PROPOSED HEAVY VEHICLE WEIGHT AND DIMENSION CHANGES

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SYNOPSIS

This paper provides a review of the weight and dimension limits currently in force in New Zealand and discusses the proposed changes to these limits. The reasons behind the proposed changes are examined and show that some of the existing fleet of heavy motor vehicles in New Zealand is less stable than desirable and that this can be directly attributed to the existing weight and dimension limits. The main emphasis of this paper relates to the dimension limits as these are the direct responsibility of the Ministry of Transport. Proposals relating to changes in forward lengths, rear overhang, overall length, gross and axle group weight limits are discussed.

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Any views expressed in this paper are those of the author and do not necessarily represent those of the Ministry of Transport.

1. INTRODUCTION

The Road Transport system has three elements

- the driver
- the vehicle

and - the roadway

In order that the system may operate efficiently each of the three elements must be adapted to the others and together they must form a balanced and integrated whole. The efficiency of the system is lost if there is a failure in any one of these elements or if resources are invested in such a way that maximisation is not obtained. e.g. The roading engineer may wish to restrict the weights carried on trucks to save maintenance expenditure but this would mean an increase in the number of heavy vehicles on the roads to carry the same amount of goods because of reduced payloads. The issue is - "is the extra cost of moving those goods with more trucks and drivers greater than that of maintaining the road and bridges with heavier axle weights".

Although the majority of road vehicles are cars and light commercial vehicles it is principally the heavy motor vehicle which determines the requirements for pavement and bridge strength, clearances of structures both vertically and horizontally and extra swept width in urban situations. With the advances in truck technology and the potential for these vehicles to carry larger and heavier loads the capability of the roading system to cater for these vehicles is an important factor when considering the introduction of regulations

limiting vehicle sizes and weights. Other equally important factors are the design and safety aspects of the vehicle and the experience and ability of the driver to operate these vehicles safely. It is not easy to always achieve a good balance between all these factors when considering changes to regulations governing the use of heavy motor vehicles however the system must remain flexible and be able to adapt to changes so that the country will benefit both from improved economics of operation and a safer vehicle fleet.

The existing dimension and weight limits are possibly out-dated and in need of major revision. The Traffic Engineering section of the Ministry of Transport commenced preliminary investigations in 1982 to try and determine the extent of the problems with the existing vehicle dimension limits. These investigations involved extensive discussions in New Zealand with fleet transport managers, maintenance managers, operators, trailer manufacturers and vehicle suppliers. Discussions were also held with overseas researchers, and engineers with reference being made to the large amount of overseas research material that has now become available on vehicle dimensions and stability.

2.0 HISTORY OF EXISTING WEIGHT AND DIMENSION LIMITS

2.1 Weight Limits

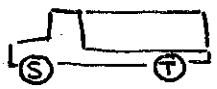
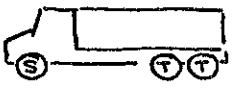
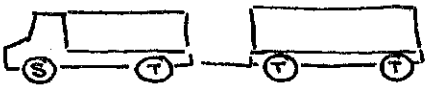
Maximum vehicle weights are controlled through the Heavy Motor Vehicle Regulations. Its use is complicated by the great variety of circumstances for which it must cater. For

instance, axles vary in the number, placement and size of tyres they carry, vehicles differ in the spacing of their axles even when carrying the same weight, roads vary in their carrying capacity or, more significantly, in the maintenance cost per passage of a heavy vehicle. If all of these variations were fully taken into account the resulting regulations would be far too complicated to be practical. Regulations which operators cannot understand and traffic officers cannot enforce are ineffective. Consequently any regulations limiting vehicle weight should be a simplified approximation to the real situation.

Table No. 1 shows the history of the maximum allowable individual axle and group axle limits from 1940 to the present day limits.

TABLE N°1 LEGAL VEHICLE WEIGHTS 1940–1985

Maximum Allowable legal Loads (in tonnes) for the Highest and Lowest Highway Class

									
1940	Class I	3·0	7·1	6·1	12·2	6·1	6·1	6·1	6·1
	Class 5	3·0	3·0	2·5	5·0	2·5	2·5	2·5	2·5
1950	Class I	4·1	8·1	6·1	12·2	5·1	7·1	6·1	6·1
	Class 4	3·6	3·6	3·6	5·1	3·0	3·0	3·0	3·0
1955	Class I	6·1	8·1	6·1	12·2	5·1	7·1	6·1	6·1
	Class 4	5·1	5·1	5·1	7·1	2·5	3·6	3·0	3·0
1969	Class I	5·4	8·2	5·4	13·2	5·4	8·2	8·2	8·2
	Class 3	5·0	5·4	5·0	9·1	5·0	5·4	5·4	5·4
1974	Class I	5·4	8·2	5·4	14·5	5·4	8·2	8·2	8·2
Present	Class 2	5·0	7·3	5·0	12·5	5·0	7·3	7·3	7·3

Relatively few countries classify their roads into weight carrying classes and according to M.R. Palmer[1] there is substantial doubt as to the effectiveness of doing this overseas because of the difficulty of enforcement. Certainly New Zealand seems to be unique in combining both a sophisticated set of axle and wheelbase limits with more than one class of road. As can be seen in Table No. 1 there is a trend towards a single road class, and this has been confirmed with the recent recommendation[2] of the National Roads Board to adopt a single road classification.

The 1974 weight limits were a vast improvement over the 1969 limits in that

(1) the number of different limits were reduced to less than half the number in existence at that time.

(2) they gave equal or better gross weight protection to bridges in the critical range of vehicle wheelbases around 3 to 6 metres and also very long wheelbases.

(3) they permitted an increase in weight on axles particularly those located closer than 2.4 metres apart with a good suspension system designed to distribute the load equally between axles and

(4) Facilitated the provision of fast weighing devices. The limits on pairs and groups of axles were so worded that vehicles could be weighed one axle at a time and the resulting weights when added could be used for enforcement of gross weight limits. This enabled local authorities to provide relatively cheap single axle weighbridges at a good number of locations and

significantly reduce the delays involved in enforcement weighing. The current weight limits are shown in Appendix No. 1.

2.2 Vehicle Dimensions

The 1956 Traffic Regulations stipulated a 36 foot limit for articulated combinations and a 30 foot limit for rigid vehicles. The maximum width at this stage was set at 8 foot. These limits remained until April 1969 when an amendment was passed to the 1956 Traffic Regulations providing a new method of limiting vehicle size. This 1969 amendment related vehicle size and manoeuvrability to road safety. This resulted in an increase in the size of some types of vehicles and a significant alteration in vehicle design.

Vehicle width is related to road safety. Normal lane widths in New Zealand vary from 3m to 3.7m. Obviously if a vehicle is very wide it tends to crowd other vehicles in adjacent lanes reducing their margin of movement and increasing the chances of a side swipe accident. The width limit widely adopted overseas was 2.5 metres. This was therefore adopted in New Zealand in the 1969 amendment. The greatest danger from vehicle width however comes not on a straight road but on a curved one especially if visibility is limited. The width of a vehicle on a curve depends not just on its length. The critical distance as far as length is concerned is that from the rear axis (or effective rear axle) to the front of that part of the vehicle.

It is important to define two terms at this stage

(a) Non-steering Axle - A non-steering axle is one, the wheels of which remain parallel to the centre line of the vehicle even when the vehicle is going around a curve. Most non-steering axles are connected directly to the chassis of the vehicle through springs.

(b) Rear Axis - When a vehicle has several non-steering axles, when it is turning it behaves as if those axles were replaced by just one. The point where this imaginary axle would be mounted is the "effective rear axle" of the vehicle and is known as the "rear axis".

Now this critical distance from the rear axis to the front of the vehicle is termed the "forward length" (see Diagram No. 1).

