22m LOG TRUCK-TRAILER COMBINATIONS

Report prepared for

Log Transport Safety Council

Prepared by:

John de Pont
Peter Baas

Version 2
June 2002

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South Auckland Mail Centre
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Executive Summary

The Log Transport Safety Council (LTSC) is seeking approval for log truck-trailer combinations to be permitted to operate with an overall length of up to 22 metres, 2 metres longer than currently allowed. Such an increase in length would mean that a much greater proportion of logs will be able to be transported as multiple packets on trailers, resulting in a significant reduction in load height, and consequently more stable vehicles and significant reductions in the incidence of log trailer rollovers. If all logs that can be carried within the 22metre envelope are transported this way, the reduction in on-highway rollover crashes could be as much as 39% to 47% when fully implemented.

With the current mix of trailers it is not possible to cart all of the “difficult” logs on multi-bolster trailers. However over 90 percent of new trailers now being built are multi-bolster which means that over 70 percent of the “difficult” loads will be able to be transported on multi-bolster trailers within 2 to 3 years once the required logistics changes have been implemented. Additional safety benefits will come from the cartage of short logs with long logs on the same trailer, for example 3.7metre logs with 6.1metre logs.

The introduction of 22 metre log trucks is proposed purely as a safety measure. No increase in weight is sought and the proposal is totally independent of the Heavy Vehicle Limits project being managed by Transit New Zealand.

This report summarises the findings of the investigations that have been undertaken. Those investigations have included:

- An assessment of the safety implications of increasing the maximum length of log truck combinations.
- A limited trial of seven log trucks including detailed observations of their performance.
- An extended trial of 20 log trucks aimed at obtaining public feedback and to identify any operational issues.

In addition the Log Transport Safety Council undertook wide-ranging consultation that included extensive media coverage, meetings with interested groups such as the NZ Automobile Association, Road Safety Co-ordinators, local authority officials and Members of Parliament. The public was encouraged to provide feedback through the “0800 LOG TRUCK” compliments and complaints system. A high level of support was obtained.

The Log Transport Safety Council is committed to monitoring the performance of 22m log trucks. It will maintain in the long term its crash database and the "0800 Log Truck" compliments and complaints system. The Log Transport Safety Council has also agreed to work with LTSA and CVIU on the monitoring of on-going compliance with the 22m requirements. The Log Transport Safety Council has agreed to have as a fixed agenda item at its regular Council meeting a review of the 22m log truck operations.

A strong case exists to allow log truck-trailer combinations to operate at 22 metres overall length provided certain conditions are met and the introduction of 22m log trucks is treated as a special case with no flow-on effect to other vehicle classes or operations. Below are the recommended requirements for the operation of 22 metre log truck-trailer combinations.

Recommendations

1) The combination when carting two packets of logs on the trailer may exceed the overall length limits of regulation 48B(1)(j)(iii) of the Traffic Regulations 1976 but shall not exceed 22 metres overall length.

2) The trailer when carting two packets of logs may exceed the rear overhang limits of regulation 48C(e) of the Traffic Regulations 1976 but shall not exceed a rear overhang of the lesser of 3.2 metres or 65 % of trailer wheelbase.

3) The trailer when carting two packets of logs may exceed the distance ahead of turntable (front overhang) limits of regulation 48D(b) of the Traffic Regulations 1976 but shall not exceed a front overhang of 2 metres.

4) The trailer when carting two packets of logs may exceed the vehicle length limit of regulation 48B(j)(i) of the Traffic Regulations 1976 but the trailer and its load shall not exceed 13.5m.

5) When the combination is able to operate as a standard combination with a maximum length of 20 metres, it must do so and must meet all of the existing standard heavy vehicle requirements and those specified in Rule 41001, including coupling position and trailer length, when the Rule is introduced.

   Conditions

   - When in excess of 20m no point of the load may exceed 3.2m from ground level. (Note: it is recommended that the side-arms on the trailer have a 100mm wide marking such that the highest point of the marking is at a height 3.2m from the ground. This load height assumes a minimum baseline SRT of 0.4g).

   - Trailers must have a wheelbase of at least 4.9 metres.

   - The inter-vehicle spacing between the towing vehicle and the trailer must not be less than 1.1metres (including its load but excluding the drawbar and front dolly assembly).

   - The trailer length, including the load, must not exceed 13.5m. (11.5m when in the 20m mode).

   - The vehicle must display a fixed upright “22m LOG TRUCK” warning sign to the rear in a conspicuous position within 1metre from the end of the load. This sign must comply with the LTSC “0800 LOG TRUCK” sign specification including the size and colour of the lettering and the use of a yellow green fluorescent background that complies with AS/NZS 1906.1:19993 Class IA. (Note: fixtures for mounting the sign must not be a projection hazard to another motorist in the event of a rear-end crash.)

   - The “22m LOG TRUCK” sign or its support must not visually obstruct the rear lights of the trailer.

- The “22m LOG TRUCK” sign may not be displayed when the vehicle is operating as a standard combination with a maximum length of 20metres.

- An “0800 LOG TRUCK” sign must be fitted.

- The lights at the rear of the trailer must be visible within an angle of 15 degrees above and below the horizontal. (Note: If the load extends 2 metres beyond the lights, this equates to having the lights at least 520mm off the ground when the vehicle is laden. The lights must also be less than 880 mm off the ground if the bolster bed height is 1.4m. Different bolster bed heights will result in commensurate changes in maximum light position, for example lights must be no more than 680 mm off the ground if the bolster bed height is 1.2m.)

- On new trailers the rear lights (tail, indicator and brake), and signs must be within 1metre of the end of the load. This may require the use of sliding drawbars or a sliding or hinged light mounting frame. Consideration should be given to making this mandatory on all trailers at a future date. Note that this increases the flexibility of the vertical position of these lights.

- Trucks must be driven with their headlights on low beam during daylight hours.

- The driver must have access to a suitable gauge to measure the rear overhang of the trailer load.

- The operator is responsible for ensuring that the vehicle does not enter any intersection or railway crossing without adequate clearance to completely cross that intersection or railway crossing before a train or other vehicle arrives. If necessary, a pilot vehicle must be provided for this purpose.

- Load security must continue to meet the requirements of the Truck Loading Code, in particular the 300mm log overhang on the bolsters or the 150mm overhang if the load is logs of uniform length and less than 4.6metres long fitted with a belly chain.

- Vehicles commencing 22m operation must be inspected to CoF standards to ensure the vehicles are roadworthy and meet the 22m permit conditions. The vehicles then need to be inspected every six months as part of the CoF inspection to ensure the permit requirements are still being adhered to.

- The 22m requirements and the safety performance of 22 metre log trucks should be reviewed 2 years after initial approval is granted.

It is also recommended that the Log Transport Safety Council, the industry, LTSA and Police ensure speed, especially around curves, and weight are actively managed to ensure any safety gains are not eroded by poor work practices.

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22m LOG TRUCKS

Introduction

In order to achieve reductions in the rollover crash rate of logging trucks the log transport industry through the Log Transport Safety Council (LTSC) is proposing that logging truck-trailer combinations with multi-bolster trailers be allowed to operate at 22m overall length. Under the current 20m length limit most multi-bolster trailers can carry logs up to 4.1m as double packet loads. Through this measure log packets with an average length of at least 5m would be able to be carried as double packet loads on the trailer thereby significantly reducing the load height and improving the stability of the vehicles.

Implementing this measure effectively requires the random length logs to be sorted by length so that all logs that can be double bunked are double bunked. For this to be worthwhile it is necessary for the fleet of multi-bolster trailers to be capable of carrying these longer two packet loads and hence the additional length is sought for existing combinations as well as for new vehicles.

The typical older existing trailer has a wheelbase of about 4.9m. In order for this trailer to be able to double bunk 5m packets of logs, it needs to be able to violate the front and rear overhang limits proposed in the new Dimensions and Mass Rule as well as the 20m overall length limit. The LTSC is proposing that for these vehicles a front overhang limit of 2m across the full width of the load and a rear overhang limit of 65% of wheelbase with a maximum of 3.2m should apply. The dimensions issues are complicated by the fact that the Land Transport Safety Authority (LTSA) is developing a new rule on heavy vehicle dimensions and mass.

This report contains an analysis of the technical and safety issues involved in granting this concession. The first stage of the investigation was a safety analysis, which is reported in full in Appendix B. The second stage involved a one-month trial of seven vehicles and detailed observations of the performance of those vehicles. The results of that trial are provided in Appendix C. The final stage involving extensive public consultation and a four-month trial involving 20 vehicles operating throughout the country.

Stage One: Safety Analysis

The safety analysis, was undertaken in two parts. The first considered the crash and incident database maintained by the LTSC, which aims to keep a record of all log truck rollover crashes. As the proposed dimensional changes relate to on-highway vehicles, only on-highway rollover crashes were considered. However, many off-highway trips are actually trips by on-highway vehicles en route to the highway and thus the use of more stable vehicles for on-highway operations should result in a reduction in off-highway rollovers. In the on-highway cases over a 14 month period from June 2000 to August 2001 there were 61 rollover crashes. 70% of these were truck-trailer combinations carrying a single packet of logs, which was not identified as a long log packet on the trailer. However, for a substantial proportion of these the log length was not identified at all and thus they may have involved log lengths that would not be able to be double bunked even with the 22m overall length concession. Thus 70% is the absolute maximum proportion of rollovers that could potentially be affected by this measure. It should also be pointed out that in a number of these crashes the rollover was the result of the crash not the cause. In these cases having a more stable vehicle would not have prevented the crash but may still have prevented the rollover.

The second part of the safety analysis used the set of performance measures being developed by the National Road Transport Commission (NRTC) in Australia as a potential alternative to prescriptive mass and dimensions limits. A typical current vehicle was assumed to be loaded with a load of mixed length logs. In the baseline case it was assumed that the vehicle was limited to 20m overall length and the load was carried as a single packet on the truck and a single packet on the trailer. For comparison it was assumed that the same load was sorted into lengths above and below 5m, with the longer logs carried as a single packet on the truck and the shorter logs carried as two packets on the trailer. The overhang and length limits described above were assumed to apply. Because the vehicles for the two cases are assumed to be identical with the only difference being in the load many of the performance measures such as gradability, startability, low speed off-tracking etc show no change. There is a slight negative impact on the measures relating to length, i.e. overtaking time and intersection clearance time. There is also a small negative impact on the front swing and tail swing because of the greater overhangs, but because a log load is only 2.2m wide rather than 2.5m neither swing goes out beyond the path of the front of the vehicle. On the other hand because there is a significant reduction in load height there are improvements in the two key dynamic performance measures, Static Roll Threshold (SRT) and Load Transfer Ratio (LTR) of 27% and 35% respectively. Based on previous work relating rollover crash risk to performance measures this level of improvement would be expected to result in a reduction is rollover crash risk of between 55% and 67%. Applying these reductions to the potential 70% of rollovers involving these vehicles suggests it might be possible to reduce the on-highway rollover crash rate by as much as 39% to 47%. This is based on the assumptions that all loads that can possibly be double bunked are double bunked and that all of the crashes identified as involving single packet loads were in fact loads that could be double bunked under the 22m overall length limit.

It was noted that the proposed rear overhang was greater than that proposed in the new Rule. Concern was raised of the increased risk of underrun crashes with the proposed rear overhang limits and it was recommended that appropriate signage and other measures be introduced to mitigate this risk.

Stage Two: Limited Trial

Based on the results of the safety analysis and other work relating to the crash risks of these vehicles, the LTSA approved a one-month trial of the concept using seven specified vehicles. The purpose of the trial was to qualitatively validate the computer simulation results and to identify any operational issues associated with these longer vehicles. As part of the trial, TERNZ were requested to observe and monitor the vehicles in operation, assess their performance and identify any issues that need to be addressed. The report on the trial is in Appendix C.

The only major area of concern raised by the trial was the difficulty following motorists may have in perceiving the length of the rear overhang and the consequent increased risk of a rear-end underrun crash. Some of the observers at the trial suggested that underrun protection was needed. However, even in Europe where underrun protection is mandatory, log trucks are exempted because their operational requirements make it too difficult to fit an effective underrun barrier. The key to mitigating the risks associated with this larger overhang is to improve the conspicuity of the rear of the vehicle.

Other relatively minor operational issues were raised including:

- The placing of a mark on the drawbar to ensure both front overhang and IVS requirements are met.
- Rear signage specifications
- Loading procedures to ensure loader drivers place the load accurately

Stage Three: Operational Trial and Public Consultation

At the end of the on-month trial LTSA agreed to an extended trial involving 20 vehicles operating throughout the country. The purpose of this trial was to identify any operational issues and to provide the public with the opportunity to observe and comment on the 22m log truck proposal.

Permit requirements

The following are the specific requirements listed on the permit under which the twenty trial vehicles were allowed to operate. When these requirements were developed for the trial, LTSA based them on the best information available at that time.

1) The combination when carting two packets of logs on the trailer may exceed the overall length limits of regulation 48B(1)(j)(iii) of the Traffic Regulations 1976 but shall not exceed 22 metres overall length.

2) The trailer when carting two packets of logs may exceed the rear overhang limits of regulation 48C(e) of the Traffic Regulations 1976 but shall not exceed a rear overhang of the lesser of 3.2 metres or 65 % of trailer wheelbase.

3) The trailer when carting two packets of logs may exceed the distance ahead of turntable (front overhang) limits of regulation 48D(b) of the Traffic Regulations 1976 but shall not exceed a front overhang of 2 metres.

4) The trailer when carting two packets of logs may exceed the vehicle length limit of regulation 48B(j)(i) of the Traffic Regulations 1976 but the trailer and its load shall not exceed 11.5m.

Conditions

- Experienced operators only to be used and drivers must undertake a pre trial briefing by the Log Transport Safety Council.

- The side-arms on the trailer must have a 100mm wide marking such that the highest point of the marking is at a height 3.2m from the ground. No point of the load may exceed 3.2m from ground level.

- The operator is responsible for ensuring that the vehicle does not enter any intersection or railway crossing without adequate clearance to completely cross that intersection or railway crossing before a train or other vehicle arrives. If necessary, a pilot vehicle must be provided for this purpose.

- The inter-vehicle spacing between the towing vehicle and the trailer must not be less than the greater of 1.1metres; or half the width of the foremost point of the trailer (including its load but excluding the drawbar and front dolly assembly).

- The vehicle must display a fixed upright "OVERSIZE" warning sign to the rear in a conspicuous position. For day use only this sign may be made of flexible or stiff weatherproof material and have black lettering on a yellow green fluorescent background. For day or night use the sign must be yellow green fluorescent to AS/NZS 1906.1:19993 Class IA. Size of sign shall be in accordance with LTSA Specifications for Warning Signs.

- The rear of the trailer load must be indicated by a clean white flag or red, orange or yellow fluorescent flag or frangible panel, which must be at least 400 mm long and 300 mm wide. For night travel the rear of the load must be indicated by steady amber lights at least 85mm in diameter and with a power output of at least 10 watts located at the extremities of the bottom of the overhanging load.

- The driver must have access to a suitable gauge to measure the rear overhang of the trailer load.

- A daily debriefing of all drivers will be co-ordinated by the Log transport Safety Council to identify any issues as they arise throughout the trial.

- Load security must continue to meet the requirements of the Truck Loading Code, in particular the 300mm log overhang on the bolsters or the 150mm overhang if the load is logs of uniform length and less than 4.6metres long fitted with a belly chain.

- The attached form must be completed for all loads carried by the trial vehicles during the trial regardless of overall length.

- Vehicles to be inspected up to CoF standards and for compliance with the approval.

Consultation

The public was made aware of the trial through the media and feedback was sought through the 0800 LOG TRUCK complements and complaints system. LTSC also organised meetings with interested groups such as the NZ Automobile Association, Road Safety Co-ordinators, Members of Parliament and Local Councils. Appendix A contains a list of the organisations and individuals contacted and the media that ran items on the trial. Those that commented did so on the express understanding that the introduction of 22m log trucks was purely a safety measure, and that it was outside the scope of the Transit NZ Heavy Vehicle Limits project.

Mr Hyde and the other LTSC members involved in the consultation have advised TERNZ that the feed back has been very positive. The evidence presented to TERNZ by LTSC backs this up. The only negative comment came from Driver magazine and the issues raised there were based on the misunderstanding that the 22m log truck proposal was a means of furthering the Heavy Vehicle Limits Scenario A and B options. Those that attended the meetings were all reported as being very supportive once they understood what is being proposed. The Road Transport Forum endorses the proposed introduction of 22m log trucks. The New Zealand Automobile Association endorses the proposal subject to the issues raised during this investigation being addressed. Only two comments were received directly from the public through the 0800 Log Truck complements and complaints system despite the publicity. Both calls were supportive of the 22m proposal.

The drivers all commented on how much safer the trailers felt on the road. They do not want to go back to high single packet loads after their involvement in the trial. Loader drivers found the trailer easier to load and that there was much less risk of dropping loads and damaging the trailer while loading and unloading.

Crash rates

At the time of writing this report, the 20-vehicle trial had been in place for nearly four months. During that time there have been no crashes involving 22m log trucks reported to the CVIU or to the Log Transport Safety Council for inclusion in their crash database. It can not be concluded from this result, however, that 22m log trucks have fewer crashes than 20m log trucks as the sample size is too small. Based on the number of crashes included in the LTSC database, it would be expected that the 22m log trucks would have experienced on average less than one reported crash if they had shown the same level of safety as normal log trucks. In addition they were not always able to obtain suitable loads and spent a considerable proportion of the trial period carrying loads within the 20m envelope. This would have further reduced their exposure as 22m configurations and hence the expected number of crashes.

Conclusions and Discussion

The analysis and field experience have shown that the gains in safety by having more stable log trucks are significantly greater than the reduction in safety associated with the affect the increase in length has on overtaking time, rail crossing and intersection clearance. It has been estimated that the on-highway roll-over crash rate could reduce by as much as 39% to 47%. This is on the assumption that all of the loads that can possibly be double bunked are double bunked and that all of the loads identified in the LTSC crash database as single packet loads (lot long log packets) were loads that can be double bunked.

Certain safeguards are required to ensure the safe operation of 22m log trucks if introduced after the trial. These are described below.

Stability/load height

The following table shows the Static Rollover Threshold (SRT) of a typical older style (1997) four axle trailer with a bolster bed height of 1.4m and a wheelbase of 4.9m when carting logs as single packets and double packets (Baas, 1997)[1]. Also in the table are the associated mean load heights. The calculations assumed the load was Radiata pine with a stacking density of 0.7. The 3-axle trailer was assumed to be carting 16 tonne and the 4-axle trailer 17 tonne.

Table 1: SRT and load height

	Log length	Single packet (20m)	Double packet (22m)	
		SRT	SRT	Height
3 axle	4.1m*	0.31g	0.41g	2.67m
4 axle	4.1m*	0.33g	0.42g	2.75m
	5 m	0.37g	0.47g	2.5m

* Many vehicle configurations can carry a double packet load of these logs within the 20m overall length.

A change in stability from 0.37g for a 4 axle trailer carting 5m logs as a single packet to 0.47g when carted as 2 packets is expected to result in a reduction in rollover crash risk of 55%.

[1] Baas, P. H. and Latto, D. J. 1997. "Logging Truck Stability Analysis" TERNZ Research Report 2nd edition.

The following graph shows the estimated crash risk for different levels of SRT.

