Regulating Heavy Vehicle Safety In New Zealand Using Performance Standards

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ABSTRACT

This paper discusses New Zealand's experience with performance standards used within a generally prescriptive regulatory regime to allow gains in heavy vehicle productivity while keeping within the safety limits of a demanding transportation environment.

INTRODUCTION

Safety regulations for heavy motor vehicles in New Zealand are based on prescriptive legislation for size limits, weight limits and equipment.

There is provision in the law for variations to the legal requirements to be approved by administrative policy. This is considered where departure from the legal prescriptive requirements may be justified by productivity improvements, while maintaining safety levels equivalent to the prescribed regulations.

In some cases provisions developed as performance standards were not included in the regulations because the added complexity could not be justified in general regulations. In other cases provisions were omitted from regulations because the small number of vehicles involved could best be dealt with on an individual basis. In other cases operators have been able to establish a case, based on new information, that net social benefits are available through conditional relaxation of the prescriptive requirements.

LAND TRANSPORT SAFETY AUTHORITY CORPORATE SAFETY PHILOSOPHY

Our response to industry requests for departures from the regular rules has been strongly guided by the performance and service principles set for the Authority by the Government.

The LTSA is a Crown entity, (controlled by a user representative Board of Directors), the Government's primary advisor on Land Transport Safety. It is not a Government department.

We are charged with the responsibility of promoting safety in land transport at a reasonable cost. An Act defines a cost as reasonable when the cost to the nation is exceeded by the benefits to the nation. We are obliged to apply cost benefit analysis to all new proposals.

The LTSA is committed strongly to improving client service. We therefore aim to be responsive to industry initiatives which are likely to meet the reasonable cost criteria.

The LTSA supports and actively encourages community and industry "ownership" and participation in addressing all road safety issues. Developments in the road transport industry are seen in this context, and extensive consultation is undertaken with a wide range of parties on all proposals.

We also operate under the philosophy of industry self management, that those running operations (i.e. causing the risk) should be responsible for running them safely (i.e. managing the risk).

This corporate approach underlines our ability to respond to industry wishes to fine tune regulations for maximum efficiency where such opportunities exist. Performance standards implemented under administrative policy have been used accordingly.

POLICIES WHICH USE PERFORMANCE STANDARDS

Prescriptive regulations for heavy vehicles limits are summarised in Appendix 1. These are more detailed and prescriptive than those of other countries which is the result of our need to allow a diverse vehicle fleet to operate near (or in some cases above) the structural and geometric design limits of bridges and roads.

Operators and industry have continually sought to extend these above limits. In the following cases performance standards have been incorporated into approval processes, or be used as a benchmark for conditional relaxation of safety based limits.

- 44 tonne A-Trains
- S-Train combination length
- Steerable axle semi-trailer
- Heavy Vehicle Brake Code
- 20m Truck Trailer Policy incorporating Inter-Vehicle Spacing
- Load Anchor Points
- Safety of Permit Loads
- Car Transporters
- Articulated bus high speed stability and tail swing

The first performance standard developed in this context was the policy for 44 tonne A-Trains. This policy is the best example of our experience with a performance standard.

44 TONNE A-TRAINS

Regulations enacted in February 1989 allowed an increase in the maximum gross weight for certain types of heavy vehicle combinations from 39 tonne to 44 tonne, subject to compliance with a range of new safety standards and design requirements. These regulations were intended to encourage, where possible, the use of combination types preferred on the grounds of superior stability and handling as part of a package to help improve both transport efficiency and overall heavy vehicle safety.

A-Trains were excluded from this weight limit increase due to potentially serious problems which had been identified concerning an inherent lack of stability in this type of configuration of existing designs, and because in the great majority of situations preferred alternatives were available.

The new policy was developed in conjunction with the dairy industry. It takes into account this industry's requirements and the Authority's objectives for improved heavy vehicle safety. Studies by the dairy industry showed that:

(a) for farm milk collection A-Trains are often the only practical vehicle type;
(b) millions of dollars can be saved in milk collection costs with increased A-Train weight limits;
(c) milk tanker A-Trains can be constructed to have very good handling and stability characteristics at up to 44 tonnes.

The standards negotiated with industry for this policy were not achieved by any existing A-Trains. Dairy companies developed special new A-Train designs which comply with this policy.

While this policy is based on the requirements of the milk industry, it is not restricted to that application. A-Trains which can be guaranteed to meet the conditions of this policy under all loading conditions can be considered for 44 tonne approval.