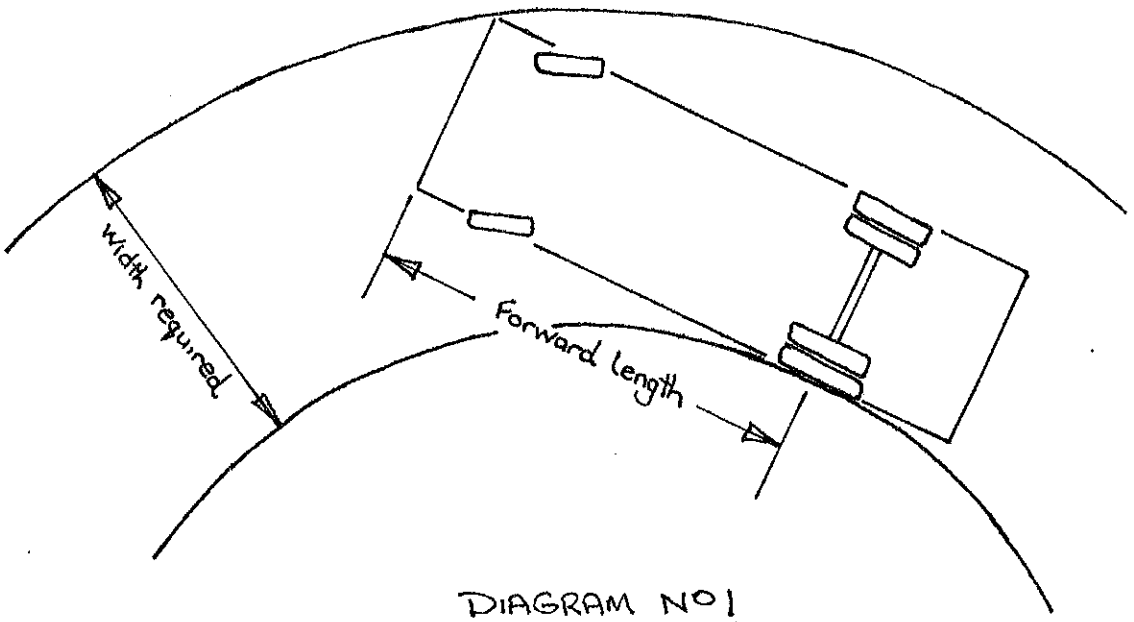


DIAGRAM NO 1

When a combination of vehicles is negotiating a curve the width of the road occupied (assuming slow speed and therefore no slip angle at the tyres) depends on the sum of the squares of the forward lengths of the vehicles making up the combination. However instead of prescribing the "sum of the squares of the forward lengths" a difficult calculation for many, the 1969 amendment instead specified three maximum allowable combinations. The use of this type of specification was not only easier to remember but encouraged the development of interchangeable fleets of trucks, trailers and semi-trailers within each of the three limits. The actual swept patch of a maximum sized vehicle on a given curve depends on the length of the curve and the number of joints in the vehicle as well as the sum of the forward length squares and the curve radius. While a rigid vehicle occupies its maximum path width immediately the front wheels reach maximum lock a truck and full trailer take a substantial distance of travel on the required lock to develop the full path width and on a tight curve, especially with a small deviation angle, the unit will have started to straighten out before its maximum width is attained.

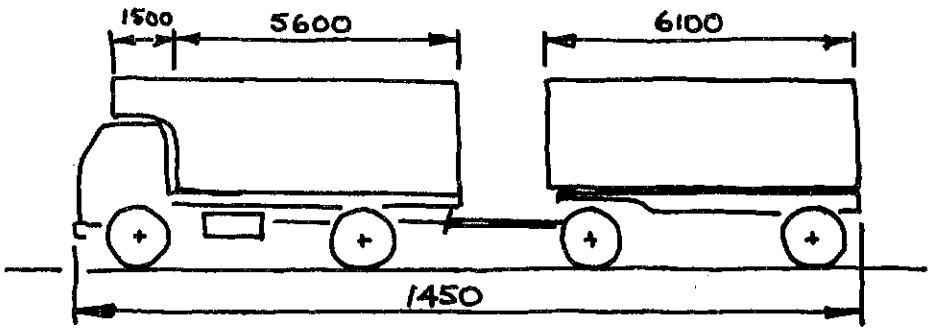
A further amendment was made in August 1970 increasing rear overhang from 9'6" to 12' (4m), a front overhang limit of 10 feet measured from the front of the drivers seat was established together with a swept turning circle limit of 80 feet. The limits were all metricated in December 1973 together with minor changes and these limits have remained in force since. Appendix II outlines the current dimension limits.

3.0 REASONS FOR CHANGE

The current metricated limits have now been in force for approximately 11 years while the forward length criteria was adopted 16 years ago. While the 1969 amendment resulted in a considerable advance over the previous limits it also gave rise to higher capacity vehicle combinations. W.R. Law[3] in an article on heavy vehicle dimensions quoted the following example

"In mid 1971 a group of 12 trucks in successive jobs had an average engine power of 153 BHP (highest was 206) while a group of 12 successive jobs in mid 1982 averaged 295 (highest 350). We have worked on several trucks within the year of 438 BHP rating. All of these trucks are operating on highway in conventional work."

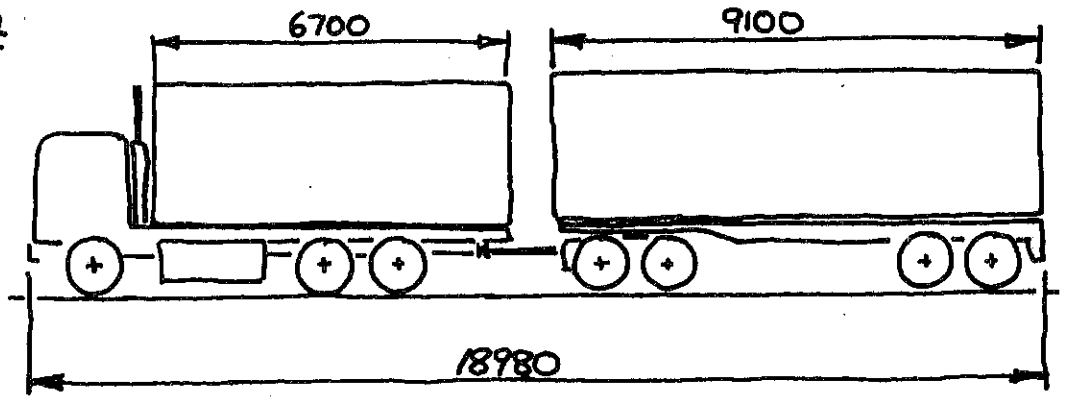
As a result of this trend there are fewer vehicles in the fleets than in 1971. Basically the road transport industry is being served by a smaller number of higher capacity vehicles. Diagrams 2 and 3 show the effect of these changes since 1971.



120-175 Brake Horse Power
23 tonne Gross Vehicle Weight

DIAGRAM Nº 2

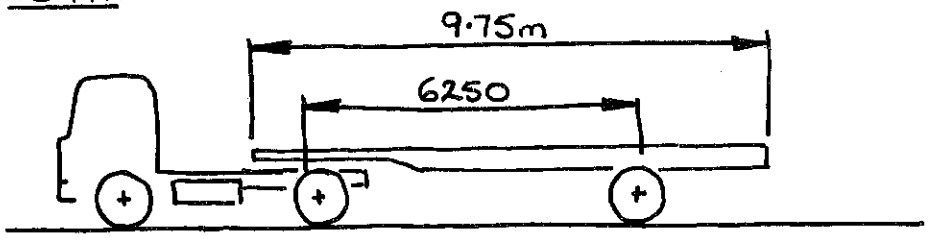
1982



295-350 Brake Horse Power
42 tonne Gross Vehicle Weight

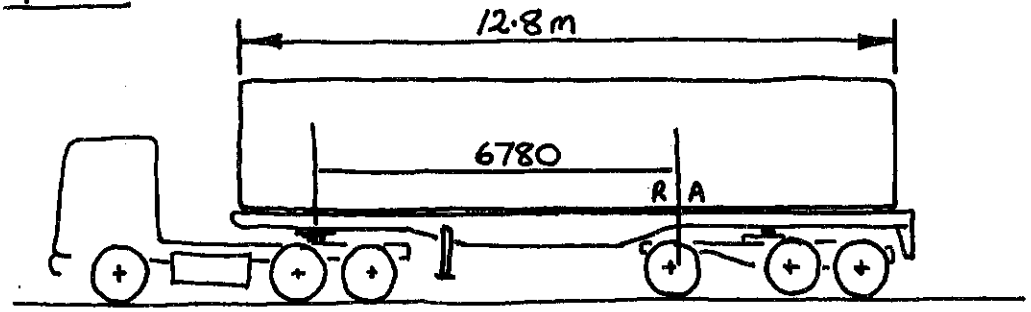
DIAGRAM Nº 2

Pre 1971



20 tonne Gross Vehicle Weight

After 1971



37 tonne Gross Vehicle Weight

DIAGRAM Nº 3

Table No. 2 below summarises the effect of the current forward length limits.