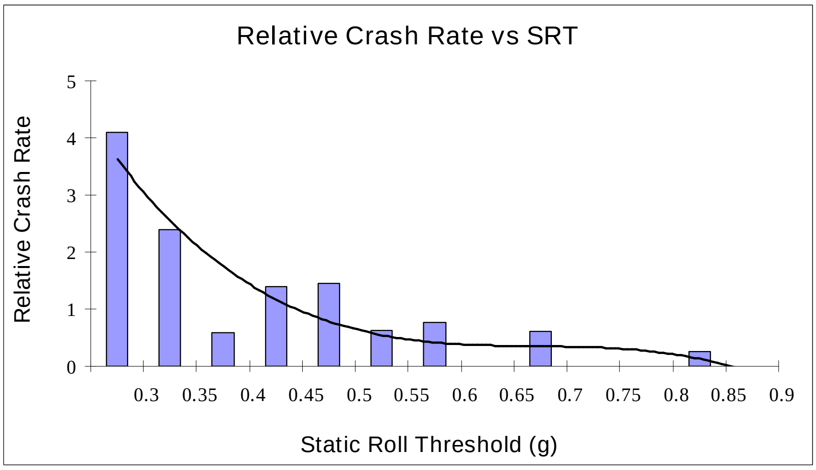

Figure 1. SRT Relative Crash Involvement Rate.

Increasing the payload on the trailer by one tonne will result in an increase in height of 70mm and a reduction in SRT of approximately 0.007g. The above suggests that 0.4g should be used as the target for SRT for 22m log trucks. The Rule proposes an SRT of 0.35g as the minimum for 20m rigs. The basis for the calculation should be based on the payload being pinus radiata with a stacking ratio of 0.7. Actual SRTs may vary for different timber species, stacking densities and due to seasonal and other differences. Taking these factors into account would overly complicate matters.

Height is only a surrogate measure for stability but has the advantage of being relatively easy to measure on the roadside. The driver log sheets completed during the trial and supplied to TERNZ showed that, when carrying logs in two packets on a trailer, average heights at the stanchions varied from approximately 2.2m to 3m. Variations of this magnitude are to be expected because of differences in timber density, stacking ratio and differences in bolster bed height. Differences in species (Radiata Pine and Douglas Fir) will result in height differences of approximately 0.15m. Bolster bed heights can vary by up to 0.3m (from typically 1.15m to 1.45m) and stacking ratio differences can alter heights by approximately 0.3m. In addition measurement error will contribute to recorded load height differences. The above heights were measured at the stanchions. LTSC has proposed a maximum height of any log of 3.2m. This will result in an average height at the stanchion of approximately 3m as the load must be crowned and variations in log shape will affect the maximum height.

For 20m log trucks, there is a difference in permitted maximum load height between 3axle trailers and 4 axle trailers of 3.5m and 3.8m respectively. This difference reflects the added stability of having an extra axle on 4 axle trailers. This difference in stability is shown in table 1 where the 3 axle trailer has a lower SRT than a 4 axle trailer despite being 1 tonne lighter. In order to raise the SRT of the 3 axle trailer to be the same as that of the 4 axle trailer, its load height would need to be reduced by approximately 0.1m. The difference in load height then between the 3 axle and 4 axle trailers would be 0.18m for the same SRT. In operation there is likely to be a significant difference in height between the packets on a 3 axle trailer because of differences in allowable axle group loads front to rear. This is not an issue when carting single packets when less than 20m overall length. One option would be to use the average of the height of the load on all four stanchions as the way of determining load height. In this case different maximum load heights for 3 axle and 4 axle trailers would be appropriate. For the ease of enforcement it is recommended that the same maximum overall height be used for both 3 axle and 4 axle trailers.

Warning to other motorists of increased length

The increase in length and rear over hang does result in increased risk to other motorists in situations such as overtaking, at intersections and when following 22m log trucks. The initial trial highlighted the difficulty following motorists may have in perceiving the amount of rear overhang when following a log truck. The vehicles taking part in the extended trial were fitted with signs and other measures to mitigate this risk. One of the extended trial vehicles is shown in figure 2.

Figure 2: Trial vehicle

In the current regulations and in the proposed Rule there is a requirement that:

2.1(4) Subject to 2.1(5), a load that is being transported on a motor vehicle and that extends more than 1 m to the rear, or more than 1 m forward from, or more than 200 mm out from the side of, the body of the vehicle must be indicated by:

(a) a clean white flag, or a red, orange or yellow fluorescent flag, which must be at least 400 mm long and 300 mm wide; or

(b) a frangible hazard warning panel, which must comply with the dimensions in Figure 1 in Schedule 5.

2.1(5) A motor vehicle that is transporting a load specified in 2.1(4) during the hours of darkness must, instead of a flag or frangible hazard warning panel, be fitted, and be operated, with the following lights:

(a) for a load exceeding 1m in width extending from the rear of the vehicle, one red lamp fitted on each side of the load at the rear of the load;

The simplest means of complying with 2.1(4) and 2.1(5) is to ensure the end of the load is within 1m of the rear of the vehicle. This can be achieved by fitting telescopic draw bars that move the trailer rearward or, when this is not possible, fitting a removable or sliding attachment to the rear of the trailer that has sufficient conspicuity to appear to be the rear of the trailer from a following motorist's perspective. Vehicles in the second stage of the trial were fitted with various designs of these sliding attachments on which OD signs were mounted. These appeared to be quite effective in warning following motorists. Care needs to be taken to ensure that this attachment is not in itself a dangerous projection in the event of a rear end crash.

There are significant operational problems with fitting lamps to the end of logs. Any metal fasteners if not removed after the journey can result in major saw damage. Strapping and other forms of fastening can be problematic. At the same time, as noted above, it is difficult for following motorists to perceive the distance from the end of the logs to the end of the vehicle. In addition the logs can be above eye level for car drivers resulting in possible comprehension errors and increased risk of an underrun crash occurring.

The Dimension and Mass Limit Rule contains certain requirements for over-dimension vehicles. 22m log trucks would fit under category 1 being over 20m and less than 25m in length, but not over-width or height. Category 1 vehicles with a length of up to 25m as outlined in Section 6, Table 6.1, require:

- Excess projections to be delineated with flags or panels
- Headlights on low beam during daylight
- A revolving amber light fitted to the cab roof during the hours of darkness
- A hazard panel fitted to the rear of the load during the hours of darkness. See figure 3 below.
- Restrictions to travel time unless the vehicle meets the swept path requirements of a maximum standard vehicle as specified in Schedule 9. 22m log truck-trailer combinations meet the swept path requirements, B-trains or tractor semi-trailers do not.

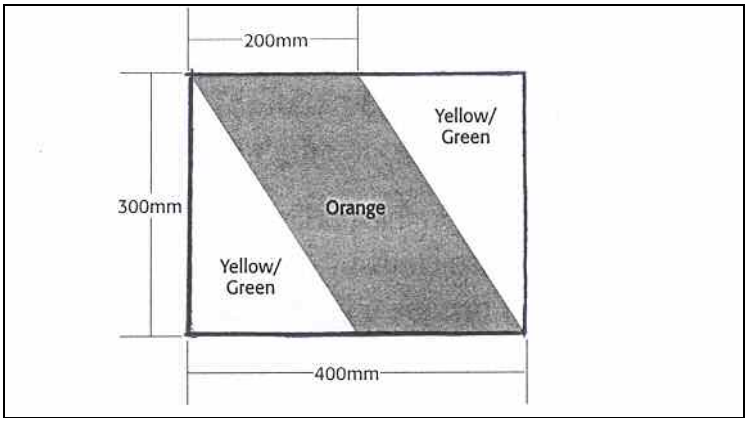

Figure 3 Minimum dimensions of hazard warning panel

Regarding delineating excess projections with flags or panels, this requirement is closely related to that in 2.1(4) and 2.1(5) above. Provided the load is within 1m of the rear of the vehicle, from the perspective of a following motorist the rear of a 22m log truck will be the same as that of a standard 20m log truck. The risk of an underrun crash or not noticing the corners of the load is the same.

The need to have headlights on low beam during daylight hours will improve the conspicuity of the truck to on-coming traffic and is easy to comply with.

The use of revolving amber lights fitted to the cab roof of 22m log trucks during the hours of darkness may be counterproductive as it will reduce their effectiveness as a warning system on other over-dimension vehicles. This is because the number of log trucks using amber light will be many times the number of over-dimension vehicles using them, especially at night. The greater the number of vehicles fitted with such a device, the less effective it is on an individual case by case basis. Motorist will generally associate revolving amber lights with log trucks. The trial would suggest that most of the 22m log trucks will in fact be less than 22m in length and represent a relatively minor risk to in terms of overtaking and intersection clearance compared to other over-dimension vehicles.

The Rule proposes the fitting of hazard panel fitted to the rear of the load during the hours of darkness on Category 1 vehicles. The trial highlighted the difficulty in fitting panels or flags to the load itself. Log trucks are now fitted with 0800 LOG TRUCK signs and during the trial they were fitted with OVERSIZE signs to increase their conspicuity and to warn other motorists. An OVERSIZE sign is not required on Category 1 vehicles and it is recommended that they not be fitted as over-use will compromise their effectiveness. As an alternative LTSC have proposed the use of a high visibility sign with the words 22m LOG TRUCK. Such a sign would meet the specifications developed for the 0800 LOG TRUCK sign that was approved by LTSA as an advisory sign. Such a sign will increase the conspicuity of the rear of the log truck and will warn following motorists of their increased length.

It is very important to ensure the tail, indicator and brake lights are visible to following motorists. The rear overhang can be as much as 3.2m under the proposed requirement for 22m log trucks. Taking the minimum distance from the rear axis to the rear of the trailer into account, the distance from the light bar to the end of the load may be as much as 2m. The current lighting regulations specify that lights must be visible within an angle of 15 degrees above and below the horizontal. To meet this with a 2m overhang beyond the light bar will require the bottom of the lights to be at least 520mm off the ground and, for a 1.4m bolster bed height, the top of the lights to be no more than 880mm off the ground. The maximum height to the top of the lights will be commensurately lower with lower bolster bed heights (for example a bolster bed height of 1.2m means that the lights can be no more than 680mm off the ground.

It is preferable if the light bar is within 1m of the rear of the load rather than at the 20m position. While the lights are visible when at the 20m mark, their horizontal visibility will be restricted by any sign placed between them and the end in front of them. Having the light bar behind the visual rear of the trailer will also add to the any overhang perception problems a following motorist may have.

LTSC believe that it is vital that as many trucks as possible are allowed to operate at 22m as soon as the measure is introduced. Having a large number of 22m log trucks available will accelerate the forestry logistics changes required to ensure a high level of adoption.

Trailer length and coupling position

Log trucks are likely to spend some of their time with an overall length of 20m or less and some of the time between 20m and 22m. When they are in the 20m configuration they will need to comply with current regulations and those in the Dimension and Mass Rule 41001 when it is introduced. In the Rule trailer length will be limited to 11.5m and coupling position will need to be within 40% of the wheelbase of the truck from the truck’s rear axis. It is proposed that when they operate at 22m the trailer length be allowed to increase to a maximum of 13.5m but that coupling position remains unchanged. It is recommended that drivers be provided with a gauge that can be used to make sure the 22m overall length is not exceeded.

Speed

The safety benefits of allowing 22m log trucks will be quickly eroded if log truck speeds, especially around curves, are allowed to increase. There is very little safety margin, even with the improved stability the 22m option provides. They will still not be able to negotiate curves at the speeds that more stable heavy vehicles such as tippers can. It is strongly recommended that log truck speeds around curves be no greater than the advisory speed limits.

Monitoring

LTSC is committed to maintaining in the long term its crash database and the "0800 Log Truck" compliments and complaints system. LTSC have also agreed to work with LTSA and CVIU on the monitoring of on-going compliance with the 22m requirements. LTSC has agreed to have as a fixed agenda item at its regular Council meeting a review of the 22m log truck operations.

Uptake

The data on vehicle numbers, load mix and utilisation used in the following analysis were estimates provided by the industry. It is not possible to verify these independently. The industry has estimated that in March 2002, fifty percent of the trailers are able to carry multiple packets. There are approximately 1,100 trailers altogether and new trailers are being built at the rate of approximately 125 per year. Ninety percent of new trailers are multi-bolster. Sixty percent of the logs are in the “difficult” category that should be carried on the multi-bolster trailers. It is estimated that approximately 50 percent of the multi-bolster trailers will be carting “difficult” loads soon after the introduction of 22m log trucks. This will increase to 75 percent as logistics changes are made. Back-loading and other factors means that it is not practical to have all multi-bolster trailers carrying only the difficult loads. The above means that initially 42 percent of the difficult loads will be carted as double packet loads. This will increase to over 70 percent by 2004 assuming no change in trailer construction volumes. In addition there will be additional safety benefits from the cartage of short logs with longer logs on the same trailer, for example 3.5metre logs with 6.5 metre logs.

The following commitment has been received from the New Zealand Forest Owners Association:

“The NZFOA will strongly encourage its members to work with logistics and distribution suppliers, harvesting operators and customers to maximise the uptake of the 22m logtrucks into operations. To capture fully the safety benefits that 22 metre logtrucks will provide the industry members will need to develop policy and procedures with:

1. Logistics providers to ensure they prioritise loadout of product for 22m trucks, and that loadout of longer lengths is prioritised for non 22m capable units.
2. Distribution providers to ensure that drivers are advised of the capabilities of the trucks & prioritise loadings accordingly.
3. Harvesting operations teams to understand the requirement for product segregation and loading priorities.
4. Customers where alternative product and segregation issues are identified and arranged”.

Appendix A: Consultation

Presentations were made to the following groups and their comments sought on the 22m log truck proposal.

- Road Safety co-ordinators AGM – Rotorua
- AA Waikato – Hamilton
- AA Executive – Wellington
- AA Tauranga
- BOP CVIU staff
- South Waikato District Council
- Forest Owners Transportation sub committee
- NZRTA Region 2 - Tauranga AGM
- Hon Mark Gosche, Minister of Transport
- Harry Duynhoven, MP, Chairman Transport and Industrial Relations Committee
- Hon Max Bradford - National
- Belinda Vernon MP, National Party Transport spokeman
- Eastern BOP road safety committee
- Environment BOP Transportation committee
- Marlborough District Council
- Nelson District Council
- AA Wairarapa

The following media reported on the 22m trial and asked for public feedback

- NZ Truck & Driver magazine
- NZ Trucking magazine
- Driver magazine
- Forest Industries Magazine
- BOP & Waikato newspapers
- Dominion
- Radio NZ - National programme

All of the comments received were very positive except those expressed in Driver magazine.

Drivers and loaders were all very positive. Driver noted how much safer the rigs appeared on the road. Comments included "handles well and "very stable". The loaders found the trailers easier to load and, because of the lower height, there was less risk of dropping logs and damaging the equipment.

The Road Transport Forum and the New Zealand Automobile Association support the proposal.

The 0800 Log truck call centre received only two comments on the 22m log truck trial. Both of the calls were very supportive of the proposal.

The AA Bay of Plenty District Council endorses the extension of log truck length to 22m.

The following are copies of some of the correspondence.

Statement from the New Zealand Automobile Association
25 March 2002

NZAA has been actively involved with the 22m log truck trial from its inception. Presentation have been organised with AA District Councils and a presentation made to the NZAA National Council in December, 2001.

When NZAA has actively sought feedback from its members, there has been limited response, most probably because the small number of trucks involved in the trial have not been sighted. Comments made have mostly concerned the effect of increased weights and dimensions of trucks overall – which is unrelated to the 22m log truck trial.

Pertinent issues and concerns raised through NZAA have centred around the increased rear overhang, and the risk of underrun accidents which the extended trial is addressing. The increased risk of underrun fatalities will be mitigated by high grade conspicuity signage required to be displayed within 1m of the rear of the load if the trial provisions are endorsed. The use of retractable signs is acknowledged, however their use will not reduce the severity of an underrun accident once it occurs

The NZAA awaits the release of the report following the conclusion of the trial to know if the increased length sought achieves a change and reduced fatality and injury risk for road users.

It is recognised that the trial is a proactive safety initiative to address the concern of all road users, at the high level of truck rollover incidents and the need for increased stability of loads.

George Fairbairn
Director - Public Affairs
NZAA
Ph: (04) 470 9984

AA Bay of Plenty

From: Barry Kidd [mailto:BKidd@nzaa.co.nz]
Sent: Wednesday, 1 August 2001 11:14 a.m.
To: Martin Hyde
Subject: Council Resolution

Good Morning Martin
The resolution from the June Meeting of the AA's Bay of Plenty District Council follows:

After a brief discussion it was moved :
That this Council support the extension of the unpermitted 20m limit for log vehicles to a maximum of 22m within the existing weight limits to enable logs to be stacked lower but longer, thus improving the safety of our roads by enhancing the stability and lowering the centre of gravity of these vehicles.
(Moved E Turbott, seconded P Hawley)

carried

After further discussion it was suggested that this issue should be put before National Council for its consideration with a view to getting the Association's support for this change. Mr Berry said it could be a good idea to arrange for Mr Hyde to attend National Council to provide some context to the issue.

Regards
Barry Kidd
Bay of Plenty District Manager
The New Zealand Automobile Association Inc
Tel +64-7-5782222 (VPN 7410)
Fax +64-7-5787227 (VPN 7417)
Mob +64-25-433880 (VPN 5616)

Road Safety Co-ordinators

Bruce McCall - Road Safety Co-ordinator
Sent: Monday, 7 January 2002 10:17 a.m.
To: Martin Hyde
Subject: Re: 22m logtrucks

Martin,
Thanks for your presentation at the Road Safety Committee. The committee were impressed with your presentation over the 22metre logging trucks and are in support of the trial and can see the safety benefits for all road users. We will be writing to you in due course.

Regards
Bruce

E-mail from Martin Hyde 8th March 2002.

The Carter Holt Distribution Key Suppliers have all been actively involved in the 22m project and have given their unanimous support to the project in a recent meeting. CHH suppliers operate approx 250 logging trucks throughout NZ - through Northland to Southland.

Likewise Fletcher Challenge Forests uses Forest Distribution Ltd to manage all of it's Distribution requirements. FDL has been actively involved in the 22m project from the start and has committed its support to the project as well. FDL operates approx 200 trucks within the North Island of NZ.

Forest Owners who have actively been involved also include:

Rayonier NZ - 100 trucks Mike Bartlett, Ian Leslie

Weyerhauser - 40 trucks - Grant Rutledge

Pan Pac - Neil Webber - 60 trucks

Juken Nisho - Sheldon Drummond / Martin Abbott - 70 trucks

NZ Forest Managers - Don McMurray

Earnslaw One - Bill Johnston / Matt Wakelin

LTSA Media Statement

For immediate release

Log truck trial one only

17 October 2001

Thirty day trial for longer, lower loads on log trucks

The Land Transport Safety Authority (LTSA) has approved a limited 30 day trial of 22 metre log trucks, beginning today. The trial will involve seven log trucks operating under special LTSA permits on roads in Northland, the East Coast and the central North Island.

The trial follows a proposal from the Log Transport Safety Council suggesting that safety could be further improved by reducing the heights of certain loads from 4.25 metres to 3.2 metres. This requires some loads to be reconfigured, increasing their length by two metres and putting the overall vehicle length beyond the 20 metre limit.

Computer modeling commissioned to assess the proposal estimated that the reduced load height would improve the trucks' stability and could reduce rollovers by up to 47%. Rollover currently occurs in over two-thirds of log truck crashes.

The trial will put the trucks through a series of handling tests in a controlled off-road environment to see if the results of the computer models can be replicated in practice. On-road video footage will also be collected to assess how the trucks perform around other traffic.

Each truck will bear an 0800 LOG TRUCK sign, and all public comments received from the free phone line will be used in assessing the trial. The trucks are also required to display extra signs and flags, including a high visibility sign on the rear of the trailer reading "22m LOGTRUCK". Each truck is checked by an LTSA Vehicle Compliance Officer before being allowed on the road.