Performance Requirements for 44 Tonne A-trains

A-trains approved to operate exceeding 39 tonnes and up to 44 tonnes shall achieve the following levels of stability:

Static Roll Threshold	= 0.45 g or greater
Dynamic Load Transfer Ratio	= 0.6 or less
High Speed Transient Off Tracking	= 0.5 m or less

Compliance is determined by computer simulation using computer programs acceptable to the Authority. (Practical tests are not recommended due to the difficulty in measuring results accurately, and because under the required test conditions sudden roll over could occur if a vehicle performs below the standard unless outriggers are fitted, and iterative re-design of the vehicle to gain compliance is difficult)

The following conditions apply:

(a) All vehicles shall be simulated in the fully laden condition.
(b) The design of the vehicles shall be such that the simulated loading conditions cannot be exceeded, assuming the highest density product for which the approval is valid. (This condition will generally have the effect of restricting approvals to only allowing totally enclosed bodies such as tanker vehicles).
(c) For design purposes there shall be no tolerance applied to vehicle weights prescribed in this policy, e.g. 44 tonne shall be the actual design and construction maximum. To be verified by test weighing.
(d) Maximum speed capability shall be controlled to 90 km/h or less by an approved method.
(e) Approved tachographs or an electronic speed time recording device shall be fitted and used at all times, and the output made available to any employee of the Police or LTSA, on request.
(f) The type of produce carried for which the simulation is valid shall be specified. (This is necessary to ensure that the loading conditions assumed for the simulation will not be exceeded in practice).
(g) The simulation for Dynamic Load Transfer Ratio and High Speed Transient Off-Tracking shall simulate a rapid path change at a forward speed of 90 km/h, using sine steer inputs adjusted so that the lead unit is subjected to a lateral acceleration of 0.15 g for both left and right steer pulses.
(h) The stability levels specified shall be achieved by every unit of the combination.
(i) Every combination shall comply with the conditions specified on the approval, current braking requirements and all other regulations, except where the approval provides written exemption.
(j) Each approval will be valid only for the units specified in the combination (i.e. dedicated units, or separate simulation tests for every variation are required).
(k) The requirements must be achieved for all intended conditions of loading.
(l) Tank vehicles shall be designed to minimise the effects of liquid slosh, with compartments arranged to provide a uniform load distribution at all times.
(m) The vehicle shall be test weighted with maximum load, under Policy supervision, prior to final approval.
(n) A copy of the approval shall be kept in the vehicle at all times and produced to a police officer on request.
(o) Trailers with converter dollys are not acceptable.

Appendix 2 shows the vehicle information required for 44 tonne A-Train applications.

EXPERIENCE WITH IMPLEMENTING THE 44 TONNE A-TRAIN PERFORMANCE STANDARDS

The policy was developed specifically to meet the needs of the dairy industry for farm milk collection. Industry commissioned reports established benefit cost justification for the policy development and implementation. Compliance costs and technical difficulty have discouraged other industries,but the policy does not exclude other types of operation.

The performance limits were negotiated with industry. These were progressively reduced from the original agreements, which were found by designers to exceed the limit of technical achievement. Many design iterations were needed to achieved the prescribed simulation performance.

At the time the only organisation with the ability to do the required simulation test in New Zealand was the Auckland Industrial Development Division of the DSIR. These tests made use of a suite of computer programs developed by the University of Michigan Transportation Research Institute (UMTRI). Approved computer programs are STATROLL for the Static Roll Threshold simulation, and YAWROLL for the Dynamic Load Transfer Ratio, High-Speed Transient Off Tracking and Static Roll Threshold.

Vehicle and component data needed (see Appendix 1) was not generally readily available. Equipment suppliers either did not always have the information, or were not prepared to make it available.

Tyre data proved to be particularly contentious, as compliance was sensitive to make and model of tyre. Tyre suppliers were concerned that products could be excluded from this sector of the market. It was argued that difference in tyre performance parameters was a result of test conditions rather than the tyres, and a series of tyre tests were undertaken at UMTRI.

OTHER PERFORMANCE STANDARDS

The 44 tonne A-Train policy established industry expectations for a further range of performance based policies.

The S-train policy allowed a special purpose S-Train a length concession from 17m to 19m, using the A-Train performance standards. Very satisfactory performance has been reported by the operator.

A weight limit increase from 37 to 39 tonnes for semi-trailers with steerable axles has been achieved by specifying the performance of the steerable axle such that equivalent stability safety performance is achieved.

A similar analysis was applied to ensure the design of safe car transporters with dimensional concessions, and the process was also used to determine the maximum safe speed for articulated buses.