Table 2 - Forward Lengths

Towing Vehicle Forward Length	Trailer Forward Length
7.4 to 8.3 metres	No Trailer allowed
6.8 to 7.4 metres	up to 4.7 metres
6.2 to 6.8 metres	up to 5.5 metres
5.5 to 6.2 metres	up to 6.2 metres
4.7 to 5.5 metres	up to 6.8 metres
4.7 metres or less	up to 7.4 metres

Tractor units towing trailers with forward lengths up to 7.4 metres are limited to 4.7 metre forward lengths. New Zealand is reliant on the overseas market for its trucks and standard models available with the higher power ratings tend to be longer than the 4.7 metres limit. This results in imported tractor units being locally modified ("sawn down") in order to comply. Interferring with the original manufacturers specifications of tractors is a practice not to be recommended as the resulting short tractors in combinations can have stability and often operational disadvantages. It can be shown that reducing the wheel base of a standard tractor could effectively shift the centre of gravity so as to induce oversteer, hence jack-knifing, or alternatively reduce steering sensitivity. An undesirable pitching effect can also result as the wheelbase of the tractor unit is reduced in relation to the distance between point of attachment of the king pin to the suspension centre.

Forty foot containers are transported on maximum sized semi-trailers fitted with complex widespread self steering or castoring suspensions. These are a direct consequence of:

(a) The present dimension regulations which require forward lengths to be minimised and

(b) the present weight limits on groups of axles which require the spacing between the first and last axle of a group to be maximised and thus leading to inefficient suspension equalising systems.

3.1 Self Steering Axles

Self-steering axles of either the castoring or turntable type have a number of disadvantages. There is little proof that self-steering axles have been directly responsible for any accidents, because such data cannot be obtained from normal accident records. However, there is some cause for concern to the extent that in some countries they are not in general use. These concerns have been generally confirmed through discussion with major fleet operators, but these types are still required in spite of the potential problems because of reduced tyre wear and manoeuvrability while obtaining maximum deck space and gross mass capacity. They do not see improved dynamic stability as more important.

The following list outlines some of the problems/disadvantages of self-steering axles

(a) Turntable Type

(i) Height of the centre of gravity is increased leading to reduced stability.

(ii) Increased tare weight-up to 1.5 tonnes.

(iii) Reduced stability due to additional turntables therefore increased risk of jack-knife and poorer resistance to lateral acceleration.

(iv) Substantially extra cost.

(v) Added mechanical complexity and need for regular maintenance. The lack of proper maintenance can result in erratic steering and loss of cornering control.

(vi) Difficulty in incorporating into load sharing suspension - potentially poor load sharing performance.

(vii) Greater potential for high speed out-tracking.

(viii) Special driving methods and driver instruction. Incorrect driver actions can result in hazardous situations.

(ix) Can be induced to steer off-track when subject to unequal horizontal road forces - for example uneven surfaces or surface water or excessive camber.

(x) The double turntable (semi-supported on 3 turntables) offers little roll resistance as turntable lift is a major factor in semi-trailer roll over.

(xi) Long rear overhang and short wheelbase affects lateral stability.

(b) Castoring Axle Type - Castoring axles are common on long tri-axle semi-trailers and are designed to support part of the load of the vehicle but to allow lateral motion to increase

manoeuvrability and reduce tyre scrub. This "self-tracking" property means however that the axle does not play its full part in resisting centrifugal forces on a cruve and thus the axle needs to be associated with a fixed axle to provide lateral guidance for the vehicle. The fixed axle will have to provide a larger side force for its weight than that necessary on a vehicle without a castoring axle and accordingly any vehicle with a castoring axle is more liable to slide outwards on a sharp curve or perhaps to jack-knife. Therefore these types of axles attract the imposition of operational and dimensional restrictions because of their lack of resistance to cornering forces.

3.2 Overseas Studies

P. Sweatman and L. Little[4] in phase I of a review and research proposal on articulated vehicle stability highlight a number of findings by overseas researchers. Briefly these are:

(a) D. Williams (1951)[5] developed analytical methods using a tyred model and found that trailer yaw oscillations were decreased by increasing the distance of the kingpin to trailer axle.

(b) Another study by Slibar and Parslay[6] reinforced the above study by Williams. They showed that provided the trailer wheelbase was of a reasonable length relative to the length of the tractor/trailer oscillations were stable under varying frequency steer inputs.

(c) F. Jindra[7] found that the effect of the distance between

the tractor rear axle and the kingpin was such that the combination tended towards instability when the kingpin was moved rearward. This meant that the damping of oscillatory motion was reduced until, for kingpin positions behind the rear axle the combination became unstable. He also found that for a given trailer wheelbase, oscillatory instability could occur at fairly low speeds if the trailer centre of gravity was shifted towards the trailer axle. On the other hand, with a fixed relative centre of gravity position, an increase in the trailer wheelbase resulted in a strong stabilising effect.

(d) I. Schmid[8] analysed the oscillatory stability of semi-trailers and reiterated the important interaction between trailer geometric factors, the fifth wheel position, trailer wheelbase, and centre of gravity position. The most significant effect was the improvement in the damping of oscillatory motions of the trailer, caused by increasing the wheelbase.

3.3 Rigid Trucks with Full Trailers

These are less desirable from a stability and safety point of view than semi-trailers due to the additional articulation points and lack of constraint in roll from truck to trailer through the coupling. A situation which is acknowledged as particularly bad is a light or unladen truck towing a laden or heavier full trailer. In every respect such a combination has unfavourable stability characteristics, but this is frequently seen on our roads.

A particular version of the full trailer encouraged by the desire under the present regulations to achieve short forward lengths is the short 3 axle full trailer with the front axle steered by the tow bar and an axle near the middle. These are particulrly unsatisfactory as the centre of gravity can be very close to the rear axis resulting in oscillatory instability. The centre (spaced) axle is subject to severe tyre scrub and can skid thus losing cornering force, which is then transferred onto the last axle resulting in trailer swing.

3.4 Semi-Trailers with full trailers or Trucks with two full trailers

This is potentially the worst type of combination which legally exists. The problems are due to the inclusion of further articulation points and reduced roll constraint compared with rigid truck and trailers. In countries with more advanced vehicle limits these combinations are either prohibited, or are strictly controlled by individual permits. Accident data suggest that this type of combination is over represented in accidents by a factor of 10 compared with other heavy motor vehicle types. This trend has also been confirmed by the opinion of major operators.

3.5 B-Trains

The B-train is a concept originating in Canada - it consists of a tractor coupled to a semi-trailer which in turn is coupled to another semi-trailer by means of a second fifth wheel mounted

near the first semi-trailer rear axis. This type of vehicle has been operating in New Zealand now for approximately 7 years. B-trains have two articulation points, it is one less than the A-train (tractor-semi-full trailer) and because they are fifth wheel type attachments they can successfully transmit to the driver "roll" signals from the rear. Therefore the B-train is a favoured type of vehicle over many of the existing combinations because of its stablising characteristics. However because of existing forward length and overall length constraints it is difficult to design and build a B-train that can take full advantage of these stability characteristics.

4.0 PROPOSED CHANGES IN DIMENSIONS

The Traffic Engineers attached to the Ministry of Transport propose a number of changes to the existing dimensions limits that will improve vehicle stability and offer more flexibility in the choice of tractor units. The proposal is similar to the approach used by most Australian states, as recommended for the national standard by the NAASRA "Study of the Economics of Road Vehicle Limits"[9] (ERVL) carried out in 1975. An additional constraint on forward length is suggested for this proposal, which was not part of the ERVL recommendation.

4.1 Width

Obviously an increase in overall width would result in improved roll stability so long as the axle and spring spacing is widened. M. Freitas[10] in his study found that an increase

in width to 2.6 metres (with axle and spring spacing being widened) improved the roll stability for doubles (tractor plus semi plus semi coupled by means of a converter dolly) by about 16 per cent which could result in a significant reduction in rollover accidents. Although a number of North American states have increased their limit to 2.6 metres this has occurred mainly as a result of the new size ISO container which is 2.6m wide and 13.7m long. There is no reason to expect 2.6m ISO containers on New Zealand's shipping routes as the cellular ships on these routes have been designed with 2.5 metre slots. Improved roll stability would appear to be sufficiently important to use the increased width for stability gains but at this stage such an increase should be kept in mind because of effective swept width increases due to proposed increases in forward length limits.