For further information:

Andy Knackstedt
LTSA Media Manager
Tel: 04 494 8751 or 025 763 222

Bruce Nairn
Log Transport Safety Council
025 943 695

Parliament House
WELLINGTON 1.

Telephone (04) 471 9999

14 March 2002

Rob McLagan
Chief Executive
NZ Forest Owners Association
P O Box 1208
WELLINGTON

Dear Mr McLagan

May I thank you very much for organising the visit of myself and Hon Mark Gosche to Rotorua on Friday.

I was sorry that I was unable to be with you on the second half of the visit as I would very much like to have been able to see firsthand the practical application of the issues we discussed at the meeting.

Certainly I am aware that the Minister was very impressed by the visit and although I had already had a briefing in the Transport Select Committee, I felt it was a very useful opportunity to hear from the people actually involved in the issues of logging truck safety etc.

Once again, thank you very much for organising it. I would be happy to visit a forest somewhere at a convenient time, to see for myself, if that could be easily arranged.

Yours sincerely

Harry Duynhoven
MP for New Plymouth

The Editor
Driver Magazine
Straight Publications Ltd
P O Box 11-464
Ellerslie
<u>Auckland</u>

By Fax : (09) 630 7022
Dear Sir,

Allan Dick in the February issue of “Driver” promotes the case against bigger trucks. Without wishing to get involved in that debate, I do wish to respond to his comments on proposals to extend the length of logging trucks.

Mr Dick correctly points to the logging industry’s pilot projects to extend the length of logging trucks to lower the height of log loads for safety reasons.
He is incorrect in stating they wish to extend the length from 20 to 25 metres. In fact the proposal is to 22 metres, which would allow a significant lowering of both the log load heights and rollover accidents plaguing the industry in recent years.

As an MP with 12 years experience in the central North Island from where most of New Zealand’s forestry exports derive, I have been dismayed at the distressing increase in the number of accidents involving logging trucks. Many have involved the death of innocent victims. I have been involved in the industry’s efforts to do something about this.
Any steps to lower the road toll here will receive my support, and the support of the National Party.

Mr Dick suggests the logging industry’s proposals will allow operators to add more logs if the truck length is increased. Nothing could be further from the truth. The increase from 20 to 22 metres will simply allow the redistribution of the same load, and lower the centre of gravity of the same sized load. That is what makes the truck safer – considerably safer - for logging truck drivers and all road users.

It works. The incidence of logging truck accidents has dropped by over 40 percent since the pilot project and other measures have been introduced by the industry (and not by the LTSA I would note). The incidence will drop further if Mr Dick and others get behind the industry’s proposals.

Nor is this a trivial issue. Over the next few years the “wall of wood” will arrive on New Zealand roads. The number of logging trucks on the road has increased from 650 in 1997, to around 1,100 now. Inside 5-7 years, this number will have to increase to around 3,000 to cope with these export volumes, so any steps to increase safety are vital to every road user. I just hope the Labour-Alliance government will support them as well.

Yours sincerely

Hon Max Bradford
National MP Rotorua

Tasman

Your Ref:
Our Ref. 3680 L02

25 March 2002

ENVIRONMENT B.O.P

Bay of Plenty Regional Council

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Whakatane New Zealand

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0800 368 288
Email info@envbop.govt.nz
Web Site www.envbop.govt.nz

POLLUTION HOT LINE 0800 73 83 93

Attention: Director

Land Transport Safety Authority
P.O. Box 2840
WELLINGTON

COPY FOR YOUR
INFORMATION

Dear Mr Wright

Longer Log Truck Trial

In October 2001 the Authority began a trial of' 22 metre log trucks, initially in Northland, the East Coast and tile central North Island, and subsequently in Christchurch, Timaru and Nelson.

Council understands the trial followed a proposal from the Log Transport Safety Council suggesting that safety could be further improved by reducing the heights of' certain loads, although this would put the overall vehicle length beyond the 20-metre limit.

In a region where log truck traffic is significant Council has formed the following view on the trial. Council:

> “agrees in principle to support the trial of 22 metre log trucks in the interests of reducing accidents and road safety, but opposes any increase in overall weight of trucks and their loads "

I would be grateful if you could make the Authority aware of the Council's view and I hope that it assists it when it considers whether or not to permanently provide for 22 metre log trucks.

If' you have any questions or would like to discuss this matter further, please phone me on 0800 368 267, or e-mail me at garry@envbop.govt.nz.

Yours faithfully

Garry Maloney
Transport Planner

for Group Manager Strategic Policy

Tasman
District Council

Reference:
R 860
Peter Thomson
Writer's Direct Dial: (03) 544-3440
Email: peter.thomson@tdc.govt.nz

19 October 2001

Blair King
Rules Team
Land Transport Safety Authority
PO Box 2840
Wellington

Dear Mr King

Vehicle Dimensions & Mass Review - Forest Industry Proposal

I refer to our Council's original submission of 31 August 2001 and subsequent telephone discussions between our CEO Bob Dickinson and yourself.

The forestry sector has raised issues with Council's transport engineers during discussions on the LTSA's Proposals for Higher Dimension and Mass Limits.

Our Council supports in principle the forest industry alternative proposal to allow current 44 tonne, 20 metre long multi bolster truck-trailer units to be reconfigured allowing the same load on 22 metre units.

The forest industry proposal is outside the scope of Transit's Scenario A or B. The proposal follows a review of the Log Truck Safety Council's (LTSC) database for log trailer roll over incidents, and is specifically aimed at improving safety.

Forest Industry Rule Change Proposal

> The Forest Industry is promoting a simpler transport rule change to improve the safety of logging truck and trailer units, which are currently the cause of high numbers of truck roll over accidents throughout the country. A map from the LTSC is attached showing South Island highway roll over incidents in the last year.

The Forest Industry proposal would be a rule change to allow existing multi-bolster trailers, towed behind a rigid truck, with the existing vehicle length dimensions to operate with:

- up to 2.5 m rear overhang of logs - measured from the trailer rear axis
- up to 2.0 m forward overhang measure from the front trailer axis
- a relaxation of the overall trailer length (up to 11.5 m) to allow longer draw bars to allow trailer coupling position closer to the rear axis of the truck

- an overall length including the load will not exceed 22.0 m on existing units
- there would be no change in overall load limit (44 tonnes)

The proposal is promoting safety by improving the units SRT (static roll over threshold) from the current 0.35 minimum to over 0.40. Rotorua Forest Haulage Ltd through an Over Dimension Permit Application to LTSA has sought this proposal. However we understand that the permit application cannot be actioned until there is a rule change.

Our Council is very interested in this Forest industry proposal which maintains the existing 44 tonne weight limit but extends vehicle load length to 22 metres maximum. This is 2 metres more than at present, but it has significant safety benefits as it allows logging trucks to carry two 5.5 metre logs on the trailer unit, thus lowering log height and trailer roll overs. This is a very significant benefit to any major log growing area with expanding forest estates, such as Tasman District.

While our Council has not carried out independent research into the proposal, from a network perspective we support the proposed changes to trailer configuration with LTSA overseeing the process on the following grounds:

1. Vehicle loads would not exceed the current weight limit and therefore would have no impact on existing bridges and pavements

2. Load configurations would exceed the present SRT limit and therefore reduce roll over and loss of control crashes

3. The swept path of the new units will be no greater than that for B-trains or semi-trailer configurations operating under existing regulations and therefore should have no impact on route geometrics

4. The possible safety disadvantages of having a total loaded vehicle length of 22.0 metres (such as increased overtaking length) will be more than offset by the safety improvements and the corresponding decrease in log truck crashes which are currently well in excess of the rest of the transport industry

5. Environmental impacts from this proposal are expected to be neutral

Based upon the support given to the forestry sector previously and comments in our submission we would be supportive of this Forest Industry proposal or any LTSA initiatives to further investigate specific issues.

Finally, Tasman District Council looks forward to your reply and continued dialogue with central government agencies, and recognition that local government is a major funding partner in the ongoing development of more efficient transport solutions.

Yours sincerely

Peter W Thomson (BE, MIPENZ)
Engineering Manager

Appendix B:

Assessment of the Safety Implications of Increasing the Maximum Length of Log Truck-Trailer Combinations to 22m

John de Pont, TERNZ Ltd.

September, 2001

Executive Summary

In order to achieve reduce the rollover crash rate of logging trucks the log transport industry through the Log Transport Safety Council (LTSC) is proposing that logging truck-trailer combinations with multi-bolster trailers be allowed to operate at 22m overall length. Through this measure it is envisaged that log packets with an average length of at least 5m would be carried as double packet loads on the trailer thereby significantly reducing the load height and improving the stability of the vehicles.

Implementing this measure effectively requires the random length logs to be sorted into lengths above and below 5m. For this to be worthwhile it is necessary for the fleet of multi-bolster trailers to be capable of carrying these longer two packet loads and hence the additional length is sought for existing combinations as well as for new vehicles. This report contains an analysis of the technical and safety issues involved in granting this concession.

The dimensions issues are slightly complicated by the fact that the Land Transport Safety Authority (LTSA) is developing a new rule on heavy vehicle dimensions and mass and the yellow draft of this rule has recently been out for public consultation. The existing regulations are considered briefly at the start of this report but the analysis is largely based on the proposed dimensions and mass limits contained in the new rule.

On this basis it can be shown that new trailers could be built to double bunk 5m packets of logs but that in order for these trailers to be in a vehicle combination that is less than 20m long the trucks would have to be considerably shorter than they are currently. This would limit their versatility for carrying a range of log lengths and preclude them from being able to piggyback the empty trailer.

Piggybacking is fundamental requirement for both safety and operational reasons. In order to be able to use trucks of sufficient length, therefore, it is necessary to have an increase in the allowable combination length. Because of the front and rear overhang limits in the new rule these trailers will have wheelbases substantially greater than those of many existing trailers. These longer wheelbases improve the stability of the vehicle during dynamic manoeuvres and thus are desirable from a safety perspective.

The typical older existing trailer has a wheelbase of about 4.9m. In order for this trailer to be able to double bunk 5m packets of logs, it needs to be able to violate the front and rear overhang limits proposed in the new Dimensions and Mass Rule as well as the 20m overall length limit. The LTSC is proposing that for these vehicles a front overhang limit of 2m across the full width of the load and a rear overhang limit of 65% of wheelbase with a maximum of 3.2m should apply.

The safety analysis was undertaken in two parts. The first considered the crash and incident database maintained by the LTSC, which aims to keep a record of all log truck rollover crashes. As the proposed dimensional changes relate to on-highway vehicles only on-highway rollover crashes were considered. However, many off-highway trips are actually trips by on-highway vehicles en route to the highway and thus the use of more stable vehicles for on-highway operations will result in a reduction in off-highway rollovers. In the on-highway cases over a 14 month period from June 2000 to August 2001 there were 61 rollover crashes. 70% of these were truck-trailer combinations carrying a single packet of logs on the trailer, which was not identified as a long log packet. However, for a substantial proportion of these the log length was not identified at all and thus they may have involved log lengths that would not be able to be double bunked even with the 22m overall length concession. Thus 70% is the absolute maximum proportion of rollovers that could potentially be prevented by this measure. It should also be pointed out that in a number of these crashes the rollover was the result of the crash not the cause. In these cases having a more stable vehicle would not have prevented the crash but may still have prevented the rollover.

The second part of the safety analysis used the set of performance measures being developed by the National Road Transport Commission (NRTC) in Australia as a potential alternative to prescriptive mass and dimensions limits. A typical current vehicle was assumed to be loaded with a load of mixed length logs. In the baseline case it was assumed that the vehicle was limited to 20m overall length and the load was carried as a single packet on the truck and a single packet on the trailer. For comparison it was assumed that the same load was sorted into lengths above and below 5m, with the longer logs carried as a single packet on the truck and the shorter logs carried as two packets on the trailer. The overhang and length limits described above were assumed to apply. Because the vehicles for the two cases are assumed to be identical with the only difference being in the load many of the performance measures such as gradability, startability, low speed off-tracking etc show no change. There is a slight negative impact on the measures relating to length, i.e. overtaking time and intersection clearance time. There is also a small negative impact on the front swing and tail swing because of the greater overhangs, but because a log load is only 2.2m wide rather than 2.5m neither swing goes out beyond the path of the front of the vehicle. On the other hand because there is a significant reduction in load height there are improvements in the two key dynamic performance measures, Static Roll Threshold (SRT) and Load Transfer Ratio (LTR) of 27% and 35% respectively. Based on previous work relating rollover crash risk to performance measures this level of improvement would be expected to result in a reduction is rollover crash risk of between 55% and 67%. Applying these reductions to the potential 70% of rollovers involving these vehicles suggests it might be possible to reduce the on-highway rollover crash rate by as much as 39% to 47%. This is based on the assumptions that all loads that can possibly be double bunked are double bunked and that all of the crashes identified as involving single packet loads were in fact loads that could be double bunked under the 22m overall length limit.

There are some other issues related to the safe implementation and operation of these 22m vehicles that need to be considered. Because of their increased length some signage needs to be attached to the rear of the vehicles to warn other motorists of their additional length. The LTSC is suggesting a high visibility sign with the words "22m Log Truck". This should mitigate the negative effects of the additional length. For existing vehicles the rear overhang is greater than permitted by the new rule. Measures need to be implemented to minimise the impacts of this overhang. Specific issues are:

- Additional care should be taken to ensure that this longer limit is not violated. Some form of guide to indicate the limit to loader drivers is recommended.
- The visibility of lights, number plates and signs needs to be maintained. The legal requirement of visibility 15° above and below the horizontal leaves quite a narrow range of vertical placement position available. Consideration should be given to mechanisms for moving the lights, number plate and signs rearward after loading.
- Underrun protection. The logs are 1.4m above the ground and will extend up to 2m rearwards from the vehicle. Consideration needs to be given as to how this risk can be minimised.

For both new and existing vehicles the purpose of the requested 22m length limit is to improve the stability of the vehicle by lowering the load height which results in a better SRT value. This should be reflected in the operating requirements of the 22m vehicles. Although the ideal is to set a lower limit for SRT, from an enforcement point of view it is easier to set a load height limit.

Introduction

Despite the efforts over the last six years by the log transport industry, the rollover crash rate of logging trailers in New Zealand is unacceptably high. What follows is an analysis of a safety initiative that, if approved, will allow the double bunking of packets of logs of at least 5m in length on multi-bolster trailers. This would reduce the incidence of logs being carried as a single packet load with a high centre of gravity. Many in the log transport industry believe this measure will significantly reduce the incidence of log trailer rollovers.

The stability of logging vehicle combinations has been well documented (White, 1996), (Baas and Latto, 1997). As a result of these studies the industry has made changes and new vehicles entering the national fleet are significantly more stable than the older generation equipment. However, even with these new more stable vehicles, carting high single packet loads results in stability at the lower end of the scale. Substantial stability benefits can be achieved by opening up the existing dimension envelope to allow packets of a least 5m length to be double bunked on trailers.

At present multi-bolster log trailers can transport double packets of logs for log lengths of up to about 4.2m although some of the newer trailers can double bunk logs longer than this. For longer log lengths the vehicle dimension limits preclude double bunking and the logs must be carried as a single packet. It is argued by the LTSC that provided log lengths up to 5m in length could be double bunked, random length packets would be sorted into lengths above and below 5m. The shorter lengths would be carried as two packet loads on the trailer and the longer lengths as a single packet on the truck. It is claimed that 5m is a critical value. If the cutoff value were 4.9m the effort of sorting could not be justified economically.

The purpose of this report is to review log truck dimensions as a basis for LTSC's submission on the Yellow Draft of the LTSA Dimensions and Mass Rule 41001. A major, but not exclusive, focus of the investigation is overall length with the view to increasing this to 22m. The analysis is based solely on 44-tonne mass vehicle and no consideration has been given to any change in mass limits.

Vehicle Dimensions Limitations

Theoretical Vehicles

The first step in the process is to determine how the vehicle dimension limits inhibit the multi-bolstering of medium length logs and the extent to which an increase in overall length will mitigate this problem. Initially we will consider the existing dimensions regulations and then we will consider how the situation will change under the proposed LTSA Dimensions and Mass Rule 41001 which is due to come into force in July 2002.

Current Regulations

Under the current dimension limits a full trailer is limited to 11m overall length. The inter-vehicle spacing (IVS) limit is 1.6m minimum. However, approval is subject to an assessment of IVS using a software package and minimum values of 1.1m are typical for log truck-trailer combinations. Assuming the trailer connection is at the rearmost point on the truck, this leaves a maximum of 9.9m of load space on the trailer, which means that theoretically logs up to 4.95m long (4.9m if there is a 0.1m spacing between the packets) can be double bunked. As will be shown later in this section, at 20m overall length this requires a very short truck that would then not be able to piggyback the trailer. The piggybacking requirement exists for both operational and safety reasons and is unique to the log transport industry. The maximum front overhang on the trailer is defined by a 1.5m radius arc centred 0.5m forward of the kingpin. Assuming the front of the load is flat, this means that the front axis of the trailer can be no more than 1.52m behind the front of the load. This means that at least 8.38m of the load must be behind the front axis. The rear overhang limit is the lesser of 3.2m or 60% of the wheelbase. For this vehicle the 60% factor is the limitation and this means that the wheelbase would have to be at least 5.24m. Note that at no stage in this analysis has the overall combination length limit been a limiting factor. The overall length limit, in fact, only determines the maximum allowable length of the truck, which for this maximum length trailer is 9m. However, a 9m truck has a maximum rear overhang of 2m or less. It also has a load bed length of no more than 6.5m for cab-over truck and 5.7m for a bonneted truck. These short trucks would be unable to piggyback the long wheelbase trailer and would be restricted to carrying relatively short log lengths. Thus this is not a practical option from an operational point of view. Increasing the combination length limit to 22m would allow these trailers to be towed by trucks up to 11m in overall length.

Dimensions and Mass Rule 41001

With proposed changes to the dimensions limits in the yellow draft of Dimensions and Mass Rule 41001 the potential log lengths than can be double bunked increase even without any change to the overall length limit. The maximum trailer length becomes 11.5m and the IVS becomes the greater of 1m and half the width of the foremost point on the trailer. As log loads are 2.2m wide this implies a minimum IVS of 1.1m which gives a maximum potential load length of 10.4m allowing logs up to 5.2m to be double bunked. Again in practice the actual maximum length will be slightly less. The maximum front overhang under the Rule is a 1.9m radius arc from the centre of the turntable. With a square fronted load and a 2.2m load width, this means that the front axis can be at most 1.549m behind the front of the load and hence at least 8.851m of the load must be behind the front axis. As the proposed maximum rear overhang limit is the lesser of 4m and 50% of the wheelbase, this means that the minimum wheelbase for this maximum length load is 5.9m. Again the limit on overall combination length has not been a factor in this analysis and only affects the length of the truck, which can now be no longer than 8.5m. For the same reasons as given before this length of truck is totally impractical. If the combination length limit were increased to 22m, the maximum length of the truck would increase to 10.5m, which is in line with current practice.

If the maximum log length to be double bunked is limited to 5m, then a load length of 10m is required. Using the maximum front overhang of 1.549m implies that 8.451m of load must be behind the front axis. With a maximum rear overhang of 50% of the wheelbase, this implies a minimum wheelbase of 5.634m. Note that a small gap between the packets is needed and hence the load length and minimum wheelbase will be slightly larger in practice.

Submissions are being made from the transport industry in general for the proposed front overhang limit to be raised from a 1.9m radius arc to a 2.04m radius arc as specified in the ISO 1726 standard. It is anticipated that these submissions will be accepted by LTSA. An arc of this radius implies a front overhang of 1.718m for a 2.2m wide square fronted load. This reduces the length of load that is behind the front axis and hence the minimum wheelbases needed for the different maximum packet lengths.