Certain truck-trailer combinations, which are allowed length concessions, have an optional performance standard for reduced inter-vehicle spacing (IVS), where reduced clearances equivalent to the prescribed minimum are demonstrated by swept path simulation. This process is administered by a national industry organisation under agreement with the LTSA and the owners of the IVS computer program.

The IVS performance standard is addressed more freely in another paper at this symposium.

CONCLUSION

The 44 Tone A-Train policy can be considered as a qualified success. Twenty combinations have been put into operation to date. These operations have reported strong driver support for these vehicles, and reduced operating and maintenance costs. Very high proto-type development and initial compliance costs have discouraged a number of operators from using this policy. Technical resources for policy development, and setting the standards exceed those generally available to the industry and strained our resources.

The outcome of this policy has been to enable the Authority to continue to discourage the general use of A-Trains in favour of semi-trailers are B-Trains, while allowing operators the option of A-Trains at the same weight limits where the need is justified.

Other performance based policies have also allowed the prescriptive standards to be effectively extended within the safety constraint imposed by road geometry and vehicle performance expectations.

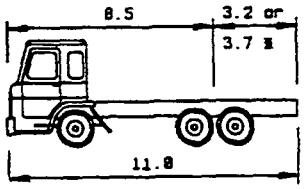
Overall Length (Including load)

Single Vehicles
Rigid truck = 11.0m
Full trailer (incl drawbar) = 11.0m

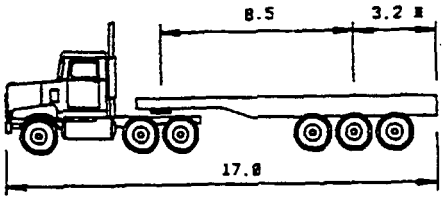
Vehicle Combinations
Articulated vehicle = 17.0m
Truck and trailer = 19.0m
A-train = 20.0m
B-train = 20.0m

Principle Maximum Allowable Dimensions of Typical Vehicles and Combinations

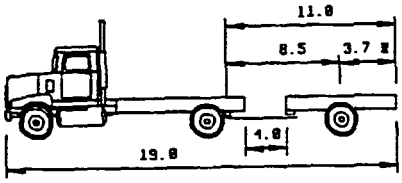
*Refer to rear overhang requirements on the previous page. All unspecified dimensions in METRES.



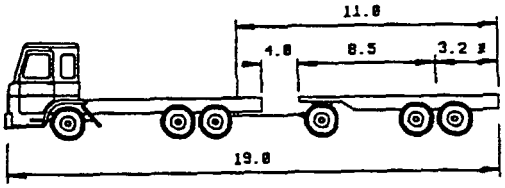
Rigid Truck



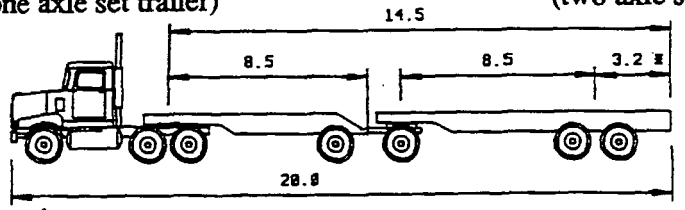
Truck and Semi-trailer (Articulated vehicle)



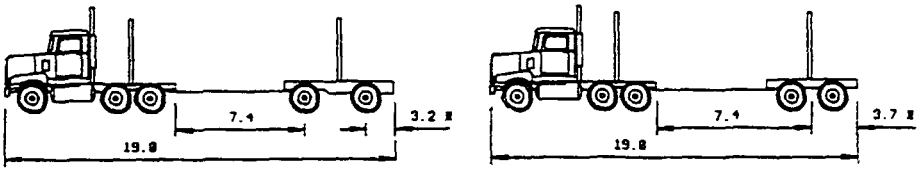
Truck and Simple Trailer
(one axle set trailer)



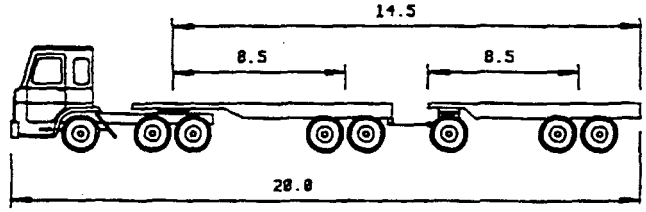
Truck and Full Trailer
(two axle set trailer)



B-train



Logging Jinkers



A-Train

Special Requirements for A-Trains

(a) Three axle, tandem drive axle tractor units (6x4) are to be used.
(b) Semi-trailer: The distance from the rear axis back to the tow coupling shall not exceed 30 percent of the distance from the rear axis forward to the centrepoint of articulation.
(c) Will be limited to 39,000kg.