4.2 Rear Overhang

A proposed limit of 3.2m or half the forward length whichever is the lesser measured from the rear axis point is proposed (currently 4m and up to 4.6m under a special approval for semi-trailers). Recent surveys by the Ministry of Transport have shown that the 3.2m limit on rear overhang would cater for 96% of existing single unit trucks with 99% of single units having rear overhangs of less than 3.6 metres. This limit of 3.2m was selected by the Australian authorities after extensive study and provides improved vehicle stability. The existing semi-trailers that exceed the proposed 3.2m

limit do so to gain suitable deck lengths for 40' containers and to keep within the existing forward length limits.

4.3 Forward Lengths

4.3.1 Single Unit Vehicles

Present maximum forward length is 8.3m and rear overhang 4m giving a total overall length of 12.3m for single unit vehicles. The recent dimension survey showed that 99% of single unit vehicles have forward lengths of 7.6 metres or less. The equivalent ERVL limit is forward length 8.3 metres and overall length of 11.0 metres. The single unit overall length should not be increased and a reduction would be desirable by reducing the maximum rear overhang. As the main application of these vehicles would be for city delivery a reduction in the near overhang would reduce tail swing which is important in city lane driving.

4.3.2 Multiple Unit Vehicles

(a) Tractor and Semi-Trailer - Diagram No. 4 shows the existing and proposed maximum sized tractor and semi-trailer combination. In many overseas countries long deck semi-trailer is the preferred type of vehicle and given the right incentive this trend could be followed in New Zealand. This would be desirable from a safety point of view; in comparison with some types of combinations presently used. Semi-trailers are more stable than full trailers due to the fewer articulation points. This provides improved roll stability, less rearward amplification of lateral acceleration and better high speed tracking stability.

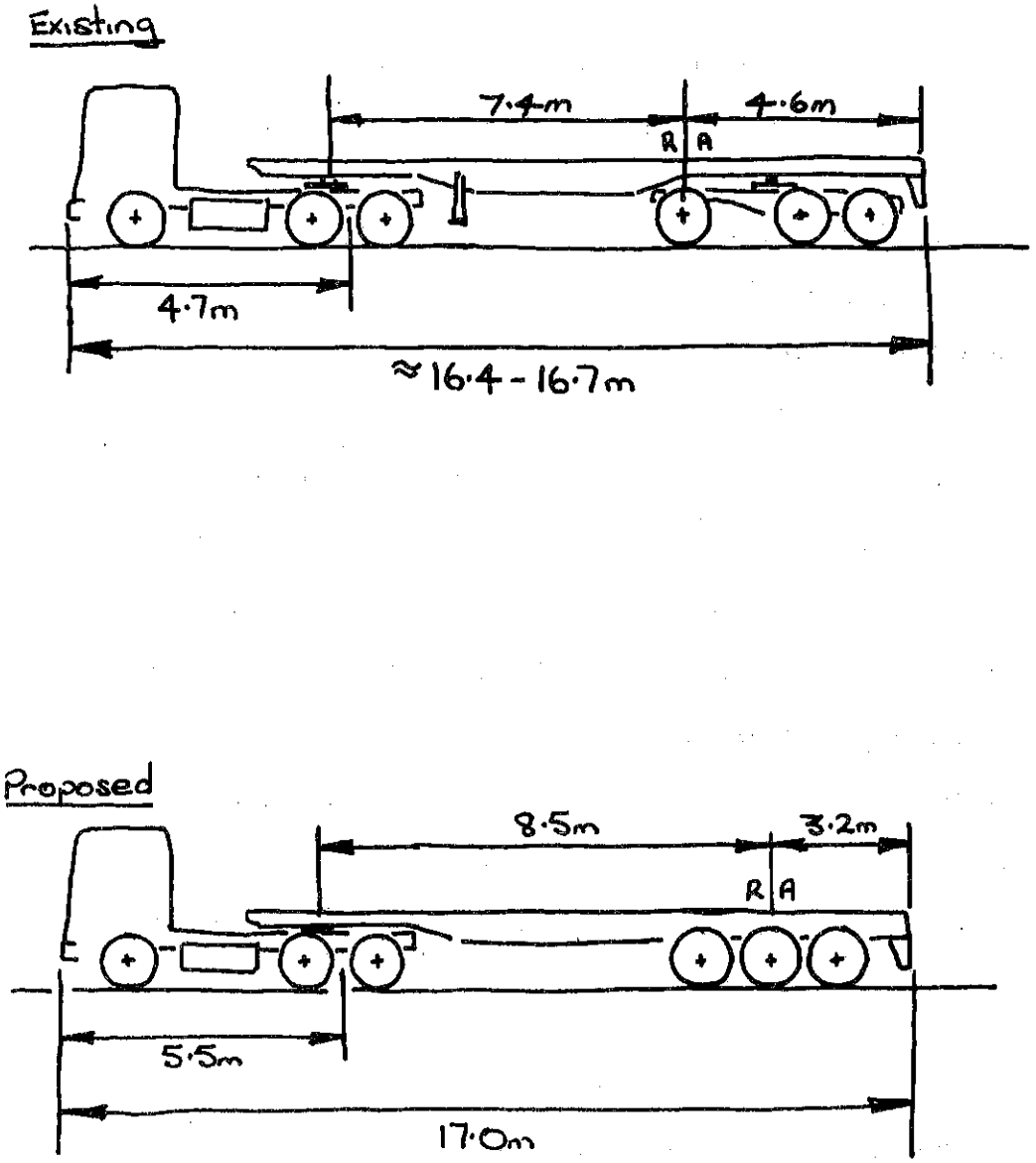


DIAGRAM No 4

The proposed maximum sized semi-trailer would have a 8.5 metre forward length trailer with a 5.5 metre (maximum up to 8.3m) forward length tractor with the sum of the forward lengths being restricted to 14.0 metres. This would be the optimum vehicle from a load carrying point of view. The reason for restricting forward lengths is to limit the width swept out by the vehicle as it travels around corners.

The proposed semi-trailer would off-track by 5.0 metres which is approximately 1 metre more than allowed under the present regulations for semi-trailers. This off-tracking is the same as for certain existing legal vehicles, namely B-trains and logging trailers. We have not been able to measure how much these existing vehicles have caused additional off-tracking problems in highway situations. The extent of off-tracking is shown in the tracking diagrams in Appendix III. Maximum weight allowed on each axle could be obtained, because of the flexibility for choosing the position of the rear bogie further aft than is presently possible. The improved weight distribution is also a safety benefit due to improved stability. Future use of self steering axles would be less attractive under this proposal and it would be an opportunity to prohibit the construction of any new vehicles of this type. A simple tri-axle on tandem is a cheaper, more reliable, lighter and safer alternative for which better load sharing designs are readily available. The increased swept path would be significant only on small radius curved rarely found on normal highway situations but the longer forward lengths of trailing units will increase stability and improve high speed tracking. This is a very important stabilising influence. By allowing the 8.5m forward length semi-trailer with the limit on the sum of forward lengths at 14m the need to shorten the wheelbase of the tractor unit is removed. The proposed new lmits would offer no advantage from using a tractor of less than 5.5 metres forward length. An important issue here

is that at present the existing weight limits encourage the use of road damaging widespread suspension systems and for this proposal to be attractive and succeed an increase in the weight on a closed spaced tri-axle group is essential. (See Section on proposed weight limits.) A shift to increased use of semi-trailers which would be encouraged by this proposal would be a significant safety gain, if other types of combinations are reduced in numbers (particularly self steers). It is likely the truck fleet would eventually tend to become more uniform in type of vehicle, which would also assist some enforcement operations, especially weighing by the use of small fixed weigh bridges which could be standardised for the most common axle spacings.