Thus the maximum length of logs that can be doubled bunked on a trailer is controlled by the trailer length and overhang limits which in turn impose limits on the trailer wheelbase. The combination length limitation only controls the length of the truck that can be used to tow these trailers. Requiring shorter trucks reduces their flexibility for carrying longer single packets of logs and may make it difficult for the trucks to "piggy-back" the empty trailers particularly when the trailer wheelbase is lengthened in order to meet the overhang requirements.

Existing Trailers Double-Bunking 5m Packets

Consider now the typical current 20m multi-bolster log truck-trailer combinations shown in Baas and Latto (1997). The vehicle geometry data for this study were provided by the industry. The trucks in these combination have vehicle lengths ranging from 9.77m to 10.09m. The trailers have a wheelbase of 4.9m. Under current regulations the payload on these trailers could have a front overhang of 1.52m and a rear overhang of 4.9*0.6 = 2.94m. This gives a total load length of 9.36m, which means that it could double bunk logs up to 4.68m in length. However, allowing for 1.1m IVS this would take the combination length up to between 20.23m and 20.55m. To meet the 20m overall length requirement double bunking is limited to logs of 4.56m or 4.4m or less unless shorter trucks are used. Allowing for 100mm between the packets these log length limits are 4.5m and 4.35m and require the drawbar to be the appropriate length.

Under the proposed new Rule, the allowable front overhang increases slightly to 1.549m (or 1.718m under the proposed variation) but the rear overhang reduces to 4.9*.5 = 2.45m. The payload length then becomes 8.899m (or 9.068m), which means that logs up to 4.4m (or 4.5m) could be double bunked. With the minimum IVS of 1.1m the combination lengths range from 19.769m to 20.258m depending on which front overhang limit is used and which length of truck is used. Some of these options meet the 20m overall length limit and it is primarily the front and rear overhang limits rather than the overall combination length limit that are the critical factors in determining the maximum length of logs that can be double bunked.

For a 4.9m wheelbase trailer under both the current dimensions limits and the new Dimensions and Mass Rule 41001 the length of logs that can be double bunked does not increase significantly by increasing the overall vehicle length limit. For this wheelbase the front and rear overhang limits are the critical factor rather than the overall length limit.

If one wanted to double bunk packets with an average length of at least 5m on these trailers a number of the proposed dimensions limits would need to be violated. Assuming the 1.1m minimum IVS is sacrosanct and 100mm space between the packets is needed, the rear of the payload would need to extend out to 11.2m from the rear of the truck. So the overall combination length would have to be greater than 20.97m to 21.29m unless shorter trucks were used. The payload position can be moved longitudinally relative to the trailer wheels so that the proposed limits for either the front overhang or the rear overhang or both are violated. If the front overhang limit of 1.549m is adhered to, the rear overhang would need to be 3.651m, which is 74.5% of the wheelbase. If the rear overhang limit of 0.5*4.9 = 2.45m is adhered to the front overhang would need to be 2.75m. All combinations in between are also possible. Note that if the trailer wheelbase were longer the extent to which the overhang limits are violated would be smaller. From the earlier analysis at 5.634m wheelbase the overhang limits can be met.

In summary then, for a new vehicle the limitation on the length of logs that can be double bunked derives primarily from the trailer length limit and the IVS requirement. The front and rear overhang limits then determine a minimum wheelbase length for the trailer. The overall combination length limit effectively only determines the maximum length of the towing vehicle. To achieve double bunking at greater log lengths on existing vehicles requires several departures from the proposed dimensions limits in Rule 41001. At current typical trailer wheelbase lengths it is necessary to depart from the front and rear overhang limits. An increase in combination length is also needed because the existing prime movers are too long to be combined with these longer trailers and stay within the existing limit. It is also assumed that the existing trucks will be able to retain their existing tow coupling positions as indicated in the yellow draft. If they were required to adopt the new requirements for tow coupling position (i.e. less than 40% of the truck wheelbase), the trailers would need to be lengthened beyond the 11.5m in order to avoid substantial mass capacity reductions from the bridge formula. The IVS requirement would also mean that the steelwork on the truck would have to be shortened which may cause piggybacking difficulties.

Thus if longer logs are to be able to be double bunked on 4.9m wheelbase trailers it will be necessary to have a revised rear overhang limit for these vehicles. The proposal from the LTSC is that the rear overhang limit for these vehicles should be the lesser of 65% of the wheelbase and 3.2m. Using these limits with a 4.9m trailer wheelbase allows logs up to 4.9m to be double bunked. Trailers with longer wheelbases will be able to double bunk longer logs. At 5.08m wheelbase, 5m logs can be double bunked. However, if the front overhang limit for logs was relaxed to 2m across the full width of the load, a 4.9m wheelbase trailer with 65% rear overhang could double bunk 5.04m logs while a 5.1m wheelbase trailer could double bunk logs up to the absolute maximum of 5.2m. To allow these trailers to be towed by the existing trucks it is proposed by LTSC that the overall combination length limit be 22m. Note that the above dimensional analysis of the trailer applies equally to 3-axle and 4-axle trailers.

Assuming that the wheelbase of the multi-bolster trailer to be used is at least 4.9m, that the rear overhang is 65% of wheelbase and that the front overhang is 2m across the square fronted load the load bed of the trailer is 10.085m long. This means that two 5m packets of logs will just fit. This trailer could be either 3-axle or 4-axle.

Existing Trucks Towing Trailers with Two 5m Packets

Based on the vehicle configurations in Baas and Latto there are three truck options to be considered for towing this trailer. They are the 3-axle cab-over truck, the 3-axle bonneted truck and the 4-axle cab-over truck. There is a 1.1m inter-vehicle spacing requirement which means that the rear of the truck must be at least 11.185m forward of the rear of the trailer.

Consider first the typical 3-axle cab-over truck in Baas and Latto. It has a front overhang of 1.468m, a 5.3m wheelbase and a 3m rear overhang. Under the new Rule the hitch offset can be no more than 40% of the wheelbase, which in this case is 2.12m. This means that the rear overhang extends 0.88m behind the hitch. As the trailer must extend to 11.185m from the rear of the truck this gives an overall trailer length of 12.065m which is greater than the 11.5m maximum specified in the Rule. To achieve 11.5m the rear overhang of the truck steel work could be shortened by 0.565m which reduces the overall length of the truck to 9.203m. Assuming the distance from the front of the vehicle to the rear of the cab guard is 2.55m, the length of the load bed is 6.65m. This is sufficient to piggy back this trailer and allows logs up to 6.65m logs to be carried on the truck in conjunction with two 5m packets on the trailer. Longer logs can be carried on the truck if the trailer load is shorter. The length from the first drive axle to the last axle is 11.735m which limits the load on these axles to 36,000kg and thus the capacity of the combination to 42,000kg. To bring the

GCM up to 44,000kg, the first drive axle to last trailer axle distance needs to be more than 12.5m. This would be achieved if the hitch offset was left at 3m as it is on the current vehicle or if the trailer length was increased by 0.765m.

Repeating the analysis for the 3-axle conventional truck. In this case the front overhang is 1.25m, the wheelbase is 5.855m and the rear overhang is 2.93m. The hitch offset under the new rule should be less than 2.34m. Thus the rear overhang extends 0.59m behind the hitch giving a minimum trailer length of 11.775m in order to fit the load. Reducing the rear steelwork on the truck by 0.275m would bring the trailer length down to 11.5m as required. The overall length of the truck then becomes 9.76m and assuming 3.3m from the front of the truck to the rear of the cab guard, the load bed becomes 6.46m which should be sufficient to piggy back the trailer. In this configuration the distance from the first drive axle to the last axle is 11.955m. This limits the load on these axles to 36,000kg and the GCM to 42,000kg. As above to bring the GCM up to 44,000kg, either the hitch offset or the trailer length needs to be increased by 0.545m.

Now repeating the analysis for the 4-axle cab-over truck. In this case the front overhang is 1.468m, the wheelbase is 5.875m and the rear overhang is 2.75m. The hitch offset under the new rule should be less than 2.35m. Thus the rear overhang extends 0.4m behind the hitch giving a trailer length of 11.585m. Reducing the rear steel work on the truck by 0.085m would bring the trailer length down to 11.5m as required. The overall length of the truck then becomes 10.008m and assuming 2.508m from the front of the truck to the rear of the cab guard, the load bed becomes 7.5m which is sufficient to piggy back the trailer. In this configuration the distance from the first drive axle to the last axle is 11.965m. This limits the load on these axles to 36,000kg and the GCM to 46,800kg, which is greater than the allowable 44,000kg.

For the two 3-axle truck options the load capacity is limited below the legal maximum unless the hitch offset is greater than the proposed new level or the trailer length exceeds the proposed new limit. As the Dimensions and Mass Rule 41001 includes a provision for vehicles already operating legally before the rule comes into force to be allowed to continue to operate at their existing dimensions, an argument can be made for these vehicles to continue to operate with their existing hitch offsets. On this basis the 22m vehicles would have the same dimensions as the corresponding vehicles in Baas and Latto with some minor changes to the drawbar length. For a maximum overall trailer length of 11.5m with 4.9m wheelbase and a 65% rear overhang for the load, the maximum drawbar length is 3.415m. For a 1.35m drive axle spacing, 1.25m rear trailer axle spacing and 44000 tonne capacity, the distance, from the rear axis of the truck to the rear axis of the trailer must be greater than 11.2m. With a trailer wheelbase of 4.9m this means that the sum of the hitch offset and the drawbar length must be greater than 6.3m.

Combination for Analysis

For this study the 22m vehicle to be considered will be the 3-axle conventional truck coupled to a 4-axle multi-bolster trailer with the same vehicle dimensions as used in Baas and Latto except that the drawbar length will be 3.37m. The trailer load will have a 2m front overhang and a 65% (3.185m) rear overhang. The performance of this vehicle will be compared with a standard vehicle of the same configuration that complies with the current weights and dimensions regulations.

As in the Baas and Latto study the vehicles will be assumed to have a tare weight of 9750kg for the truck and 5500kg for the trailer. The GCM will be 44000kg, so the payload will be 28750kg and it will be assumed that the truck is loaded to its legal maximum of 21000kg and is therefore carrying

11250kg of payload and thus the trailer carries 17500kg of payload. The critical type of load for which the 22m overall limit is sought are the random length packets which contain log lengths from 4m to over 6m. Currently these are carried as single packet loads. With 22m vehicles it is assumed that these will be sorted into lengths above and below 5m. Those below 5m will be doubled bunked on the trailer while those above 5m will be carried as a single packet load on the truck. Assume that the load to be analysed consists of random log lengths with 61% at 5m or less with a mean of say 4.5m and 39% at more than 5m with a mean of 5.5m. The overall mean log length then is 4.89m.

For the 20m vehicle it is assumed that these will be carried as two packets each containing a random mix of lengths. Based on load width of 2.2m, a log density of one and stacking density of 0.75, the packet on the truck will be 1.394m high and the packet on the trailer will be 2.169m high. If the bolster bed height on the truck is 1.3m (as used in Baas and Latto) the load height on the truck will be 2.694m, while on the trailer the bolster bed height is 1.4m resulting in a load height of 3.569m.

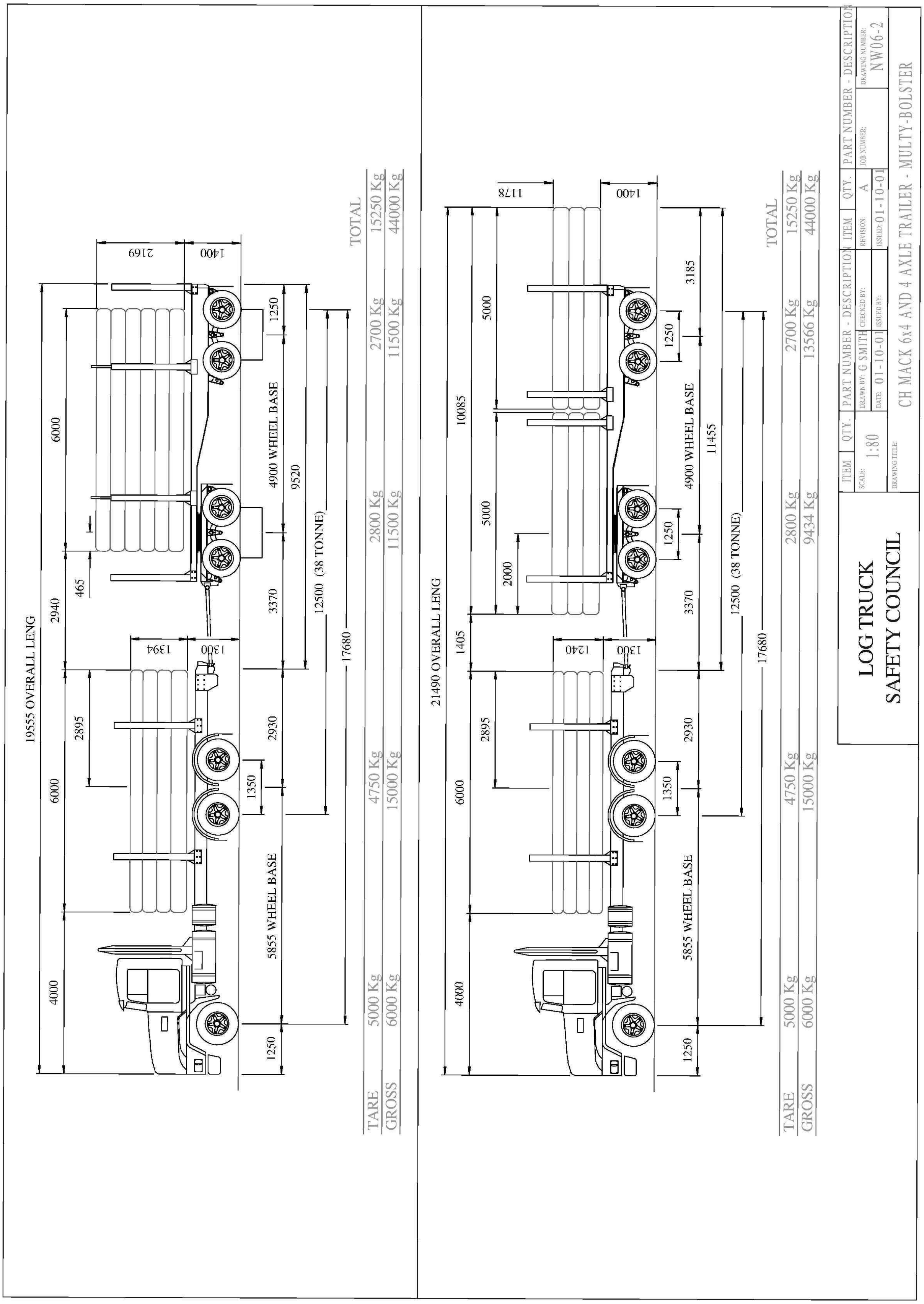

Figure 1. Load Configurations for Analysis.

For the 22m vehicle it is assumed that the trailer will carry the sub 5m logs as two packets. Using the same density values this implies a packet height of 1.178m giving a load height of 2.578m on the trailer. The truck carries the logs over 5m as a single packet. Again using the same density values this implies a packet height of 1.24m and hence a load height on the truck of 2.54m. Sorting the log length reduces the load height on both the truck and the trailer. These two vehicle-load configurations are shown in Figure 1.

Crash Data Analysis and Potential Safety Benefits

The primary purpose of this proposed variation to the dimensions and mass regulations is to facilitate the increased use of double packet loads on log trailers thereby improving their stability and reducing the rollover crash rate of logging trucks. In this section, the relevant crash data are reviewed and analysed.

Reliable rollover crash data are difficult to obtain. A previous analysis of the logging truck rollover crash rates was undertaken by (Baas and Latto, 1997) using the police CVIU crash reports. This analysis found that 31 on-highway rollover crashes were reported and assumed that the off-highway number was similar based on anecdotal evidence from the NZ Police, the Department of Labour and the industry. Based on these it was found that there were at least 60 logging truck rollover crashes per annum, which, at the time implied that 1 in 11 logging trucks were rolling over each year. Baas and Latto also reported a CVIU officer estimating that they only attended $2/3^{rd}$ of log truck rollover crashes but did not scale up their figures accordingly. Thus the 60 rollover crashes per annum was quite a conservative estimate. In response to these very disturbing figures the LTSA and the industry instigated a number of measures to improve log truck safety. A subsequent analysis undertaken by TERNZ for the LTSA in September 2000 compared the rollover crash rate for logging trucks for the year ending June 2000 with that for the year ending June 1997. It was found that although the number of logging truck combinations had increased by 44% the number of rollover crashes had declined by 48%. If the increase in the number of vehicles is taken into account the rate of rollover crashes reduced by 64%. Over the same period the rate of rollover crashes for all combination heavy vehicles also declined by 45%. Thus the improvement in rollover crash rate for logging trucks was significantly greater than that of the general fleet. Nevertheless the rollover crash rate for logging trucks was still significantly higher than the fleet average. However, these figures include assumptions that the level of under-reporting of rollover crashes had reduced because of increased resourcing of and activity by the CVIU. The validity of the assumptions on reporting rates in both the analyses is very difficult to test.

One of the measures introduced by LTSC to try to address the log truck safety problem was the development of a crash database detailing all log truck crash incidents. Because this database is strongly supported by the forest owners and because the data are not used as a basis for legal action against either the driver or the operator, the reporting rate particularly for rollover crashes appears to be very high. There is provision in the database for quite detailed information on the vehicle and its load but because the data are provided from a number of difference sources these details are not always available. Nevertheless this database is the best record currently available on log truck rollover incidents and therefore will form the basis of this discussion.

The database records provided cover the period from 12 June 2000 to 13 August 2001. During this period there were 115 rollover crash incidents recorded, which equates to a rate of 99 per year. As there are now approximately 1000 log truck combinations operating this indicates a rollover rate of about 1 in 10 vehicles each year. This is no better that the rate estimated in 1997 but, of course, the 1997 rate was clearly quite conservative and the true rate then may have been considerably higher.

Of the 115 rollover crash incidents recorded, 61 were on-highway and 54 were off-highway. As this study is addressing variations to the dimensions and mass regulations that apply to truck-trailers operating on-highway, the analysis will consider only the on-highway truck-trailer rollover crashes. There were 57 of these. It should be noted, however, that many off-highway trips are under undertaken by on-highway vehicles en route to the highway. Thus improving the stability of on-highway vehicles will have a positive impact on the off-highway crash rate. Cases where only the truck rolled over are also not affected by the proposed dimension limits changes which further reduces the number to 54. Of these 54, 8 involved double bunked or empty vehicles (1), which would not be affected by the proposed dimensional changes. 40 of the rollovers involved vehicles with single packet loads while 6 were not specified.

To determine which of these crashes might have been preventable through double bunking we need to look at the length of the logs on these vehicles. Clearly if they are below 4.1m they could have been double bunked using existing equipment and were not. There is no reason to believe this would change if overall length is increased. If they are much longer than 5m, they could not be double bunked even if the dimensional limit changes were introduced. Thus the potential benefits apply when the single packet loads are logs between 4.2m and 5m. Unfortunately log length of the load is one of the areas where the database records are incomplete. Of the 40 rollovers involving single packet loads plus the 6 unspecified configurations, 3 can be identified as not being affected by a change in dimension limits. Only 4 clearly fall into the category where a change in dimensions regulations would enable double bunking where it is not possible now. For the remaining 39 crashes the load description is not sufficient to be able to make a determination. 7 are described as random saw logs with a further 4 as just random. 10 are described as pulp logs and there are 1 each of export and domestic and 16 with no description. With random logs, the length of the packet is determined by the length of the longest log in the packet. If the sum of the lengths of the two packets is greater than 10m, then double bunking within the length limits may not be possible. It is therefore, possible that a proportion of the random length log loads will not be able to be double bunked and therefore will not gain any safety benefit from these dimensional limits changes. Pulp logs vary in length from 3m to 6m but it is not possible to determine from the data what lengths the logs on the crashed vehicles were.