APPENDIX 2

A-TRAINS AT 44 tonne: DATA REQUIRED FOR STABILITY ANALYSIS

The following tables describe the information necessary to conduct a computer stability analysis in accordance with the Ministry of Transport *Policy for 44 tonne A-trains*. If any parameters are not clear or obtainable, contact David White or Richard Wong [at Auckland Industrial Development Division, DSIR Ph (09)303-4116 Fax (09)370-618].

Depending on the influence of unobtainable parameters on the result, DSIR - AIDD will either calculate the parameter, or use published data from available sources. If that is unsatisfactory, physical measurement will be required.

Vehicle Unit	Tractor Unit	Semitrailer	Trailer Steer Mass[1]	Full-trailer[2]
Make				
Model				
Serial No.				
Registration No.				
Tare Mass (kg)				
Mass of Load (kg)				
Sprung Mass[3] Laden (kg)				
Sprung Mass C.G. height[4] (m)				
Sprung Mass Roll Moment of Inertia[5] (kg.m²)				
Sprung Mass Pitch Moment of Inertia[6] (kg.m²)				
Sprung Mass Yaw Moment of Inertia[7] (kg.m²)				
Wheelbase[8] (m)				

1 Trailer Steer Mass includes the drawbar and other components below the turntable that steer with the axle.
2 Mass figures for the Full Trailer are to exclude the Trailer Steer Mass.
3 Sprung Mass = Tare Mass minus Unsprung Mass (ie, mass of axles, rims, wheels, tyres, brakes, 1/2 of springs)
4 Height of Centre of Gravity (or Centre of Mass). Height is measured from the ground.
5 Mass Moment of Inertia of the Sprung Mass about a longitudinal axis through the Sprung Mass C.G.
6 Mass Moment of Inertia of the Sprung Mass about a lateral axis through the Sprung Mass C.G.
7 Mass Moment of Inertia of the Sprung Mass about a vertical axis through the Sprung Mass C.G.
8 For trailers the wheelbase is the distance from the front articulation to the rear axis.

Axle Group	Steer	Drive	Semitrailer	Trailer Steer Mass	Trailer Rear
Axle Properties					
Axle Load (kg)					
Unsprung Mass (kg)					
Suspension Properties					
Suspension Designation (eg. Hendrickson RTE380)					
Suspension Load Rating (kg)					
Axle group spacing (m) (if > 1 axle in group)					
Suspension C.G. Height (m)					
Roll Centre Height (m)					
Mean Track Width (m)					
Dual Tyre Separation (m)					
Spring Spread (m)					
Damper Spread (m)[9]					
Damper Inclination (deg) (from vertical)					
Auxiliary Roll Stiffness (N.m/rad)					
Suspension Friction Force (N)					
Viscous Damping (N.s/m)					
Rollsteer Coefficient					
Tyre Properties					
Tyre Designation, including aspect ratio (eg. Michelin XZA 11R22.5)					
Tyre Rolling Radius (m)					
Tyre Vert. Stiffness (kN/m)					

9 Damper Spread is the lateral distance between the shock absorbers, measured at the lower mounts.

Additional Data Required

Fifth wheel offset[10] (m) _____
Laden fifth wheel height (m) _____
Load on fifth wheel (kg) _____

Tractor Steering Ratio[11] _____
Tractor steer axle trail (m) _____
Tractor steering system stiffness _____
Tie rod linkage stiffness _____

Fifth wheel type: (tick one)
- O Single oscillating (conventional)
- O Compensating
- O Double oscillating
- O Single oscillating (inverted)

Drawbeam hitch point overhang[12] (m) _____
Laden drawbeam hitch point height (m) _____

Additional Tables Required

For each different suspension: A table of force v deflection for the range bump stop to bump stop.

For each different tyre: A table of cornering force as a function of slip angle (e.g. 0 - 12°) and vertical load (e.g. 0 - 1.5 x Rated Load).
A table of aligning torque as a function of slip angle and vertical load.

An elevation drawing of the vehicle combination.

Dimensioned drawings showing the tank cross-section.

10 Longitudinal distance from tractor rear axis to fifth wheel centre (negative if behind the rear axis)
11 No. of degrees of steer wheel rotation for one degree mean steer angle of road wheels
12 Longitudinal distance from semitrailer rear axis to drawbeam hitch point