(b) Truck and Full Trailers - Full trailers must still be permitted, as for certain applications they are quite necessary for satisfactory commercial operations, (e.g. stock cartage) and they are currently the predominant vehicle in New Zealand long haul operations. However from a safety point of view, this should be discouraged in favour of the use of long single semi-trailers or B-trains. Because of the influence of long vehicles on the characteristics of the traffic stream the overall length should not exceed the present 19 metre limit. Characteristics such as rearward amplification of lateral acceleration, straight line off-tracking (crabbing) and snaking and sway are all speed related and these vehicles have been observed operating in excess of 110 km/h. Experience within the industry, and reported

accident numbers tend to confirm these less favourable stability aspects of full trailers, especially 2 axle types. While an increase in length is not favoured, some increased flexibility in forward lengths is desirable to reduce the need for unsatisfactory combinations of short forward length which only exacerbate the inherent weaknesses. It is therefore proposed that for a truck and trailer combination the maximum forward lengths not exceed 7.4 metres on either the truck or trailer and the sum of the forward lengths not exceed 14.0 metres.

(c) A-Trains - (semi-trailers with full trailers or two full trailers,)

As discussed previously this is potentially the worst type of combination which exists and to discourage the use no size advantages should be available under any proposed size limit changes. They should be confined to the present limits, with provision for phasing out in the future.

(d) B-Trains - Currently B-trains commonly operate at forward lengths summing to 17.8 metres. In order to allow a longer tractor forward length and increase stability the sum of the forward lengths should be such that tractors with forward lengths shorter than 5.5 are discouraged. The proposal is that no forward length exceed 7.0 metres (many existing B-trains have a forward length of 6.8m), no two forward lengths sum to more than 12.5 metres and that no three forward lengths sum to more than 18 metres. This

however poses a problem in that the 19 metres overall length limit would be exceeded if full advantage is taken of these forward length limits and to comply with it could lead to the undesirable shortening of the tractor units. Therefore this is the only combination where a proposal to exceed 19 metres is being recommended.

4.4 Overall Length

At present only three types of vehicle combinations can operate at the maximum allowable overall length limit of 19 metres. These are the truck and full trailer/s, the A-train and the B-train. Because of the inferior operational performance of full trailers compare with semi-trailers and the includence of increased overall length no increase in overall length is being proposed. The additional articulation points of A-trains on a truck with two trailers further impair the situation. Long overall length increases overtaking time, which in combination with the poorer dynamic performance makes overtaking a truck and trailer more difficult and riskier than overtaking a semi-trailer. It is however proposed that the overall length of a B-train be increased to 20 metres. The reason for this was explained in the previous section and relates to the possible shortening of the tractor unit if the limit is kept at 19 metres. Because of other proposed increases in forward lengths this is not likely to occur with the other types of vehicle combinations that can remain at 19 metres.

5.0 PROPOSED CHANGES IN WEIGHT LIMITS

Although the Ministry of Transport's main area of expertise and responsibility relates to vehicle dimensions serious consideration needs to be given to a number of proposed changes to the present weight limits in order to successfully implement these proposed size limits. The New Zealand Road Transport Association in its submission[11] to the Ministers of Transport and Works and Development have asked for an increase in the maximum allowable gross weight from 39 tonnes to 44 tonnes. Recent investigations of the effect on the road pavement and bridges of a 44 tonne gross weight limit have indicated that neither would be overstressed and therefore the proposal is a viable one. However an increase in only the gross weight would tend to encourage the increased use of truck and trailer combinations as opposed to the favoured truck and semi-trailer that has the superior stability characteristics. The reason for this is that the present structure of the weight limits in New Zealand restricts weights on individual axles and axle groups before the gross weight limit is reached. Therefore if only the gross weight was increased to 44 tonnes it is unlikely that any vehicles would be able take full advance of the increase because of internal axle group restrictions. Diagram No. 5 shows the implication of these internal axle group limits.

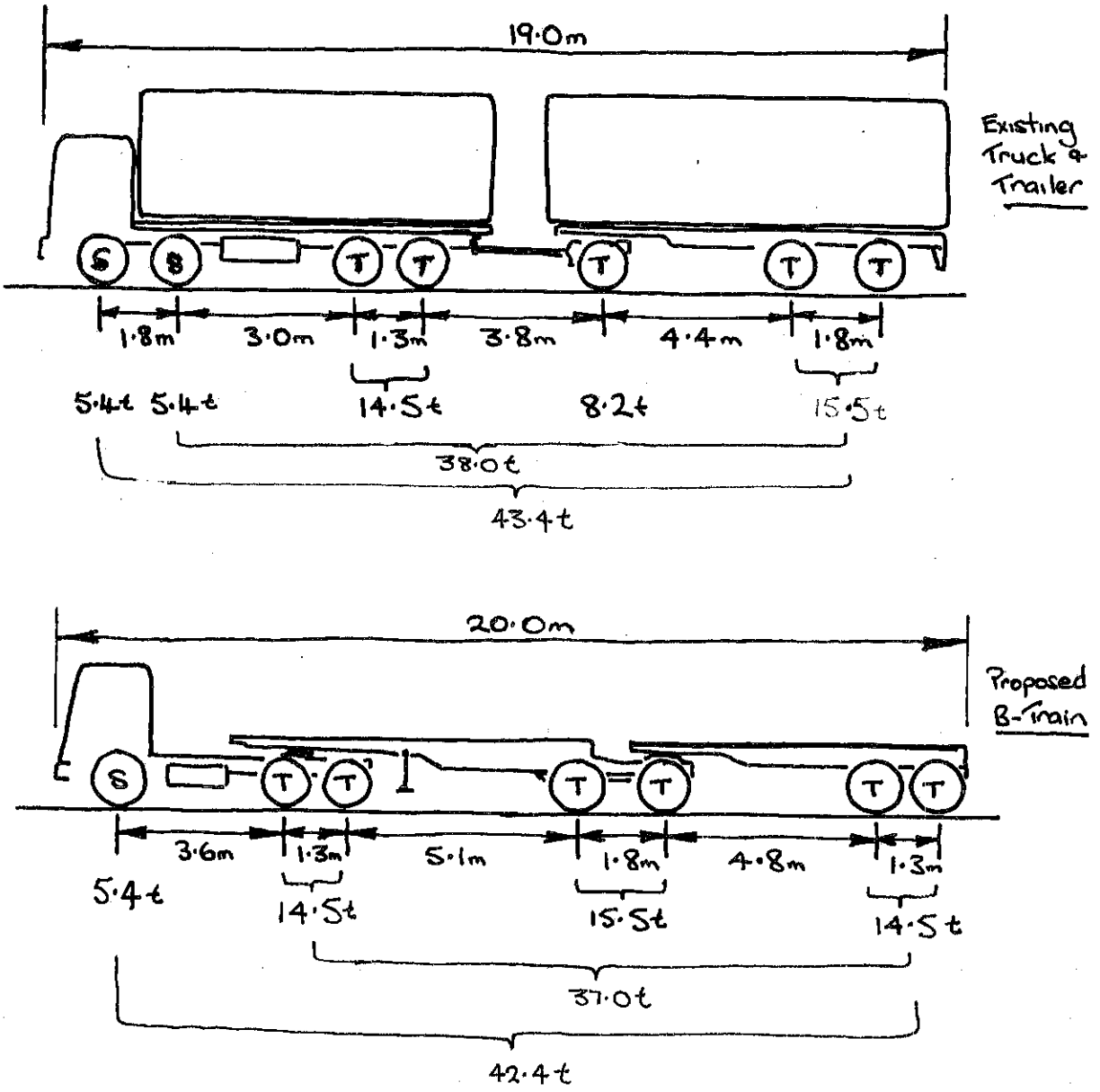


DIAGRAM Nº 5

To firstly encourage the semi-trailer configuration the proposal is to increase the allowable group weight on a close spaced tri-axle from the existing 17.5 tonnes to 19 tonnes over a 2.8 metre first to last axle spread. A 2.8 metre spread is a distance that conforms to existing standard suspensions units. By raising the gross weight over a 16 metre spread to 44 tonnes a large gap is left between this

and the 38 tonne limit over a 14.4m spread. The 44 tonne must be a starting point and cannot be treated in isolation. Similar adjustments must be made to the other limits particularly at the top range and around the 2.8 to 5.2 metre range. A limit of 39 tonnes over say 13.5 metres would allow a truck and semi-trailer to load to 39 tonnes making this unit a viable alternative to the truck and trailer. Although the 44 tonne proposal has been investigated further investigations on the effect of other group increases on pavement and bridge structures must be made. It is thought that loadings over a short spaced axle group will overload a number of bridges, but it is important that the cost of upgrading these bridges be calculated and offset against the benefits to be gained from any further weight increases.

