this limitation, the two truck and tag-trailer combinations assessed (both 6x2) were found to fail two of the drivetrain standards for unrestricted road access. The standards are startability, the maximum upgrade on which a vehicle can start from rest, and gradeability A, the maximum upgrade on which a vehicle can maintain steady forward motion.

These results highlight the fact that the Australian requirements in this regard are particularly stringent compared with what the South African National Road Traffic Act requires (e.g. that the total combination mass must not exceed five times the load on the drive axle/s), and that it is likely that no 6x2 car-carrier combination would be able to meet these requirements. The Smart Truck Review Panel will take this into consideration in assessing each PBS car-carrier application. The tractor and semitrailer combination has not yet been assessed against the drivetrain standards.

## **4 THE FUTURE OF CAR-CARRIERS IN SOUTH AFRICA**

Given the progress to date and the challenges faced, a few predictions may be made for the future of car-carriers in South Africa. Should the first PBS car-carrier vehicles be approved, and should they operate safely and economically to the consent of the relevant authorities, it is likely that operators will explore higher productivity vehicles within the PBS framework in future. Such vehicles would be longer than the current vehicles and would possibly exceed the maximum combination mass allowance of 56 tons. These vehicles would be restricted to primary freight routes (Port Elizabeth–Johannesburg for example).

The inherent variability of car-carriers presents a number of challenges in a PBS framework. Not only does this complicate the assessment process, but it also makes for difficult enforcement. For this reason, it is anticipated that the regulatory framework in which car-carriers operate will deviate from the standard PBS framework, and tend more towards a “pro-forma” framework (see for example (De Pont, 2010)). “Pro-forma” design restrictions would be established that are known to yield compliant vehicles within a PBS context, without the need to assess every new vehicle design individually.

## **5 CONCLUSIONS**

1. The ALTC has proposed that new car-carriers that exceed legislated dimension limits must comply with the South African RTMS/PBS framework.
2. 740 car-carriers in South Africa are currently RTMS-certified, indicating the industry’s willingness to adopt the proposed new framework.
3. Three typical car-carriers designs have undergone PBS assessment, highlighting certain performance characteristics that will likely influence future designs.
4. A perceived future for the industry in South Africa has been discussed, outlining the possibilities of longer/heavier car-carriers for major freight routes, and a PBS-influenced “pro-forma” framework for future regulation of the industry.

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