Thus there is a high level of uncertainty in the number of rollover crashes involving vehicles that could be made more stable through the dimensional limits changes. Of the 61 on-highway rollover crashes there are at least 4 and possibly as many as 30 or more. Improving the vehicle stability does not, of course, guarantee that the rollover crash would be prevented as some crash incidents are such that any vehicle would rollover regardless of its stability. Analysing the incident details field in the database for the vehicle configurations that could possibly gain improved stability through the proposed dimension limit changes and assuming that:

1. any rollover related to cornering, or an evasive manoeuvre could be avoided through having a more stable vehicle
2. all other incidents including leaving the road and then rolling over in the soft ground, crashes with other vehicles and mechanical failures might avoid rollover with a more stable vehicle.

On this basis 26 rollover crashes fall into the first category and 17 into the second.

In summary then, because of the uncertainties it is very difficult to estimate the potential reduction in rollovers. However, it is simpler to identify crashes where the proposed changes in the dimensions limits will have no effect. Of the 61 on-highway rollover crashes in the database:

- 4 are not truck-trailers
- in 3 cases the truck rolled without the trailer rolling
- a further 8 are already double-bunked or are empty
- a further 3 are carrying log lengths which could either be double bunked already or could not be double bunked even with the changes.

This leaves 43 (70%) rollover crashes in the group that potentially could be prevented by the changes. However, only 4 (7%) of these are definite candidates. For the remaining 39 the load information is not sufficiently detailed to be confident that double bunking would be possible under the revised dimension limits. 15 have no log length or log type information at all. Analysing the incident details for these crashes is more encouraging. 26 out of the 43 crashes are of types where the rollover is directly related to the vehicle stability. For the other 17 crashes a more stable vehicle may not have rolled over but it is difficult to be sure. The incident itself would not have been prevented. Thus the changes in dimension limits could prevent between 7% and 70% of rollover crashes. The critical factor is what proportion of vehicle-trips could utilise the new limits and double bunk loads they would otherwise carry as a single packet. Most of the crashes are clearly stability/speed related. It is important to note that, for typical heavy vehicles, speed and stability are inextricably related. When cornering, an unstable vehicle will not roll over if it is driven slowly enough while a stable vehicle will roll over if it is driven fast enough.

Performance Based Standards

Introduction

The primary purpose of prescriptive dimensions and mass limits is to ensure that heavy vehicles have acceptable safety and impact on the infrastructure. In this regard prescriptive regulations are rather crude in that they often do not directly address the issue they are targeting. However, they have advantages in that they have evolved over a considerable period so that they are comprehensive and anomalies have been minimised. Furthermore compliance checking is relatively straightforward both at the vehicle certification stage and in-service.

Performance based standards provide an alternative compliance scheme where the safety characteristic, or infrastructure impact or environmental impact is addressed directly by a performance measure for which an acceptability level is set. A performance measure consists of tightly specified test procedures (which may include computer simulation) with a clearly defined measurement. The performance standard consists of both the measure and the level for an acceptable result. A good example is Static Roll Threshold (SRT) which reflects the propensity of a vehicle to roll over during steady cornering. The SRT is the lateral acceleration that causes all the vehicle's wheels on one side to lift off the ground. It can be measured using a tilt table test and very clear specifications for how the test should be conducted are detailed in an SAE standard or it can be determined by computer simulation and again the simulation procedure needs to be clearly defined. The yellow draft of the LTSA Dimensions and Mass Rule 41001 includes a requirement that heavy vehicles should have an SRT greater than 0.35g. Thus SRT is a performance measure but the requirement that SRT needs to be measured and that it shall be greater than 0.35g is a performance standard.

Performance standards are better than prescriptive requirements in directly addressing the issue that they are targeting. However, the concept of using performance based standards as an alternative compliance regime is a relatively new one and considerable work is still needed before this is a practical reality. Key issues include:

- Completeness; that is, will the set of performance based standards address all the aspects of vehicle operations that need to be covered or are there loopholes which will allow undesirable vehicle configurations to operate.
- Levels; what are the appropriate levels for the various performance measures and should these be different for road environments.
- Compliance; compliance checking is much more complex than with prescriptive regulations so there are issues relating to the accreditation of assessors and in-service testing.
- Regulation; should approvals under performance based standards be handled through permits or licences or some other mechanism.

The National Road Transport Commission (NRTC) in Australia is currently undertaking a substantial research project on Performance Based Standards aimed at resolving all these questions. Although this project still has a considerable time to run some of the preliminary findings will form the basis of the analysis in this section.

The NRTC (Prem et al., 2001) study has identified 23 performance measures that could form the basis for a performance based standards regime, which are shown in Table 1. For each measure there are proposed levels for the different roading environments in Australia. As these have not yet been agreed and in any case apply to Australian not New Zealand conditions it is not sensible to use these too rigidly. For this analysis therefore it is proposed that each performance measure value for the 22m vehicle will be compared with the performance of the similarly configured 20m vehicle that it replaces. For some performance measures it will be clear that the proposed variations in the dimensions limits will have absolutely no impact. In these cases this will be noted and the performance measure will not be evaluated. The other difficult question to be resolved is the extent to which a change in performance, as indicated by the performance measure value, changes the crash risk. For some performance measures such as SRT there have been some investigations and there is some basis for an estimate. For most of the performance measures however, the data available are very limited.

Table 1. List of Performance Measures in PBS regime.

#	POTENTIAL PERFORMANCE STANDARD
	SAFETY RELATED
	Longitudinal Performance (Low Speed)
1	Startability
2	Gradeability
3	Intersection Clearance Time
	Longitudinal Performance (High Speed)
4	Overtaking Time
5	Tracking Ability on a Straight Path
6	Ride Quality
7	Braking Stability on a Straight Path
	Directional Performance (Low Speed)
8	Low-Speed Offtracking
9	Frontal Swing
10	Tail Swing
11	Steer Tyre Friction Demand in Low-Speed Turn
	Directional Performance (High Speed)
12	Static Rollover Threshold
13	Rearward Amplification
14	Load Transfer Ratio
15	Yaw Damping
16	High-Speed Transient Offtracking
17	High-Speed Steady-State Offtracking
18	Handling Quality (Understeer/Oversteer)
19	Braking Stability in a Turn
	INFRASTRUCTURE RELATED
	Pavements
20	GVM/GCM per Standard Axle Repetition
21	Horizontal Tyre Forces
22	Tyre Contact Pressure Distribution
	Bridges
23	Maximum Bridge Stress

Longitudinal Performance (Low Speed)

The first of the measures in this category is startability, which is the ability of the vehicle to start from rest on a grade. This depends primarily on the engine torque, clutch losses and the load on the drive axles. There is no reason to expect the longer vehicle to be any different from the reference vehicle in this regard. That is, the vehicle performance is unaffected by the proposed dimension limits changes.

Gradability is the ability of the vehicle to maintain a speed up a grade. Again, the proposed dimension should not have any negative effect on gradability. It is conceivable that with a lower load height the longer vehicles will have a smaller frontal area and generate less aerodynamic drag. This would lead to a slight improvement in gradability.

The final performance measure in this category is intersection clearance time. This depends on both the performance of the engine and transmission in being able to accelerate the vehicle and on the length of the vehicle which determine how far it has to travel before the intersection has been cleared. Intersection clearance time can be determined by physical testing in which case it can depend on the driver's ability or it can be computer simulated using the torque characteristics of the engine and transmission and a model of the driver to handle the accelerator and gear changing. Both these approaches are specific to a particular vehicle while in this case we are comparing two generic vehicles. Based on simple Newtonian mechanics the intersection clearance time is given by

$$t = \sqrt{\frac{2.s}{a}}$$

$$\begin{aligned} \text{where } t &= \text{intersection clearance time} \\ s &= \text{width of intersection} + \text{length of the vehicle} \\ a &= \text{average acceleration that the vehicle can achieve from rest} \end{aligned}$$

In the NRTC project, intersection clearance time is based on an intersection width of 25m and the target level for general access routes is 12s. This implies that a 20m long vehicle must be able to achieve an average acceleration of more than 0.625m/s^2 while a 22m long vehicle must be able to achieve 0.653m/s^2, i.e. 4.4% more. Because the nature of log transport operations demands relatively high powered engines, it is expected that the typical 20m log truck would very comfortably exceed the performance measure and hence the 22m long truck will also meet the level easily. In the example, illustrated in the NRTC report (Prem et al., 2001), the driver takes 1 second to complete a gear change and completes two gear changes in the first 12 seconds. As there is no acceleration during a gear change this means that to achieve 0.625m/s^2 average acceleration the vehicle must accelerate at 0.75m/s^2 when not gear changing. As a crude calculation, accelerating a 44 tonnes mass by 0.75m/s^2 requires 33kN of force at the wheels. Rolling resistance on medium hard surfaces is typically 0.06 the weight of the vehicle which requires a further force of 26kN giving a total of 59kN. With a 0.5m radius tyre this requires 29.5kN.m of torque at the drive axles. The combined gear and differential ratio for second gear is typically between 45 and 60. Using 45 and allowing for 10% transmission losses this requires an engine torque of approximately 728Nm. For the 22m vehicle the engine torque requirement would be 747Nm. Although the actual values may be a little higher to cope with additional losses and aerodynamic drag, which have been neglected, both are well below the torque capabilities of the typical engines used in logging transport.

If the 22m vehicle has exactly the same mass and towing unit as the 20m reference vehicle then the intersection clearance time will be 2.2% longer. That is, if the intersection clearance time for the 20m vehicle is 10 seconds, the time for the 22m vehicle will be 10.2 seconds. Although no good data are available for the safety impact of such a change it is reasonable, given the very small difference, to assume that it would be negligible.

Longitudinal Performance (High Speed)

Overtaking time is directly related to vehicle length. Using the method outlined in the NRTC report (Prem et al., 2001), the overtaking time is given by

$$T = \frac{3.6L}{0.15V} + 8.2$$

$$\begin{aligned} \text{where } T &= \text{overtaking time (s)} \\ L &= \text{length (m) of the overtaken vehicle} \\ V &= \text{design speed (km/h)} \end{aligned}$$

For a 100km/h speed environment and a 20m vehicle the overtaking time is 13 seconds while for a 22m vehicle the value is 13.48 seconds or 3.7% more. Note that both these values are above the level suggested in the NRTC report (Prem et al., 2001) for general access roads. This is because the levels in the NRTC study are derived from a 19m vehicle which is the upper limit for a general access vehicle in Australia. At 100km/h the additional 0.48 seconds corresponds to a little over 13m, which is the additional road space required to make the overtaking manoeuvre. As with the previous measure there are no good data from which to determine the safety implications of this change but because it is so small it is hard to imagine that it would be significant.

Tracking ability on a straight path reflects the road width a vehicle occupies when travelling at highway speed on a moderate roughness road with 4% cross-fall. It can be determined by computer simulation or by measurement. In this instance we have undertaken a computer simulation.

Ride quality is intended to reflect the driver comfort in operating the vehicle. This measure has been set to one side in the current NRTC research project because there is considerable debate on how the measure should be determined and no clear standards as to what constitutes satisfactory performance under those test conditions. Factors affecting ride quality in the NRTC report (Prem et al., 2001) are load, suspension and tyre characteristics, prime mover wheelbase, seat location, seat transmissibility characteristics, road roughness, speed, kingpin lead and trailer characteristics. Almost none of these will change in going from 20m to 22m overall length. There will be a change in the pitch and yaw inertia of the load on the trailer but this will have negligible impact. Thus the ride quality will be nearly identical for the two vehicles.

Braking stability on a straight path is a measure of the road width occupied by the vehicle during heavy braking. This measure has also be set to one side in the current NRTC project on the basis that braking performance is covered by the Australian Design Rules (ADRs). In New Zealand heavy brake performance is controlled by the New Zealand Heavy Brake Code, which ensures that the brakes on each unit of a combination vehicle are reasonably compatible with those of the other units. Furthermore there will be no significant difference in the braking capabilities of the 22m truck-trailer compared to the 20m vehicle.

Directional Performance (Low Speed)

The four measures included in this category of performance standards are all determined using the same standard manoeuvre. The vehicle is required to execute a 90°circular arc of 11.25m radius with straight tangent entry and exit paths at a speed of 10km/h or less. Precise definitions of the four measures are given in Prem et al.(2001). Simulating the two test vehicles using AutoSim and evaluating the four measures gives the results shown in Table 2 below.

Table 2. Results for Low Speed Directional Performance Measures.

Performance Measure	20m log truck	22m log truck	% difference
Low-Speed Offtracking	2.62m	2.62m	0%
Frontal Swing*	0.01m	0.06m	-600%
Tail Swing*	0.01m	0.1m	-1000%
Steer Tyre Friction Demand in Low-Speed Turn†	0.17	0.17	0%

*These values were calculated assuming the load extends out to the full vehicle width at both the front and rear. For a well-loaded log truck the load width is 2.2m and hence is 150mm inboard from the maximum. In this situation the front swing and tail swing are zero in all cases.

†The definition of this measure specifies it as a proportion of the available friction, which then depends on the road surface. The value reported here is the absolute value, which is independent of the road surface.

Directional Performance (High Speed)

Of the measures in this category the Braking Stability in a Turn has been set to one side because the original measure proposed was a US one that is designed to test the performance of an ABS braking system. Vehicles without ABS will not pass. As ABS is not a requirement for heavy vehicles in Australia (or New Zealand) this measure is flawed. While it is generally accepted that braking stability in a turn is important no alternative satisfactory measure has been agreed. It is expected that the regulations covering brake performance will to a large extent ensure satisfactory performance in this regard. For the two vehicles under consideration here it is not expected that there would be much difference between them in this respect.

Handling quality has also been set to one side because of a lack of general agreement of how acceptable levels should be defined. In this case because two vehicles are being compared to each other rather than against an absolute standard it is possible to comment on the change in handling behaviour due to the change in combination length and load distribution.

The other measures were all evaluated by running the AutoSim simulation models through the required manoeuvres and calculating the measures. Details of the manoeuvres and the required calculations are presented by Prem et al.(2001). The results are shown in Table 3.

Table 3. Results for High Speed Directional Performance Measures.

Performance Measure	20m log truck	22m log truck	% difference
Static Rollover Threshold	0.37g	0.47g*	+27%
Rearward Amplification	1.90	1.85	+3%
Load Transfer Ratio	0.66	0.49	+35%
Yaw Damping	0.47	0.43	-9%
High-Speed Transient Offtracking	0.36m	0.34m	+6%
High-Speed Steady-State Offtracking	0.37m	0.34m	+8%
Handling Quality (Understeer/Oversteer)†	-0.11 deg/g 0.14g 0.07	0 deg/g 0.16g 0.015	+ve

*The SRT in this case is for the truck, which rolls over first.
†The NRTC definition of this measure specifies three points on the handling diagram. These are the three values reported.

Pavements

The first of the measures in this category, GVM/GCM per Standard Axle Repetition, is aimed at limiting the amount of pavement wear generated by the vehicle. Because the longitudinal position of the double bunked load is effectively determined by the overhang limits on the 22m vehicle the load cannot be optimally distributed for pavement wear. The axle loads and equivalent standard axles for the two vehicles are shown in Table 4.

Table 4. Results for Equivalent Standard Axle (ESA) Performance Measure.

Axle	20m log truck		22m log truck		% difference
	Load	ESA	Load	ESA	ESA
Steer	6000	1.52	6000	1.52	0%
Drive axle group	15000	1.48	15000	1.48	0%
Front trailer axle group	11500	0.51	9434	0.23	55%
Rear trailer axle group	11500	0.51	13566	0.99	-94%
Total	44000	4.02	44000	4.22	-5%

Because the GCM is the same for both vehicles the 22m truck-trailer is 5% worse in terms of pavement wear due to vertical loading. Both vehicles easily exceed the proposed minimum level for general access roads in Australia of 8.3 tonne/ESA.

The second pavement wear measure is horizontal tyre forces. This refers to the horizontal forces applied to the pavement during low speed cornering and during steady-speed hill climbing. As these two vehicles have the same drive axle loads and the same wheelbase lengths there will be relatively little difference in this regard.

Tyre Contact Pressure Distribution is another measure that has been set to one side in the Australian project because the technology for simulating it and for measuring it is still in the early stages of development. For this reason it is difficult to determine appropriate levels. Because the two vehicles being compared are using the same tyres and carry the same mass there will be little difference between them. The unequal load distribution between the two axle groups on the trailer may cause some minor differences.

Bridges

The sole bridge loading measure is maximum bridge stress. This measure also has been set to one side because of the difficulties in determining the capacity of the current bridge stock. The bridge formula, which specifies a maximum load against span relationship for all axles in a vehicle, essentially controls the maximum bridge stress. Both vehicles comply with the bridge formula specified in the yellow draft of the dimensions and mass rule and consequently do not exceed the maximum allowable bridge stress for New Zealand.

Summary

For most of the performance measures the impact of increasing the vehicle length to 22m with larger overhangs is small. In all the tables above summarising the performance measure results a positive difference implies better performance and a negative difference implies poorer performance. Thus for low speed manoeuvres we see a small negative change in intersection clearance time and some negative changes in tail swing and front swing due to the longer overhangs. Although in percentage terms these seem quite large, in absolute terms they are relatively small with the tail swing value being 100mm. There is a small negative change in yaw damping ratio because of the larger yaw inertia of the longer load but the absolute value of yaw damping is very good at 0.43 for the 22m vehicle. The level proposed in the NRTC project is that yaw damping should be greater than 0.15. There is also a small negative impact on pavement wear because it is not possible to optimise the axle load distribution with the double bunked load.

On the positive side there are substantial improvements in Static Roll Threshold (SRT) and Load Transfer Ratio (LTR). These come from the significantly lower load height and hence the reduced centre of gravity height. There are also small gains in most of the other directional stability measures all for the same reason.

Interpreting these measures in terms of safety is difficult because the relationship between performance measures and crash risk is not known for all the measures. However, there are several studies that have investigated the relationship between SRT and crash risk including one based on New Zealand data (Mueller et al., 1999). Using the relationship developed in this study, which is shown in
Figure 2, we would expect the change in SRT shown above (0.37g to 0.47g) to reduce the crash risk by 55%. This study also considered the relationship between DLTR and crash risk, shown in Figure 3. Using this relationship the calculated change in DLTR predicts a reduction in crash risk of 67%. Most of the negative changes relate to low speed manoeuvres and are relatively small. It is reasonable to expect that the impact of these changes on crash risk will be much smaller than the benefits from the improved stability. As well measures could be implemented to mitigate these.