6.0 SAFETY

The proposed 44 tonnes limit would be a higher limit than permitted by many other countries even where heavy vehicle safety and design standards are stricter. The Ministry of Transport is concerned about the safety aspects of the proposed weight increase and are currently investigating substantial safety trade-offs that would be required to make the increase acceptable. Because of the complexity and detail of these investigations I will not be covering them in this paper.

7.0 REFERENCES

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(2) NATIONAL ROADS BOARD (July 1985) Submission No. 8415.

(3) LAW, W.R. (1982) Heavy Vehicle Dimensions. Domett Fruehauf Trailers Ltd.

(4) SWEATMAN, P. and LITTLE, L. (1979) Articulated Vehicle Stability, ARRB Internal Report AIR 323-1.

(5) WILLIAMS, D. (1951) The Mathematical Theory of the Snaking of Two Wheeled Trailers. Proc. Automobile Division. Inst. Mech. Engrs. (1951-2), 175-187.

(6) SLIBAR, A. and PASLAY, P.R. (1957) The Forced Oscillations of Trailers, ASME J. Appl. Mech. vol.24, 515-519.

(7) JINDRA, F. (1963) Tractor and Semi-Trailer Handling. Directional Stability and Control of a Tractor and Semi-Trailer Combination in a Flat Turn. Automobile Engineer, October 1963.

(8) SCHMID, I. (1967) Engineering Approach to Truck and Tractor Train Stability. Society of Automotive Engineers SAE 670006.

(9) NAASRA (1975) A Study of the Economics of Road Vehicle Limits. Summary and Recommendations. Study Team Report R.3., October 1975.

(10) FREITAS, M.D. Safety of Twin-Trailer Operations. Public Roads Volume 48 No. 4., March 1985, 117-120.

(11) NEW ZEALAND ROAD TRANSPORT ASSOCIATION (1984) The Case for an Increase in Gross Vehicle Weights and Dimensions.

MAXIMUM VEHICLE AND AXLE WEIGHTS

METRIC KILOGRAMS

AXLES	Class I	Class II
(S)	5 400	5 000
(T)	8 200	7 300
(4)	9 500	8 200

Single Tyred Axle - two single tyres

Twin Tyred Axle - four tyres or two tyres larger than 1300 x 24 or 1400 x 20

Oscillating Axle - four separate wheels

WHEELS:

(S) and (T) ½ axle limit +500 kg

(4) ¼ axle limit +250 kg

GROSS and maxima for any grouping of axles

Distance from first to last axle of any group: (Metres)	Maximum Sum of Axle Weights	
	Class I	Class II
16.0 or more	39 000	39 000
14.4 "	38 000	38 000
13.0 "	37 000	37 000
11.8 "	36 000	36 000
10.8 "	35 000	35 000
10.0 "	34 000	34 000
9.4 "	33 000	33 000
8.8 "	32 000	32 0000
8.2 "	31 000	31 000
7.6 "	30 000	30 000
7.0 "	29 000	29 000
6.4 "	28 000	27 000
5.2 "	26 000	23 000
3.6 "	21 500	19 000
2.4 "	17 500	15 000
1.8 "	15 500	13 500
1.0* "	14 500*	12 500*
Less than 1.0	Limits as for one axle	

BRIDGE LIMITS (Gross and maxima for any grouping of axles)

Percentage of Class I						
90%	80%	70%	60%	50%	40%	30%
35 100	31 200	27 300	23 400	19 500	15 600	11 700
34 200	30 400	26 600	22 800	19 000	15 200	11 400
33 300	29 600	25 900	22 200	18 500	14 800	11 100
32 400	28 800	25 200	21 600	18 000	14 400	10 800
31 500	28 000	24 500	21 000	17 500	14 000	10 500
30 600	27 200	23 800	20 400	17 000	13 600	10 200
29 700	26 400	23 100	19 800	16 500	13 200	9 900
28 800	25 600	22 400	19 200	16 000	12 800	9 600
27 900	24 800	21 700	18 600	15 500	12 400	9 300
27 000	24 000	21 000	18 000	15 000	12 000	9 000
26 100	23 200	20 300	17 400	14 500	11 600	8 700
25 200	22 400	19 600	16 800	14 000	11 200	8 400
23 400	20 800	18 200	15 600	13 000	10 400	7 800
19 400	17 200	15 100	12 900	10 800	8 600	6 500
15 800	14 000	12 300	10 500	8 800	7 000	5 300
14 000	12 400	10 900	9 300	7 800	6 200	4 700
13 100	11 600	10 200	8 700	7 300	5 800	4 400

* NOTE: If axles in this distance include a single tyred axle paired with a twin tyred or oscillating axle, special limits apply:-

		Class I	Class II
(S)	(T)	12 000	11 000
(S)	(4)	13 000	12 000

(Also the maximum weight permitted on a pair of single tyred axles within this distance is the sum of the individual weights allowed on each axle.)

APPENDIX II

W.R. PETTERSSON

MAXIMUM PERMITTED VEHICLE DIMENSIONS.

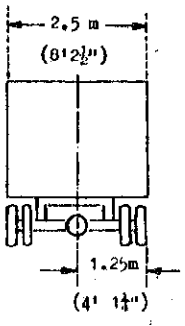
The following are the maximum dimensions of motor vehicles permitted by Regulation 48 Traffic Regulations 1976. Where two conflicting dimensions are shown the vehicle must not exceed the lesser of the two, i.e. the most restrictive of the two measurements.

WIDTH

48 (1) No person shall operate any vehicle, if the vehicle or its load or both exceed 2.5 metres in width or extend more than 1.25 metres from the longitudinal centre-line of the vehicle. The provisions of this subclause shall not apply to any agricultural trailer or agricultural machine, where -

(a) The vehicle does not exceed 3.7 metres in width; and
(b) The vehicle is not operated during the hours of darkness; and
(c) The vehicle is not driven at a speed exceeding 25 kilometres an hour; and
(d) The extreme right-hand front edge of the vehicle is indicated by a flag of the type specified by regulation 50 hereof to indicate excess dimensions.

(2) For the purposes of subclause (1) of this regulation, any mirrors, side marker lights, or direction indicators shall be deemed not to be part of the vehicle or its load.



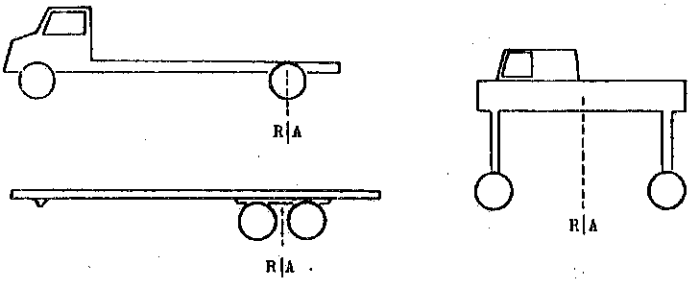
Except:- Agricultural vehicles up to 3.7 metres (12' 1½") in width travelling no faster than 25 km/h (15.5mph) in daylight.

DEFINITION:- REAR AXIS

(a) In relation to a vehicle with only one non-steering axle, means that axle:

(b) In relation to a vehicle with 2 or more non-steering axles, means a horizontal line at right angles to the longitudinal centre-line of the vehicle and midway between the first and last non-steering axles:

(c) In relation to a vehicle with no non-steering axle, means a horizontal line at right angles to the longitudinal centre-line of the vehicle at a point to be determined by the Secretary:



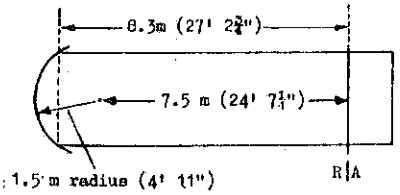
DISTANCE AHEAD OF REAR AXIS

48 (3) No person shall operate any vehicle if any part of the vehicle or its load extends more than 8.3 metres ahead of the rear axis of the vehicle.

Provided that this subclause shall not apply -

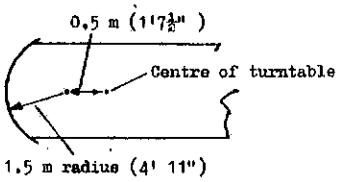
(a) In the case of any trailing unit, to its towbar or to any load the forward end of which is supported by the towing vehicle:

(b) In the case of a vehicle the load of which does not extend forward of the body, provided no part of the body of the vehicle extends forward beyond the arc of a circle of 1.5 metres radius with its centre on the vehicle centre line 7.5 metres ahead of the rear axis.



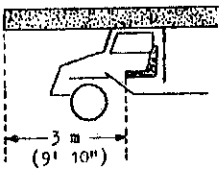
DISTANCE AHEAD OF KINGPIN OR TURNTABLE

48 (4) No person shall operate any articulated vehicle if any part of the trailing unit or its load extends forward beyond the arc of a circle of 1.5 metres radius with its centre on the vehicle centre line 0.5 metres ahead of the centre of the turntable or kingpin on which the trailing unit is hinged.



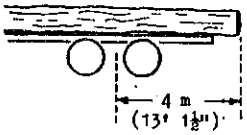
FRONT OVERHANG

48 (5) No person shall operate any vehicle other than a trailer if the vehicle or its load extends more than 3 metres forward from the front edge of the driver's seat.



REAR OVERHANG

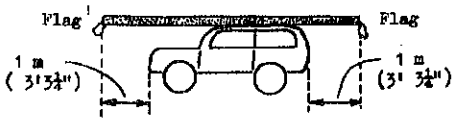
48 (6) No person shall operate any vehicle if the vehicle or its load extends backward more than 4 metres from the rear axis.



FLAGS TO INDICATE EXCESS DIMENSIONS

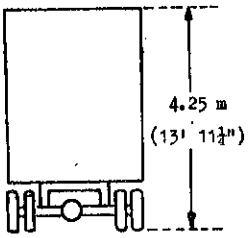
50 (1) No person shall operate a motor vehicle under a permission given under regulation 49 hereof, or any motor vehicle the load of which projects more than 1 metre backward from the body of the vehicle or more than 1 metre forward from the body of the vehicle or more than 200 millimetres out from the side of the body of the vehicle, unless the projecting load or the excess dimensions of the vehicle are suitably indicated by means of a clean white flag or a red or orange or yellow fluorescent flag. Such flags shall be at least 400 mm long and 300 mm wide.

(2) For the purposes of this regulation any rear vision mirror or direction indicator shall be deemed not to form part of the vehicle.



HEIGHT

48 (7) No person shall operate any vehicle, if the vehicle or its load or both rise to such a height as to be liable to damage any construction or wires lawfully over the roadway used by the vehicle, or in any case to a height exceeding 4.25 metres from the ground.



DEFINITION OF FORWARD LENGTH

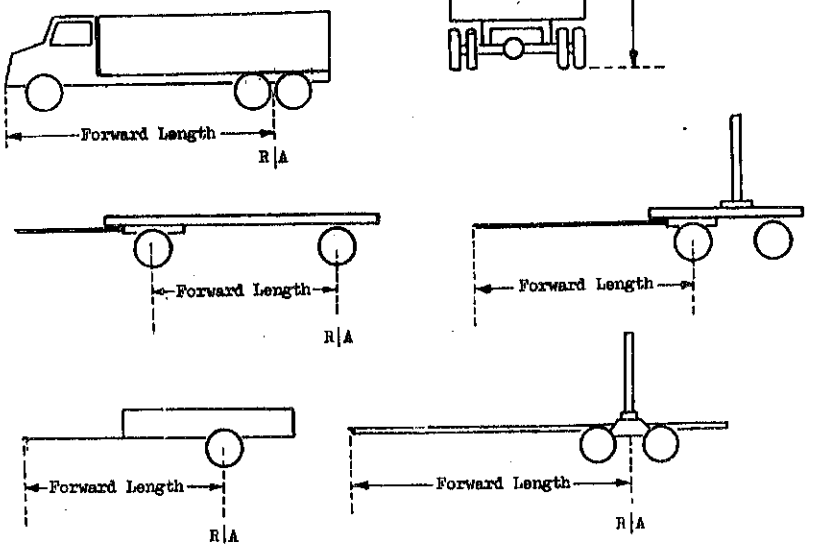
(a) In relation to a motor vehicle other than a trailing unit, means the distance from the rear axis to the foremost part of the vehicle or its load, whichever is the greater:

(b) In relation to a trailing unit the front axle of which is steered by the towbar, means the greater of the following distances:

(i) From the front axle of the trailing unit to the point of attachment of the tow-bar to the towing vehicle;

(ii) From the rear axis of the trailing unit to the front axle:

(c) In relation to any other trailing unit, the distance from the rear axis of the trailing unit to the point of attachment to the towing vehicle:



FORWARD LENGTH (VEHICLE COMBINATIONS)

48 (10) No person shall operate any combination of vehicles if the forward length of that vehicle in the combination with the greatest forward length -

(a) Exceeds 7.4 metres; or

(b) Exceeds 6.8 metres if the combination includes another vehicle with a forward length exceeding 4.7 metres; or

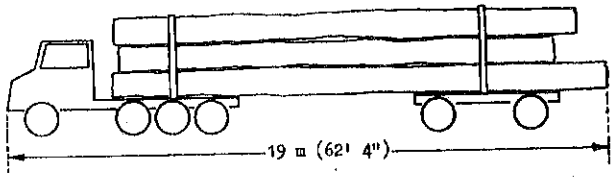
(c) Exceeds 6.2 metres if the combination includes another vehicle with a forward length exceeding 5.5 metres.

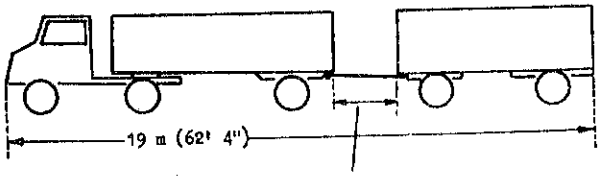
Acceptable Combinations of Forward Length

7.4 metres	with	4.7 metres	(24' 3¼"	with	15' 4")
6.8 "	"	5.5 "	(22' 3¾"	"	18' 0½")
6.2 "	"	6.2 "	(20' 4"	"	20' 4")

OVERALL LENGTH

48(11) No person shall operate any combination of vehicles if the total length of the combination together with its load exceeds 19 metres.

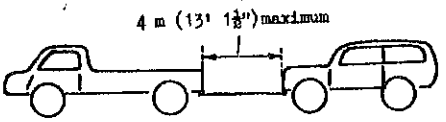




LENGTH BETWEEN VEHICLES BEING TOWED

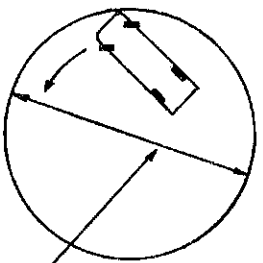
48(12) No person shall operate any combination of vehicles if the space between any 2 vehicles in the combination exceeds 4 metres. For the purposes of this subclause, any towbar, rope, wire, or chain used to connect 2 vehicles together shall be deemed not to be part of either vehicle.

Provided that this subclause shall not apply to 2 vehicles which are designed or being used to support a common load.