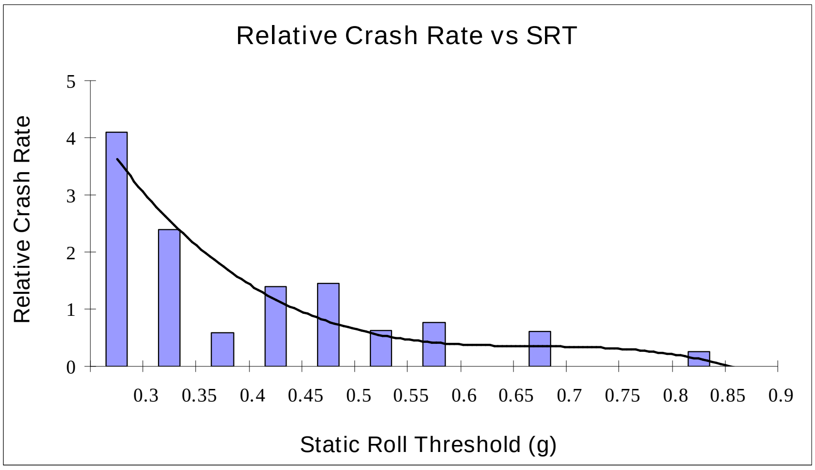

Figure 2. SRT Relative Crash Involvement Rate.

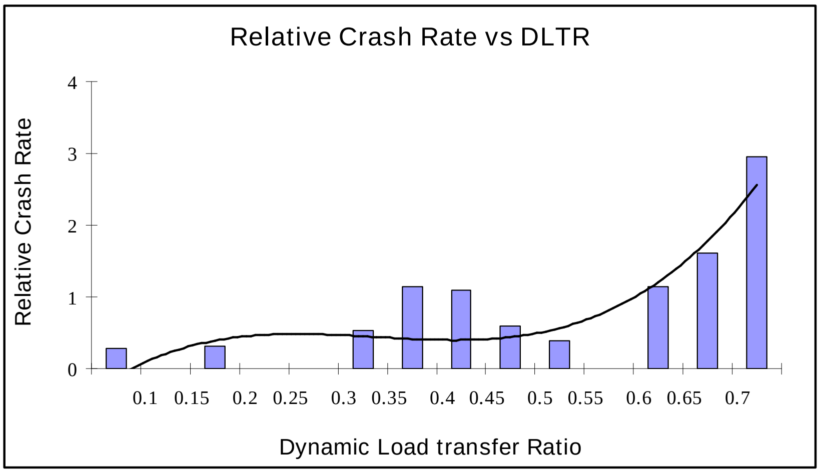

Figure 3. DLTR Relative Crash Involvement Rate.

Other Issues

The proposed vehicles fall outside the envelope of mass and dimensions allowed in the rule. Consideration needs to be given to what other safety measures should be required of these vehicles to mitigate their impact on other road users. Because the divergence from the rule is relatively small these measures need not be very extensive.

The vehicles are longer than the overall length limit in the rule therefore some signage indicating a long vehicle is desirable. The LTSC is suggesting a high visibility sign with the words "22m Log Truck" on it.

When the 22m option is used on existing vehicles, the trailers have a greater front overhang than is permitted by the rule. However, because they are full trailers (that is, they have two pivoting links) and because they are towed behind trucks which have a moderate to long wheelbase, this does not cause significant front swing issues.

Similarly when the 22m option is used on existing vehicles, the trailers also have a greater rear overhang than is permitted by the rule. This does raise some issues, which need to be addressed:

- It is very important that this higher overhang limit is not exceeded. While this can be controlled by the penalties for exceeding the rear overhang limit it is desirable to have some form of guide to loader drivers to indicate the limits of the allowable rear overhang. These devices are already in use on some vehicles.
- It must be ensured that the number plate, the lights and the 0800 sign are not hidden below the rear overhang. The current lighting regulations specify that the lights must be visible within an angle of 15° above and below the horizontal. For a rear overhang of 3.2m it is likely that the logs will extend to about 2m beyond the lights and number plate. If the bottom of the logs is 1.4m above the ground (the bolster bed height), then the lights can be no more than 880mm off the ground. However, in order to meet the "below the horizontal" criterion they must be more than 520mm off the ground. This leaves quite a narrow range. The problem can be overcome by having some mechanism to move the lights, number plate etc rearwards after loading.
- Finally there is the issue of underrun protection. There were two fatal crashes last year that involved cars running into log trucks. Logs overhanging the rear of the trailer by around 2m with the bottom of the logs at a height of 1.4m pose a serious injury/fatality risk to a passenger car in the event of a rear-end collision. The LTSC has to consider what measures they can take to minimise this danger.

The only purpose of the 22m proposal is to allow more stable log trucks to operate. This improved stability comes from a lower load height resulting in a lower payload centre of gravity. The fundamental requirement is for an improved SRT. From an enforcement point of view SRT is not an easily usable measure and therefore a load height limit seems a sensible surrogate. For both the truck and the trailer in the analysis above the load height was below 2.6m. This is the mean load height and is based on particular load density values. LTSC have suggested the SRT requirement should be greater than 0.4g and thus that a load height limit of 3.2m for 4-axle trailers and 2.9m for 3-axle trailers measured using the current CVIU procedure is appropriate. This SRT level is considerably below the level achieved by the vehicle that was analysed. The reason given for this is that the additional load height will ensure that irregularly shaped and tapered logs can be accommodated. A higher SRT limit and hence lower load height restriction is desirable if it is possible. LTSA have indicated that they would like to see a trial of one or two 22m vehicles over several weeks of operation. During the trial it should be possible to determine what is the lowest practical maximum load height.

The analysis of the dimension limits in section 0 showed that for new vehicles to be able to double bunk 5m logs the only concession required from the proposed Dimensions and Mass Rule 41001 is a 22m overall length. For existing vehicles concessions on overhangs are also required because of their wheelbases. However, in practice trucks are replaced more frequently than trailers and thus the situation of connecting a new truck to an old trailer will occur. The new truck would then be subject to the new hitch offset requirements (less than 40% of wheelbase). Provided the trailer continues to be allowed to operate with the overhang concessions this does not cause any real difficulties. If the truck is a 3-axle truck the combination may not be able to achieve 44 tonne GCM because of the bridge formula but this is currently the case for existing 3-axle trucks anyway.

A further issue is the question of whether allowing log trucks this concession on overall length will immediately open the floodgates for all other transport operators to gain similar concessions. While the LTSC case is that the log trucks should be granted this concession in order to achieve improved safety other operators whose vehicles are no less safe than logging trucks could argue that they should have the same concessions on equity grounds even if there was no safety benefit. This issue has not been considered by this study. One option is imposing an SRT requirement on 22m vehicles that is higher than that required for 20m combinations as suggested above for the log trucks. This will limit the increase in length to those transport operations where a similar level of safety can be achieved. The higher the SRT limit imposed the lower the risk for LTSA in allowing this variation to proceed.

Conclusions

The log transport industry would like to operate 22m log truck combinations in order to achieve better stability and significantly reduce the incidence of log truck rollovers. The basis of the argument is that if multi-bolster trailers could double bunk logs up to 5m in length it would be practical to sort the random length packets and pulp logs into packets with lengths above and below 5m. The logs below 5m would be double bunked on the trailer while the logs above 5m would be carried as a single packet on the truck. It is fundamental to this proposal that this sorting is done. If the 22m trucks are permitted but then are not widely used in the way described the safety benefits will not accrue.

In order for this log sorting procedure to be implemented there needs to be a fleet of trucks capable of double bunking 5m logs available. Thus the length concession needs to be available to existing multi-bolster trailers as well as new ones.

The dimensions analysis in section 0 was based on the proposed new Dimensions and Mass Rule 41001 of which the yellow draft has been out for public consultation. It showed that for new vehicles the only concession needed to be able to double bunk 5m logs on the trailer is an increase in overall length to 22m. Vehicles configured under this Rule would have a slightly longer truck wheelbase than is currently typical with a reduced hitch offset. The trailers would have a significantly longer wheelbase than typical vehicles now operating in order to meet the reduced rear overhangs allowed. In order for the typical current vehicles to be able to double bunk 5m logs it is necessary not only to have a 22m overall length concession but also to allow greater overhangs than permitted by the proposed rule. The hitch offset would also be greater than permitted by the Rule but the Rule provides for existing vehicles to continue to operate with their current hitch offsets so this is acceptable.

An analysis of the crash statistics showed that up to 70% of rollover crashes comprised vehicle configurations and crash types where these concessions could possibly prevent the rollover. Some of these crashes are crashes where the rollover is a result of the crash rather than the cause and hence the rollover may still occur.

A performance measure analysis was undertaken comparing one particular combination, a 3-axle conventional truck with a 4-axle multi-bolster trailer carrying the same load in both 20m and 22m configurations. The 22m configuration shows a substantial improvement in stability performance with some minor degradation in low speed performance. Based on an earlier study relating crash rates to performance measures the improved stability performance would reduce the crash risk by 55%-67% for this vehicle. Other configurations such as 4-axle truck 3-axle trailer, 4-axle truck 4-axle trailer etc would have different performance but show the same gains when going from 20m to 22m. If the 22m vehicles were used in all cases where the safety benefits would occur, then the potential rollover crash reduction could be as high as (55%x70% - 67%x70%) 39% to 47% of the total on-highway rollover crashes. Note that the 70% value used in the calculation is an upper limit and the actual value may well be somewhat lower. However, even if the rollover crash reduction were only half the estimated maximum, i.e. 20%-24%, it would still represent a substantial improvement. The new Dimensions and Mass Rule has several requirements that encourage more stable configurations. Thus new vehicles which would comply with the Rule in those respects will be more stable than the vehicle analysed thus generating greater gains.

The proposal is that new vehicles with multi-bolster trailers would be allowed to operate at 22m overall length but would meet the Rule in all other respects. Existing rigs would also be allowed to operate at 22m overall length and would also be allowed the following concessions:

- The hitch offset would remain as it is. This is already provided for in the rule.
- The maximum rear overhang on the trailer would be the lesser of 3.2m or 65% of the trailer wheel base.
- The maximum front overhang would be 2m across the front of the load.

In all other respects the vehicle would meet the new rule.

The LTSC have suggested that the trailer length limit of 11.5m should also be relaxed. This option has not been investigated in this study.

The concessions are sought in order to improve safety and thus should be subject to the following requirements to ensure that this safety benefit is realised:

- They only apply when the vehicle is carrying two packets of logs on the trailer.
- When operated at 22m the vehicle SRT should be greater than the 0.35g required of vehicles that comply with the dimensions in the rule. LTSC have suggested that this level should be 0.4g. From an enforcement point of view it is simpler to specify a load height. For a typical trailer the load height corresponding to 0.4g SRT is 3.2m for a 4-axle trailer and 2.9m for a 3-axle trailer. The heights are 0.6m lower than the limits for these trailers when operating in the standard sub 20m configuration.
- The vehicle is fitted with a "22m Log Truck" sign.
- The rear overhang needs to be strictly adhered to. Some method for enabling loaders and drivers to ensure this is desirable. A possibility is a flexible rod attached to the rear of the vehicle that can be extended out to the overhang limit during loading as a guide.

The large rear overhang may make it difficult to see the number plate and tail lights. The current regulations require the lights to be visible from 15° above and below the horizontal. Provided the lights are mounted at a suitable height this can be achieved. Some mechanism to move the tail lights and number plate out towards the rear of the load after loading could improve this situation. Similarly the large rear overhang increases the risk of serious injury or death due to underrun in a rear end collision. The industry needs to consider how to mitigate this risk.

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Appendix C: On-Road Trial

Introduction

The Log Transport Safety Council (LTSC) has proposed to the Land Transport Safety Authority (LTSA) that log trucks towing multi-bolster trailers carrying two packets of logs should be permitted to operate at 22m overall length rather than the 20m currently permitted subject to specific operating conditions. The purpose of the request is to enable logs of at least 5m to be carried as double packet loads thereby substantially reducing the load height and improving the roll stability of the vehicles. In order for this double-bunking of 5m logs to be able to be undertaken on older existing trailers, the LTSC have asked that the front and rear overhang limits be relaxed beyond the levels proposed in the new Dimensions and Mass Rule 41001. Specifically, a front overhang limit of 2m across the width of the load and a rear overhang equal to the minimum of 65% of the trailer wheelbase and 3.2m were requested.

To support the LTSC request a computer simulation analysis was undertaken to evaluate the performance of a typical current vehicle operating under this regulatory regime. The vehicle was loaded with random length logs to 44 tonne GCM in both 20m and 22m mode. In the 20m mode both the truck and the trailer were loaded with single packets of the random length logs while in the 22m mode the truck was loaded with the longer logs and the trailer was loaded with two packets of the shorter logs. The analysis compared the performance of the two vehicles using the performance measures proposed by the National Road Transport Commission (NRTC) Performance Based Standards project currently being undertaken in Australia. The 22m configuration, as expected, proved to be substantially more stable than the 20m configuration for all the rollover related measures. For the low speed manoeuvres the tail swing and front swing were poorer but still very low and unlikely to cause any problems. The two length-related measures, overtaking time and intersection clearance time also showed a small worsening but again appeared unlikely to cause any problems. The drawing of the 22m configuration did, however, highlight the magnitude of the rear overhang of the log load beyond the steelwork of the trailer.

Based on this evidence and other work relating to the crash risks of these vehicles, the LTSA approved a one-month trial of the concept using seven specified vehicles. The purpose of the trial is to qualitatively validate the computer simulation results and to identify any operational issues associated with these longer vehicles. As part of the trial, TERNZ were requested to observe and monitor the vehicles in operation, assess their performance and identify any issues that need to be addressed. This report describes the TERNZ observations.

Trial Conditions and Vehicles

A temporary permit to operate the 22m vehicles was issued by LTSA and was worded as follows:

Vehicle Dimension Limits

Pursuant to regulation 49A(1) of the Traffic Regulations 1976, and by way of a delegation from the Director of Land Transport Safety dated the 3rd day of May 1999, I, DONALD NORMAN HUTCHINSON, Senior Engineer, Safer Roads, hereby authorise operation of the vehicles specified above subject to the following conditions:

6) The combination when carting two packets of logs on the trailer may exceed the overall length limits of regulation 48B(1)(j)(iii) of the Traffic Regulations 1976 but shall not exceed 22 metres overall length.

7) The trailer when carting two packets of logs may exceed the rear overhang limits of regulation 48C(e) of the Traffic Regulations 1976 but shall not exceed a rear overhang of the lesser of 3.2 metres or 65 % of trailer wheelbase.

8) The trailer when carting two packets of logs may exceed the distance ahead of turntable (front overhang) limits of regulation 48D(b) of the Traffic Regulations 1976 but shall not exceed a front overhang of 2 metres.

Conditions

- Experienced operators only to be used and drivers must undertake a pre trial briefing by the Log Transport Safety Council.
- Maximum height for any log in the trailer load must not exceed 3.5 metres measured from the ground to its highest point.
- A rear facing high visibility sign “22 m LOGTRUCK” must be affixed to the left-hand mudflap of the trailer.
- The rear of the trailer load must be indicated by a clean white flag or red, orange or yellow fluorescent flag or frangible panel, which must be at least 400 mm long and 300 mm wide.
- The driver must have access to a suitable gauge to measure the rear overhang of the trailer load.

This permit applies to the seven vehicles detailed in Table 5 below.

Table 5. Vehicles permitted to operate at 22m.

Operator	Fleet #	Rego Truck	Rego Trailer	Trailer Confign
Rotorua FH	4639	XG5599	W 5832	4.90m 4 axle Multi
McCarthy	64	ZP 9975	6955 T	5.00m 3 axle Multi
McCarthy	66	ZX 8462	6010 U	5.33m 3 axle Multi
J Thorby		UL 8559	9639 S	5.11m 4 axle Multi
W Wilshire		AAP 304	901W	5.40m 4 axle Multi
W Wilshire		WW 14	3250 Y	5.80m 4 axle Multi
B Honeycombe	4579	PTABLT	7208 P	5.10 4 axle Multi

During the trial the drivers were required to complete a form which details every load carried by the vehicle, both in 20m and 22m configurations. This form records the load weights, load types, front and rear overhangs and the load heights. A copy of the form is shown in the Appendix A.

The Observations

The observation assessment took place on Tuesday, October 30th, 2001 at the "Webb" in Kaingaroa. Those in attendance were Martin Hyde of Rotorua Forest Haulage, Bruce Nairn, representing the LTSC, John de Pont and Doug Latto of TERNZ, Phil Brown of Traffic Planning Consultants and Lynn Sleath of Transit New Zealand. The primary roles of the participants can be summarised as follows:

- TERNZ staff: to measure all the key vehicle dimensions for subsequent review against the regulatory requirements and for use in interpreting the drivers' data forms, and to observe the vehicles in operation and qualitatively assess the match between the predicted and actual performance.
- Phil Brown: to observe and identify any traffic engineering issues particularly those related to low-speed manoeuvring.
- Martin Hyde: to manage the flow of vehicles into and out of the facility and to answer any questions relating to the operation of the 22m vehicles so far.
- Bruce Nairn: to represent the client for the project.
- Lynn Sleath: independent observer with an interest in longer vehicles.

All seven permitted vehicles were operated from the site during the day and were available to be measured and observed.

A data form was prepared for each of the three configurations of vehicle involved in the trial and all the basic geometric dimensions of each vehicle were measured and recorded. An example of this data form is included in Appendix B. Information such as tare masses and tyre sizes was also noted. Several of the vehicles were taken through some typical low speed manoeuvres such as jack-knifing the trailer and a low speed full-lock turn starting from the straight ahead position. These were to check inter-vehicle spacing clearances, off-tracking and front and rear tail swing. For these fundamental measurements six of the vehicles were loaded with three packets of 4.95m peeled saw logs and one was loaded with three packets of 4.3m logs. These loads did not extend the rear overhang out to the maximum permitted level so one of the vehicles was loaded with a second load where the spacing between the two packets was increased (beyond normal practice) so that the rear overhang was close to the maximum that could occur.

Three of the vehicles were then followed on the highway and videotaped through various curves and corners as they proceeded on a typical journey. The independent observers were also provided with a form that outlined some of the issues that have been raised in regard to these longer vehicles and asking them to provide feedback. A copy of this form is included in Appendix C.

Results of the Observations

Longitudinal Dimensions

The measurements were made by getting the loaded vehicle to park in a straight line on a flat sealed surface. The longitudinal measurement points were marked on the ground using pavement chalk and a plumb-bob. For the wheel position both left and right wheels were marked and a straight edge was used to mark the axle position at the vehicle centreline. A 30m steel tape measure was used to determine the lengths and all measurements were reference back to the point at the front of the vehicle. The height measurements were obtained using a 5m steel tape measure and were all referenced back to the ground. Some of these height values are potentially less accurate because of difficulties in getting the tape into a vertical drop at the measurement point (due to various vehicle components being in the way). With the measurement procedures used it is estimated that the measurements are likely to be accurate to about ±30mm. This accuracy will be considered further in the discussion of results. A summary of the longitudinal dimensions is presented in Table 6 below. Note that the second Williams & Wilshire vehicle appears in the table twice because it was loaded with two different loads.

Table 6. Longitudinal dimensions of the trial vehicles.