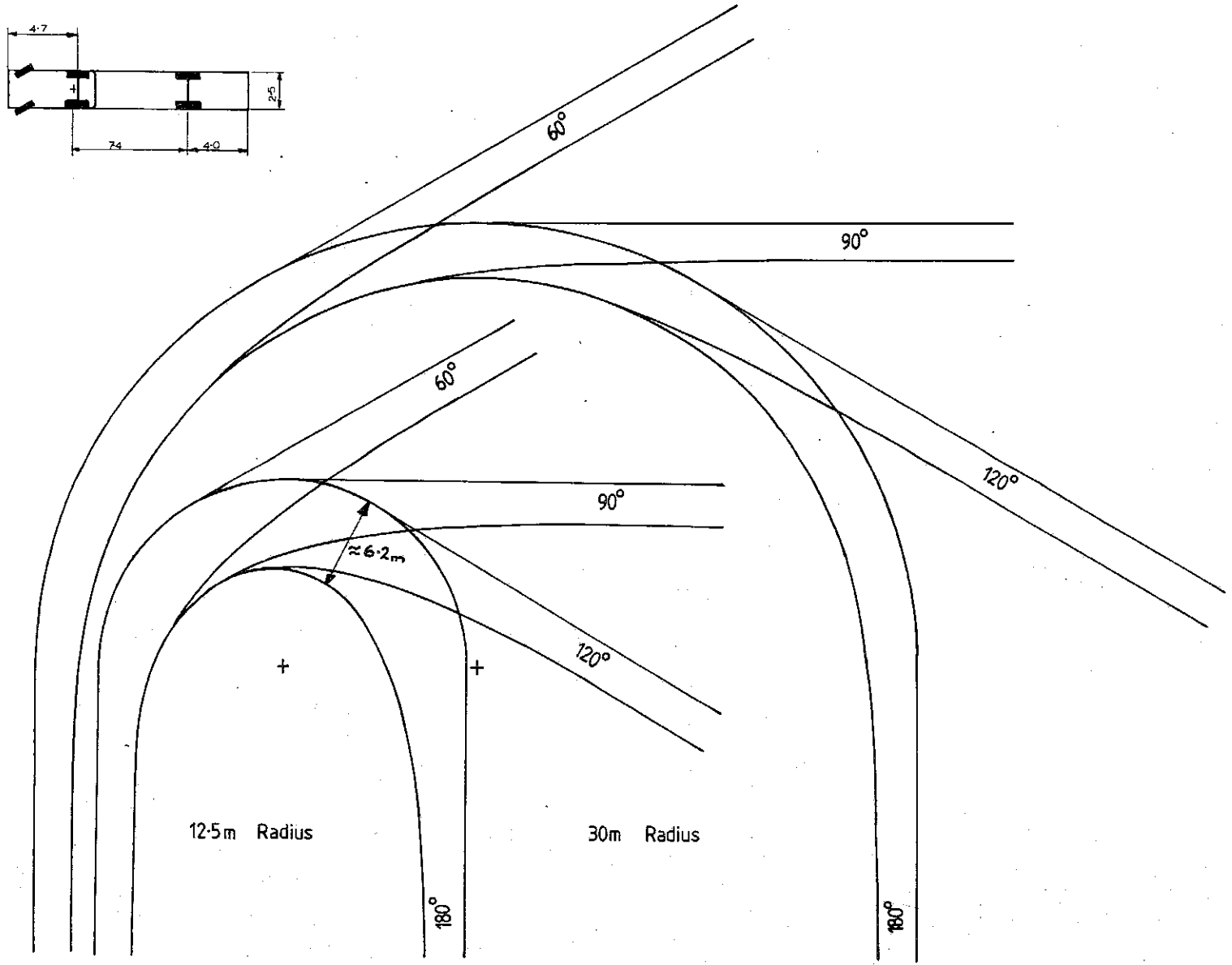
TURNING CIRCLE

48(13) Except in the case of a vehicle first registered before the 1st day of January 1971, no person shall operate any motor vehicle or combination of motor vehicles if the vehicle or combination is not capable of completing a 360° turn without projecting outside the circumference of a circle of 25 metre diameter.



OVERDIMENSION VEHICLES AND LOADS

Vehicles or loads which exceed these dimensions may not travel on New Zealand roads unless they have a permit from the Secretary for Transport, Chief Traffic Officer or other authorised person and unless they abide strictly by all the conditions on the permit.



APPENDIX III

TRACKING DIAGRAMS

Designed	SWEEP		
Drawn	C.B.+W.P.	SHEET 6	
Checked			
Recom'd			

Max Legal Semi
4·7m – 7·4m

Issue

Sheet ... of ... Sheets
Scale 1:200

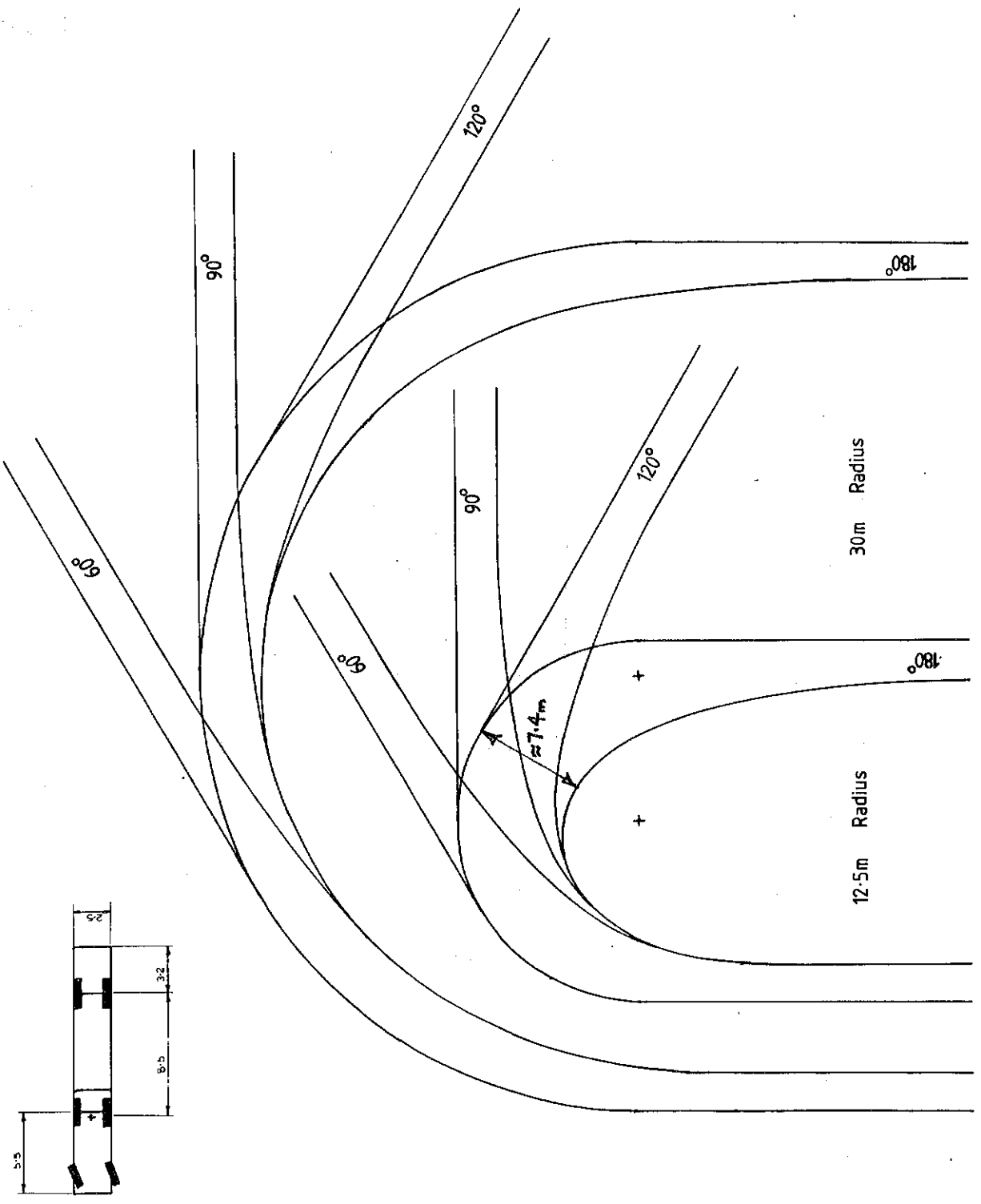
TE 5 / 1984

A2
ORIGINAL SIZE
420 × 594 MM

W. R. PETTERSON.

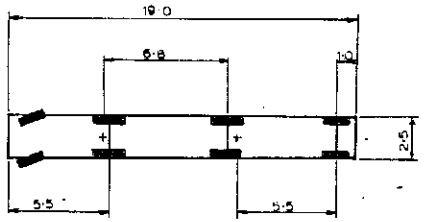
APPENDIX III

TRACKING DIAGRAMS



Proposed Max Semi
5·5 m – 8·5m
TE 4 / 1984
Sheet of Sheets
Scale 1:200
Issue
Designed
Drawn
Checked
Recom'd
Swept
CS & VP
Starts

A2
ORIGINAL SIZE
420 x 594 MM



APPENDIX III
TRACKING DIAGRAMS

Designed	SWDGP		
Drawn	CG+WP	Turtle	
Checked			
Recom'd			

Max Legal 'B' Train
5·5m – 6·8m – 5·5m

Issue

Sheet of Sheets
Scale 1 : 200

TE 3 / 1984

W.R. PETTERSSON.

A2
ORIGINAL SIZE
420 × 594 MM

72

33