Operator	McCarthy	McCarthy	Thorby	Williams Wilshire	Williams Wilshire	Williams Wilshire	RFH	Honey-combe
Config	8x4x3	8x4x3	8x4x4	8x4x4	8x4x4	8x4x4	6x4x4	6x4x4
Model	Mack	Quantum	KW	Mack	DAF	DAF	KW	Peterbilt
Trk Regn	ZX 8462	ZP 9975	UL 8559	WW 14	AAP 304	AAP 304	XG 5599	PTA BLT
Load	4.95m	4.95m	4.95m		4.95m	4.3/5.2m	4.3m	4.95m
TRUCK								
1st steer	1.45	0.97	1.475	1.435	1.37	1.37	0.9	1.195
2nd steer	3.15	2.86	3.22	2.95	3.07	3.07		
1st driver	6.92	6.27	6.61	6.855	6.365	6.365	6.19	6.59
2nd driver	8.26	7.61	7.99	8.25	7.77	7.77	7.53	8.05
hitch	9.34	8.9	9.72	9.35	9.4	9.4	9.77	10.35
truck rear	9.7	9.45	9.58	9.68	9.29	9.29	9.66	10.25
TRAILER								
Front of load	10.63	10.25	10.875	10.675	10.56	10.56	12.06	11.185
Front of steel	11.7	11.69					12.645	12.08
1st axle	12.45	12.28	12.26	11.75	11.85	11.85	13.27	12.66
2nd axle			13.525	12.95	13.095	13.095	14.51	13.9
3rd axle	17.14	16.59	17.35	17.555	17.24	17.24	18.17	17.75
4th axle	18.45	17.935	18.61	18.79	18.47	18.47	19.405	18.97
OAL Steel	19.44	18.69	19.35	19.45	19.24	19.24	20.01	19.625
OAL Load	20.72	20.36	20.96	20.735	20.745	21.14	20.99	21.27

From the dimensions in Table 6 all the key longitudinal dimensions can be calculated. For example, the trailer wheelbase is given by the average of the 3rd and 4th axle minus the average of the 1st and 2nd axles (1st only for the 3-axle trailers). The results of the measured wheelbases compared to the nominal wheelbases are shown in Table 7.

Table 7. Comparison of measured wheelbase with nominal wheelbase.

Operator	McCarthy	McCarthy	Thorby	Williams Wilshire	Williams Wilshire	RFH	Honey-combe
Config	8x4x3	8x4x3	8x4x4	8x4x4	8x4x4	6x4x4	6x4x4
Trk Regn	ZX 8462	ZP 9975	UL 8559	WW 14	AAP 304	XG 5599	PTA BLT
TRAILER							
Nominal wheelbase	5.33	5	5.11	5.8	5.4	4.9	5.1
Measured wheelbase	5.345	4.9825	5.0875	5.8225	5.3825	4.8975	5.08

As can be seen the differences range from –22.5mm to +22.5mm which is well in line with the accuracy estimated previously. It is no clear what level of accuracy applies to the nominal wheelbases.

Similarly the load length can be calculated from the difference between the rear of the load and the front of the load as shown in Table 8.

Table 8. Trailer load length.

Operator	McCarthy	McCarthy	Thorby	Williams Wilshire	Williams Wilshire	RFH	Honey-combe
Config	8x4x3	8x4x3	8x4x4	8x4x4	8x4x4	6x4x4	6x4x4
Trk Regn	ZX 8462	ZP 9975	UL 8559	WW 14	AAP 304	XG 5599	PTA BLT
Log Length	4.95	4.95	4.95	4.95	4.95	4.35	4.95
Theoretical load length	9.9	9.9	9.9	9.9	9.9	8.7	9.9
Measured load length	10.09	10.11	10.085	10.06	10.185	8.93	10.085
Difference	0.19	0.21	0.185	0.16	0.285	0.23	0.185

Interestingly the measured load length is about 200mm (significantly more in one case) longer than the theoretical load length. The measured load length is from the foremost log to the rearmost log and hence includes the worst of the unevenness in the two ends of the load. In practice this implies that the practical maximum log length that can be double bunked within the dimensional restrictions of the vehicle will be around 100mm less than the theoretical maximum.

Generally all the operators/drivers have adopted the same approach to ensuring that the load complies with the front and rear overhang limits. The drawbar is marked at the foremost allowable point for the load. The driver guides the loader operator to place the first logs in the front packet on the trailer and aligns these with the mark. The loader driver then aligns the remainder of the front packet of logs with the guide logs and places the rear packet as close as possible to the front packet. As the truck drivers know the maximum log length capacity of their vehicle (within the overhang limits) then provided the logs are shorter than the limit the load should comply. Some of the drivers checked the overhangs with a tape measure after loading while others assumed compliance based on the alignment with the drawbar mark and the log length.

When the jack-knife parking tests were done it was found that, on some of the vehicles tested, the front of the log load on the trailer passed over the top of the rear steelwork on the truck. This indicated that if the log load had been angled downwards or if there had been a gradient change along the length of the vehicle there may have been a clash. From the data given in Table 6, the inter-vehicle spacing (IVS) for the particular loads can be calculated. These are shown in Table 9. The proposed requirement in the yellow draft of LTSA Dimensions and Mass Rule 41001 is that the IVS should be greater than 1.1m. Four of the seven vehicles do not comply with this and the vehicles that were found to have a potential problem with the jack-knife manoeuvre were among those that had an inadequate IVS. What appears to have happened is that in marking the drawbars to show the forward-most limits for the load the operators considered only the front overhang limit and neglected the IVS requirement. In the short-term this can be resolved by moving the front load limit mark backwards so that the IVS limit is met at the expense of reducing the maximum front overhang and the load length capacity. In the longer term the vehicle drawbars can be lengthened so that IVS can be achieved while utilising the maximum front overhang. For all the vehicles in question the overall vehicle length is sufficiently short for this to be possible without exceeding 20m for the steelwork. Note that the IVS on the RFH vehicle is much greater because it is carrying shorter logs.

Table 9. Inter-vehicle spacing.

Operator	McCarthy	McCarthy	Thorby	Williams Wilshire	Williams Wilshire	RFH	Honey-combe
Trk Regn	ZX 8462	ZP 9975	UL 8559	WW 14	AAP 304	XG 5599	PTA BLT
IVS (m)	0.93	0.8	1.295	0.995	1.27	2.4	0.935

Low Speed Manoeuvres

In the analysis that preceded this trial, three performance measures related to low speed manoeuvres were assessed. These were front swing, tail swing and low speed off-tracking. Because the basic vehicle configuration (number of axles, axle positions, drawbar length, hitch position etc) is unchanged from the 20m vehicle the low speed off-tracking will not change. However, the 22m vehicle as proposed has a greater front and rear overhang and consequently will have greater front swing and tail swing. The analysis predicted that the front swing would increase from 10mm to 60mm but that because a log load is 150mm inboard from the vehicle width the swing would remain inside the path of the steer axle. Similarly the tail swing increases from 10mm to 100mm but again because the log load in 150mm inboard of the truck the tail swing does not encroach outside the swept path of the vehicle.

Figure 4 shows a typical "22m" configuration as observed during the trial. This particular vehicle has an overall length of 21m, a front overhang of 2m and a rear overhang of 3m. This load consists of 4.95m radiata saw logs and is a full on-highway load at approximately 44 tonnes GCM. As the maximum allowable rear overhang for this vehicle is 3.2m, this vehicle could carry a load that is 200mm longer than this. Figure 4 clearly illustrates the typical magnitudes of the load heights, which are significantly reduced and the front and rear overhangs, which are somewhat greater for the 22m configurations.

Figure 4. Typical 22m log truck configuration.

Figure 5 shows the front swing of the payload during a tight radius turn just prior to the vehicle being backed into the jack-knife position to look at the IVS. Although this front swing may appear quite large the tyre marks left by the truck steer axles in making this turn are visible on the ground and it is clear that the front swing will not extend outside the swept path of the truck. This is as predicted by the analysis.

It is difficult to illustrate the tail swing with a still photograph but a review of the video footage taken in the trial shows a slight tail swing of the order of magnitude predicted by the analysis.

Figure 5. Illustration of front swing during a tight turn.

Quantitative measurements of the front swing and tail swing was outside the scope of these observations but the visual observations show that the magnitudes of these effects were very much in line with the values predicted by the analysis and thus within acceptable levels.

Stability

The analysis showed very substantial gains in stability through the reduced payload heights. Measuring the stability improvements was outside the scope of the trial and as the main indicator of poor stability is a rollover crash it was not possible to directly observe the stability improvements. However, a 20m combination with a "shorts" trailer was loaded with the same load as was being used for the 22m vehicles. This vehicle is shown in Figure 6 below. Comparing with the vehicle in Figure 4, which is carrying substantially the same load, shows the dramatic reduction in load height on the trailer.

The "shorts" trailer combination was followed and videotaped for part of its journey for comparison purposes. It was not possible to see any significant stability differences from the observation process. Feedback from the drivers, which will be discussed in a later section, did suggest that there was an significant improvement in stability "feel".

Figure 6. "Shorts" combination loaded with 4.95m saw logs.

Vehicle Length

Two of the performance measures assessed relate directly to the vehicle's length. These are: overtaking time and intersection clearance time. The analysis showed that the overtaking time for a 22m vehicle was approximately 0.5 seconds (in 13 seconds) longer than that of a 20m vehicle. Most of the vehicles observed actually had an overall length less than 21m and so the increase in overtaking time would be less than 0.25 seconds. This is a very small change and the observations could not detect any impacts of this change.

Intersection clearance time depends both on the vehicle length and the performance of its engine and drive train. The analysis showed that the changes in intersection clearance time would be small. Again because the actual lengths of the test vehicles were mostly less than 21m rather than 22m the impact is even less still and too small to be observed.

Two other issues related to vehicle length that have been raised are the length of right turning bays and the distance of railway crossings from intersections. The NZ standard for the marking of rural right turning bays specifies that the stacking length should be at least 20m and then specifies the geometry of the flush median markings. In a 100km/h rural zone the painted flush median markings should be at least 160m long. If the stacking bay is at the minimum length the rear overhang of a 22m vehicle will extend over the paintwork of the flush median by up to 2m. It will lie well within the width of the flush median and well clear of the straight through lane. It is not anticipated that this will pose any additional safety risk. The observations did not identify any problems with right turning bays.

Tranzrail's current minimum design clearance between the nearest railway track and an adjacent intersection at a level crossing equipped with half-arm barriers is 23 m (unless traffic from the railway has right of way) in order to allow standing room for a 20 m maximum length vehicle between the railway and the intersection. However, according to Tranzrail there are a many level crossing installations around the country where the clearance between the railway and an adjacent parallel road intersection is significantly less than 23 m yet there is no on-going history of collisions or even near-misses. The risk of collision would therefore appear to be related to frequency of trains, frequency of long road vehicles and the level of traffic on the parallel road. One crossing that was identified by Tranzrail as a potential problem was that at Hewletts Rd in Mount Maunganui. One of the 22m log trucks was observed and videotaped traversing this crossing twice. No problems were observed, although it should be noted that the distance from the intersection to the crossing was 7m. Hence all 20m vehicles and even light vehicles towing trailers would be unable to stand between the intersection and the crossing.

Signage and Conspicuity

Several measures have been applied to inform other motorists that the vehicle is 22m long and to indicate the rear of the load given the larger rear overhang. A related issue is the visibility of the tail-lights and signage from beneath the rear overhang.

One of the vehicles was deliberately loaded to maximise the rear overhang and thus illustrate the worst case situation as shown in Figure 7. In this case the rear of the load extends 1.9m beyond the rear steelwork of the trailer. A rear view of the same load (prior to readjustment, securing and fitting of the flags) as shown in Figure 8 indicates the difficulties for following vehicles in perceiving the magnitude of the rear overhang. One of the potential crash risks associated with this rear overhang is graphically illustrated in Figure 9.

Figure 7. Maximum rear overhang.

Several points should be made about this issue. The first is that even with a 20m vehicle, a car involved in a nose-to-tail collision with a log truck will not activate its crumple zone until the car bonnet hits the rear axle of the trailer. At this point the rear bumper of the trailer is probably near or beyond the front windscreen. That is, the level of rear under-run protection on all log trucks is poor. However, there is no requirement for any heavy vehicles in New Zealand to be fitted with under-run protection and thus the level of under-run protection on many other categories of heavy vehicle is also poor. Furthermore in Europe where under-run protection is mandatory for most heavy vehicles, log trucks are exempt because it is operationally too difficult to fit suitable under-run protection to them.

Figure 8. Rear view of long load.


Figure 9. Potential rear underrun problem.

On this basis it would seem that it is not sensible to require under-run protection on the 22m log trucks because it is not required for any other heavy vehicles, some of which may pose as great a risk and because it is internationally accepted that it is operationally too difficult to do so. However, in order to mitigate the risk of under-run crashes the conspicuity of the rear of the load should be made as high as possible. All the loads in the test were required to be marked with a flag at the right rear of the load. Different operators approached this problem differently. One operator used a high visibility yellow pennant with a reflective band across it tied to the rearmost log using a light chain and a bungee cord. Although this worked well initially and was said to be very effective at night, during the observations following a vehicle fitted with this arrangement the pennant at times folded itself in half so that only the white backing was visible. Other operators used high visibility flags stapled across the end of one of the logs. One driver had two flags and so stapled one at the right edge and one at the left edge of the load. This arrangement seemed to be quite effective. Overall the yellow high visibility flag with the reflective stripe was probably superior to the plain yellow flags but stapling them to the ends of the logs so that they did not flap was better than hanging them from a log.

A high visibility orange sign with the words "22m logtruck" was attached to the mudflap on each vehicle as can be seen in Figure 8. Some relatively minor issues have been raised with respect to this sign. The first is that the orange colour used is reserved for roadworks in transport applications and thus should not be used for this sign. Future signs should use the same high visibility yellow that is used for the 0800 Logtruck signs also seen in Figure 8. A second point is that the signs are currently permanently displayed. The primary purpose of the signs is to inform other road users that they have a longer than normal vehicle in front of them and that they should adjust their decision making accordingly. Thus the signs should not be displayed when the vehicle is not operating in the "22m logtruck" configuration. Similarly the Police will use the "22m logtruck" signs as indicators that the vehicle should be operating at reduced load heights. If the vehicle is loaded to operate below 20m the reduced load heights do not apply and the sign should not be displayed. It is suggested that fold-up signs such as those used for dangerous goods should be used. The LTSC is currently investigating a sliding mount arrangement for the sign to bring it out to 21m when longer logs are carried. If this can be done it will improve the rear conspicuity and should reduce the under-run risk.

A final issue is the visibility of the tail-lights and number plate. The regulations state that these must be visible at 15° above and below the horizontal. Clearly with longer rear overhangs care needs to be taken to ensure that this requirement is met. From the dimensional measurements the maximum rear overhang and hence the length by which the load can extend beyond the steelwork can be calculated for each vehicle. These values range between 1.56m and 1.96m. From this the minimum distance that the tail-lights must be below the bottom edge of the load can be calculated. If we assume that the bottom edge of the load is equal to the bolster bed height then all but one of the seven vehicles meet this requirement. The one that does not meet the requirement is 50mm too high. However, these calculations were done from the centre of the lights while the regulations just say that the lights must be visible, which implies that the edge of the light is sufficient. On this basis all vehicles probably comply. The other issue is that in all cases the height of the lowest log at the rear of the load was always below the bolster bed height, in some cases by 130mm. This could partially obscure part of the lights from some angles but they would almost certainly still be visible and hence comply. From the visual observations of the vehicles there did not appear to be any issues with the lights being obscured but these tests were all done from a passenger car, which is relatively low. The observers' lines of sight were below the 15° above the horizontal line, which is the potential problem area. There may be an issue for an observer in a truck.

Reports of Other Observers

A detailed report has been prepared by Phillip Brown of Traffic Planning Consultants, who is a traffic engineer specialising in heavy vehicles. Phil's report is attached in full as Appendix D.

The three main issues identified and discussed in detail by Phil Brown are:

- IVS requirements
- perception of depth by following motorists
- implications of underrun by following vehicles

As the earlier part of this document arose out of discussions with Phil during the trial it is not surprising that his findings in these area coincide quite closely with the views already presented. Phil suggests that: "If the perception of depth can be improved by providing a good visual indicator beneath the logs to help break up the 2 metre rear overhang, we believe motorists will increase their following distance." This supports the idea of extending the "22m logtruck" sign rearwards, which is currently being investigated by the LTSC.

Other minor issues that Phil raises are the difficulties in attaching the flag to the rear of the load effectively and problems with dirt obscuring the advisory signage.

In relation to the rear overhang of the logs beyond the trailer steelwork, he highlights another potential risk where in congested traffic, the vehicle steelwork clears a roundabout, for example, but the logs still protrude into the circulation path. Cars circulating on the roundabout may see the steelwork and axles and judged that they can proceed without looking up to see the log load, which is at about car roof height. As previously discussed some form of extension from the chassis to indicate the additional length would mitigate this risk.

Phil further raises the issue that drivers might adjust their speeds upwards to take advantage of the more stable vehicles and thus erode the safety benefits. This effect has been observed with some other safety counter-measures such as ABS brakes. The industry needs to take steps in terms of driver education and instructions from the operators to their drivers to ensure that this does not occur. If the 22m concession does not result in a substantial reduction in rollover crashes LTSA will almost certainly withdraw their permission to operate these vehicles.

Doug Latto of TERNZ and Lynn Sleath of Transit New Zealand were also asked to complete the observer form shown in Appendix C. It should be noted that these views are personal and do not necessarily represent the views of their organisations. All the matters raised by these two observers have been raised previously in this report. The major concern of both was the large rear overhang of the logs beyond the steelwork and the lack of perception of this overhang when viewing the vehicle from the rear. Both suggested that some way of extending the rear of the trailer backwards to reduce the extent of the load overhang was desirable. Lynn also raised concerns regarding the railway crossing close to an intersection situation which was not extensively tested in this trial. Phil Brown has discussed this issue in greater depth.

Reports of Drivers

Some brief informal discussions were had with two of the drivers at the trial. Both were very positive about the improvements in handling and stability from the lower loads. One raised the issue of having to violate OSH requirements in guiding the loader drivers to align the loads with the marks. This is, of course, not strictly correct as OSH does not generally specify detailed procedures but places the onus on the companies and the individuals to have and use safe procedures. The LTSC are currently working on procedures for the safe loading and unloading of log vehicles and these need to take into account the additional requirements of loading a 22m truck. This issue should not be a concern for LTSA as it does not relate to the on-highway operation of these vehicles.

Load description forms

Drivers are expected to complete an entry on the form shown in Appendix A for every load they carry during the trial period. Some of these data have now been forwarded and can be reviewed. Specifically we have data from five of the seven vehicles describing 34 loads. Only one of these loads is not a two packet 22m configuration load. The period covered spans 17th October to 1st November. It would appear that most operators are not bothering to record loads that are carried in the standard 20m configuration.

Based on this rather limited dataset we can derive a few basic results but some further analysis will be needed when the dataset is more complete. The load heights on the trailer (averaged across all bolsters) ranged from 2.08m to 2.94m and the load densities ranged from 0.55 to 1.09. For the density calculations the length of the longest log in each packet was used. Interestingly the lowest height and the highest density, and the greatest height and the lowest density both coincided. The lowest height/highest density load was the only load of eucalyptus in the dataset, while the low density/high height was random pulp radiata logs.

Where complete weights were recorded the loads were between 43.7 and 46.2 tonnes indicating that these were full loads. This suggests that it should be possible to operate these 22m vehicles at 44 tonnes gross mass within an average maximum load height of 3m. However more load data needs to be analysed before a firm conclusion can be drawn.

Conclusions

The trial to date has highlighted a number of relatively minor operational issues relating to 22m log trucks and one significant area of concern that needs to be addressed.

Minor issues that can be easily resolved are:

- While the concept of placing a forward load mark on the drawbar and then referencing the load to this mark appears to work well, the mark needs to be placed such that both the front overhang and the IVS requirements are met. Some vehicles were marked on the basis of the front overhang and violated the IVS limits.
- The "22m logtruck" signs need to meet legal requirements for colour. The current orange colour is reserved for roadworks. It is recommended that the specifications in terms of font size, colour etc developed for the "0800 logtruck" signs be used. The signs also need to be configured so that they are only displayed when the vehicle is operating in the 22m configuration. Finally they need to be kept clean enough to be clearly visible.
- Loading procedures need to accommodate the requirement for drivers to assist the loader in accurately placing the load. Driver safety is, of course, paramount.
- Some work needs to be done on developing an effective system for marking the rear of the load. The two flag system, which can be seen on the vehicle in photos 4 and 5 in Appendix D was probably the best for daytime visibility but the attachment method using staples was relatively crude. One of the other vehicles used a flag with a reflective stripe across it, which would be better at night. This flag was attached with a light chain and a bungee cord, which was more elegant than the staples but the flag could flap and fold itself so that the high visibility face and reflective stripe were invisible. Based on our observations our recommendation would be that two flags are used, one at the left hand and one at the right hand edges of the load. These flags should have a reflective stripe across them and should be fixed so that the reflective stripe and high visibility face are always visible.

The main area of concern from all observers is the potential large rear overhang of the load beyond the rear of the vehicle and the difficulty in perceiving the extent of this from a rear-on view. Some of the observers at the trial suggested that underrun protection was needed. However, even in Europe where underrun protection is mandatory, log trucks are exempted because their operational requirements make it too difficult to fit an effective underrun barrier. The key to mitigating the risks associated with this larger overhang is to improve the conspicuity of the rear of the vehicle.

Marking both rear corners of the load with a reflective marker as suggested above will assist in this. It is also desirable that some visual cues on the rear of the trailer itself flag the overhang to the following motorist. LTSC are investigating the possibility of mounting the "22m logtruck" sign on an extendable frame so that it can be moved closer to the rear of the load. This would reduce the rear overhang for following vehicles although it is not anticipated that the frame would be strong enough to provide any significant protection. This extending frame would also address the potential problem highlighted by Phillip Brown where the vehicle structure has cleared an intersection but the load still encroaches and other vehicles (passenger cars) do not see the encroachment.

APPENDIX C-1

Load description form completed by the driver.

Date				
Truck				
Docket number				
TRUCK				
Truck pkt load type				
Species				
• Longest log				
• payload				
Trailer				
Species				
1st pkt load type				
• Longest log				
2nd pkt load type				
• Longest log				
Front axle wt				
Rear axle wt				
Forward O'Hang				
Ht bolster 1				
Ht bolster 2				
Ht bolster 3				
Ht bolster 4				
Rear O'hang				
Ht to lowest log				
Ht bolster 5				
Ht bolster 6				
Ht bolster 7				
Ht bolster 8				
Despatch issues				
Crew issues				
Other comments				

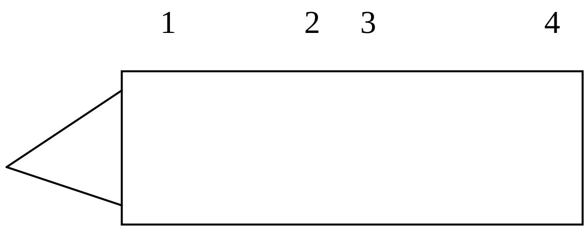
Terms:

Product type	Abbreviation
5m Sawlog	5 saw
Random Pruned Butt	Rdm prune
Fixed length Pruned	Fxd prune
Random Pulp	Rdm pulp
Random Slog	Rdm slog
4.1m sawlog	4.1 saw
Thinnings pulp	Thinnings
Aged pulp	Aged

Species

- Pine
- Douglas fir
- Other

Bolster numbering



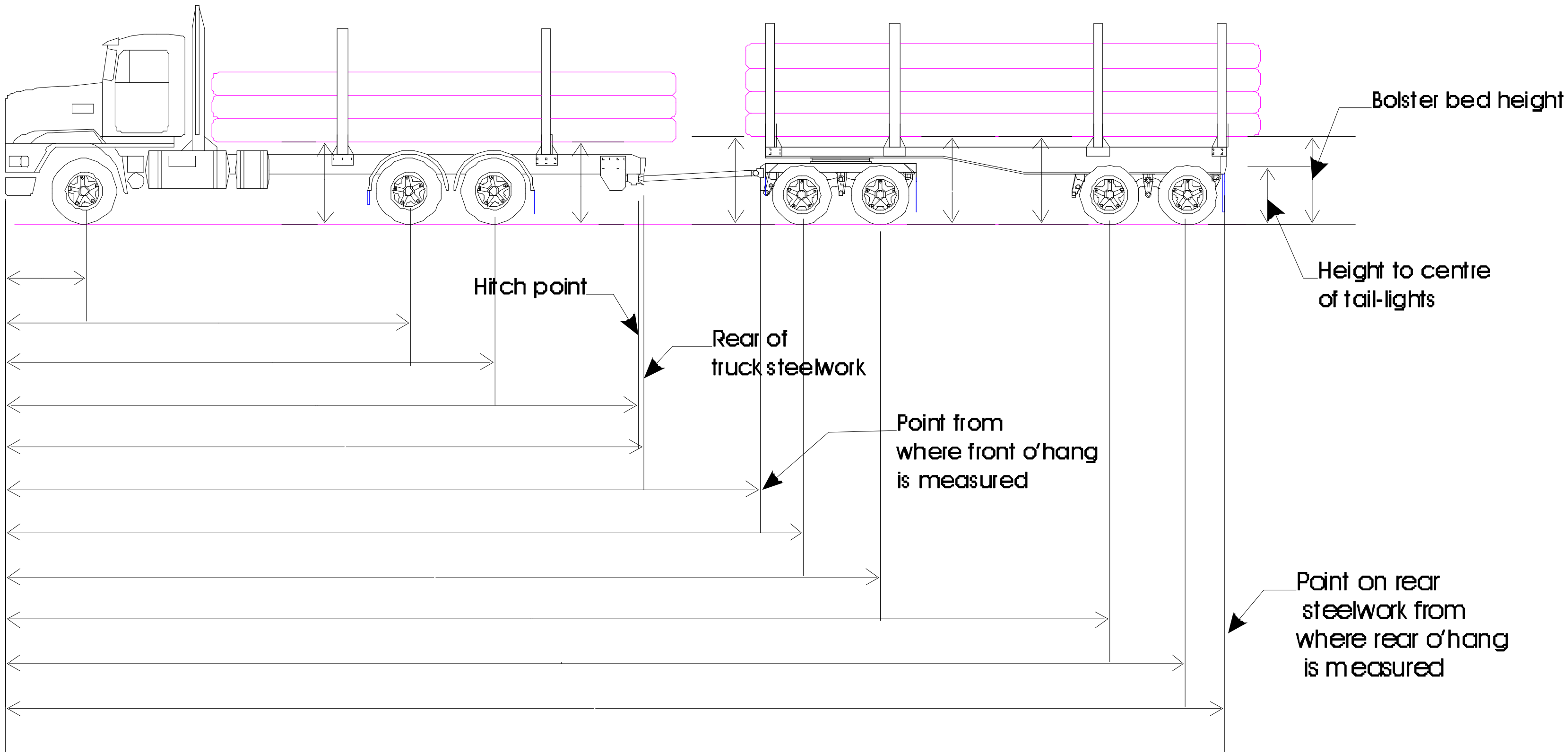
<u>Ht to lowest log</u>:- height from the ground to the underside of the lowest log at the extreme rear end of the load.

<u>Front overhang</u>:- distance from steel work to front of load (please mark steelwork where measurements are taken from).

<u>Rear overhang</u>:- distance from steel work to rear of load (please mark steelwork where measurements are taken from).

If in doubt write it down.
The more information we get the better.

Registration No: Operator:



Measurement Procedure

- The dimensional measurements should be undertaken on flat level ground, ideally paved or sealed so that it is easy to draw measurement marks, with the truck parked in a straight ahead position.
- For the vertical measurements the truck should be laden to approximately 44 tonnes GCM with a typical load split between truck and trailer.
- The longitudinal measurements should be done by using a plumb-bob to project the measurement point onto the ground and marking and labelling the point using chalk or similar.
- For the wheel positions both the left and right wheels should be marked and the corresponding point on the vehicle centreline should be found using a straight edge.
- All longitudinal measurements should be along the centreline and be from the forward-most point of the vehicle.

APPENDIX C-3

Independent Observer Response Form

Observation of 22m log truck trial

We would really appreciate your comments on the 22m log truck trial. Your comments will help us with the assessment of the 22m option. We would like your comments as an individual with specialist knowledge of transport matters and as an observer of the trial rather than the views of your organisation. We will collate the comments when we prepare the report and will not link any comment with individuals or their organisations.

Could you please write any comments you may have below and forward it to TERNZ. The types of issues we would like to receive comments on include:

Is the additional rear overhang noticeable and, if it is, does it affect other road users?

Are the tail lights and signs visible even with the maximum proposed rear overhang?

Is the additional front overhang noticeable and, if it is, does it affect other road users?

Do you have any concerns about fit on the road?

Are there any problems that you observed at intersections?

Are there any problems that you observed at rail crossings?

Are there any other issues of interest regarding 22m log trucks?

Name:

We would appreciate knowing your name so that we can call you if we require any clarification. As mentioned above though, we will not attribute the comments to an individual in the report unless you would prefer us to do so.

APPENDIX C-4

Report from Phillip Brown, Traffic Planning Consultants.

Ref: 01337
5 November

2001
TERNZ
P.O. Box 97846
SAMC

Attn: Mr John de Pont

Dear John

Re: 22m Log Truck Trial

This letter sets out our assessment of the trials and also provides a brief discussion on the implications of the extra length from a traffic engineering perspective.

The main issues identified and discussed in detail during the trials were:
- IVS requirements
- perception of depth by following motorists
- implications of underrun by following vehicles

IVS

The IVS issue was highlighted with one of the trial vehicles that had a 2.42m long steel beam at the rear of the truck (to accommodate lights, number plate etc), a ringfeder set back under this bar and an IVS in the order of 0.9m. The front overhang of this vehicle was, from memory, not the maximum permitted. During a tight turn the vehicle reached a situation which highlighted the potential problem and it wasn't until the vehicle was deliberately manoeuvred into a position that minimised the IVS that it was appreciated the potential seriousness of the situation. Photos 1, 2 and 3 show the angle of the vehicle and the clearances that were achieved in this "critical" situation.

With a slightly higher bar or a bent log, we expect that contact between the two would have occurred.

It is therefore essential that the vehicles comply with the IVS requirements.

Perception of Depth

Motorists following the truck get no appreciation of the extent to which the logs overhang the rear of the trailer's steelwork. This is a particularly significant issue as the trials illustrated to us just how deceptively far out from the rear of the steelwork the logs extend.

We believe this will have implications on the following distances, with the configurations that were tested likely to result in motorists having a smaller actual separation to the back of the log truck than what the motorist believes exists or is appropriate. If the perception of depth can be improved by providing a good visual indicator beneath the logs to help break up the 2 metre rear overhang, we believe motorists will increase their following distance.

Photos 4 and 5 clearly show the lack of perception for the same vehicle at the start of a turn and through the latter stages of the same turn in a controlled on-site situation.

Photos 6 and 7 show the view a following motorist has of the rear of the vehicle close up (perhaps in an urban area) and in a highway situation (where following distances should be greater).

Underrun

We believe this is a very serious issue and has significant safety implications in the event of a nose-to-tail collision. The crumple zone of a vehicle is designed to absorb a significant amount of energy before the occupants are subjected to the balance of the forces arising from the collision. As Photos 8, 9 and 10 show it is highly likely that the roof of a vehicle will be damaged in a collision before the front of the vehicle has actually started to collapse.

During the impact we understand there can be a transfer of weight from the rear axles to the front axles and this can, in some situations, result in the rear of the vehicle lifting off the ground. If this was to occur when a car hits the rear of the truck it is possible that the roof of the vehicle (if it hasn't already been ripped off) will then be forced onto the end of the log. This could have safety implications for rear seat passengers.

Although the attached photos have considered one small and two large passenger cars, we are mindful that in each case the driver and any passengers will be relatively low to the ground. A very serious situation (possibly resulting in death) will result if the driver is higher up than those shown in the photos. Examples of these higher vehicles include vans and recreational 4WDs.

We believe that it is essential that some mechanism is provided that allows the crumple zone of a vehicle to absorb as much energy as possible before the driver or any passengers are exposed to the end of the log. In considering the design details of this mechanism, it will be necessary to ensure that it does not become a lethal projectile into the passenger cabin in the event of a rear-end collision.

Other Minor Issues

Other minor issues were noted during the trials. These include:

- the fact that the logs are not evenly placed (at the rear) thus making the fixing of the flag potentially more difficult (Photo 11)
- the use of an office stapler to fix the flag and the requirement for these types of staples to resist any buffeting of the flag by wind turbulence (Photo 12)
- the fact that advisory signage alerting following motorists to an “overlength” vehicle can be easily obscured or covered in dirt from the on-road and off-road environments the vehicle is required to work in (Photo 13)

With respect to the traffic engineering issues, we believe the underrun concerns are the most significant. The extra 2 metres in the overall length of the vehicle, whilst having the potential to increase queue lengths is not considered significant with variations greater than this likely to occur at most intersections through variations in the gap between queued vehicles and the types and mix of vehicles in the queues.

With respect to the queuing at roundabouts, if the log truck is required to stop at a rail crossing and the rear of the vehicle blocks a roundabout, the blockage will create operational problems. However, these operational problems will quickly clear in situations where the degree of saturation of the intersection is excessively high. In this regard we are aware of a railway line that passes straight through the middle of a roundabout in New Lynn (a suburb close to our office in Auckland). The barrier arms effectively stop the circulation of all traffic around the roundabout. However, this quickly clears despite it being close to a large shopping centre, bus/train transport centre, community centre, multiplex cinema complex (recently closed) and the busy retail and commercial area.

An example of the trial vehicle blocking the roundabout is shown in Photo 14. This roundabout is located in Mt Maunganui and was identified as one that should be investigated.

Close examination of the photo shows the extent to which the rear of the logs overhang the rear of the trailer. Although this adds to the significance of the disruption, we are mindful that if only the rear of the vehicle obstructed the roundabout a motorist may misjudge the situation if they assessed the opportunities to enter the roundabout by glancing at the steelwork and the position of “the rear tyres” rather than appreciating the extent to which the rear of the load projected beyond this point.

This situation could be made worse if only the rear of the load projected into the circulating area of the roundabout while the steelwork was clear. The ability for the log truck driver to gauge just where the rear of the load is in this type of situation will, we believe, be more difficult because of the extent of the overhang.

The roundabout shown in Photo 14 is in some respects a very poor example of a situation that could be aggravated by the longer vehicle. Specifically, the distance from the limit lines at the barrier arms (close to the leading drive axle in the photo) to the point where the nearest limit lines meet the kerb (where the light truck is standing) is only 7 metres. Anything longer than a car (including a car towing a trailer) has the potential to adversely affect the operation of this roundabout.

Of greater concern is the risk that the log truck driver, on deciding to cross the railway tracks finds that the downstream exit (in the case of the photo, another roundabout) is blocked. This could result in the rear of the log truck extending over the tracks and raises safety issues if a train is imminent.

Whilst this is a matter that needs addressing, a similar (or worse) situation would occur if the log truck had instead been a B-train or truck and trailer combination and either the gap between the vehicles in front of the truck was greater or a car changed lanes into the path of the subject truck. We therefore believe that there are other factors that have an equally significant effect on the length of any queue and the risks to society of one need to be weighed up against the benefits that society can get through the increased stability of the log truck.

In considering this, we believe it is also worthwhile considering what changes the drivers may make to their driving style. In this regard we believe it is reasonable to assume that the speed drivers travel at with the existing log trucks is influenced in part by the stability of the vehicle. As there is evidence that they can roll over at excessive speeds, it is therefore likely that drivers are slowing in situations where roll-over could occur.

If the proposed changes are adopted, the stability of the vehicle is, we understand, significantly improved. We wonder then whether the manner in which the vehicle is driven will also change with the potential for the speeds to increase. Equally a less cautious attitude may be taken by the drivers with respect to the manner in which they approach and travel through bends in the road.

In summary, we believe the trial has highlighted several key issues. These have potentially very serious safety implications to following traffic and the measures to mitigate the identified problems need to be carefully considered. However, in considering the potential implications of these risks and any mitigation measures that may be identified, consideration should also be given to the benefits that can be achieved through increased stability.

We trust this is sufficiently detailed for your immediate needs. Should you wish to discuss any matter in greater detail, do not hesitate contacting us.

Yours faithfully

TRAFFIC PLANNING CONSULTANTS LTD

P.R. Brown
Associate

Photo 1 Vehicle configuration to achieve minimum IVS

Photo 2 Minimum IVS (extent of front overhang of log beyond steelwork)

Photo 3 Minimum IVS (vertical clearance)

Photos 4 & 5   Perception of Depth from different angles

Photo 6 Following motorist’s close up view

Photo 7 Following motorist’s view in an on-road situation

Photo 8 Underrun situation – Commodore

Photo 9 Underrun situation – Falcon

Photo 10	Underrun situation - Corolla

Photo 11	Log placement not even

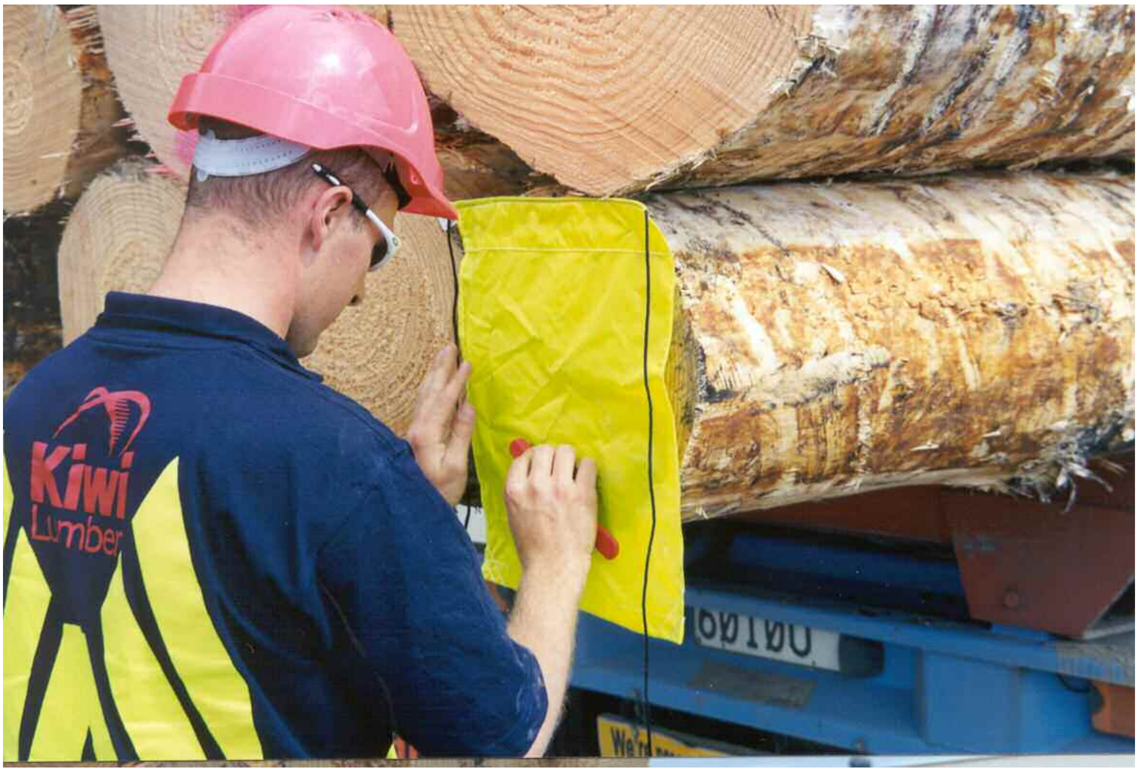


Photo 12 Reliance on office staples to secure the load

Photo 13 Advisory signs can be obscured or become covered in dirt

Photo 14 Trial vehicle at Hewletts Road roundabout