A COMPARISON OF THE AUSTRALIAN AND NEW ZEALAND APPROACHES TO PBS

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Abstract

The Vehicle Weights and Dimensions Study undertaken by Roads and Transportation Association of Canada in the early 1980s highlighted the potential for using performance-based standards as a basis for regulating size and weight. Australia and New Zealand have subsequently both adopted this methodology to some degree but with quite different approaches.

This paper presents an overview of the development of the PBS system used in each country and the approach used to implementing it. The differences in outcomes are compared and discussed.

Keywords: Performance Based Standards, Size and Weight Regulation, High Productivity Vehicles

1. Introduction

A performance standard consists of a performance measure, i.e., some quantity that is measured under a specified set of test conditions, and a pass/fail criterion. There are Performance-Based Standards (PBS) that have been part of motor vehicle regulations since the 1930s or earlier. For example, in New Zealand there is a very old requirement that a vehicle's brakes must be able to stop the vehicle within 7m from 30km/h on a clean dry surface. However, the concept of using PBS for regulating size and weight only really came to the fore with the Vehicle Weights and Dimensions Study undertaken by Roads and Transportation Association of Canada (RTAC) in the early 1980s (RTAC 1986). In this study a number of performance measures were used to quantify the overall safety performance characteristics of different vehicle configurations. The results of this study were presented at an International Symposium on Heavy Vehicle Weights and Dimensions in 1986. This symposium was effectively HVTT1.

In Canada, size and weight regulation is controlled by the provincial governments rather than by the federal government and as a result there was a lack of compatibility between the different sets of provincial regulations. The aim of the RTAC study was to identify vehicle configurations and size and weight limits that would be acceptable to all the provinces. PBS was used to quantify the safety performance of the various vehicle options. The eventual implementation was through a Memorandum of Understanding (MoU) which defined prescriptive size and weight limits for several vehicle configurations based on the PBS results. The original MoU was endorsed in 1988 but there have been ten amendments since then which have expanded the range of vehicle configurations covered and changed some of the allowable weights and dimensions. In addition to this, some provinces use the PBS approach for permitting larger vehicles outside of the MoU.

Subsequently, both Australia and New Zealand began to use this PBS approach to size and weight regulation but with significant differences in the way that it was done. In this paper I will present an overview of the history of PBS use in these two countries highlighting the key differences.

2. PBS in New Zealand

New Zealand was very quick to adopt the PBS approach. By the time of the second International Symposium on Heavy Vehicle Weights and Dimensions (effectively HVTT2) in 1989, PBS analysis had already been used in New Zealand to inform a review of the size and weight regulations which increased the gross combination weight limit from 39 tonnes to 44 tonnes (Baas and White 1989). Based on these PBS results, 3-axle trucks with 3-axle trailers were limited to 42 tonnes while A-trains (called A-doubles in Australia) were limited to 39 tonnes. In both cases, this was because these vehicle configurations inherently have poorer high speed dynamic performance. Subsequently, based on PBS assessments of individual vehicle designs including specific tyres and suspensions, several A-trains were issued with permits to operate at 44 tonnes. As far as I am aware, none of these higher weight vehicles are still operating and there are very few, if any, A-trains currently operating in New Zealand because they are less productive than the alternative configurations.

Between 1999 and 2004, the New Zealand Heavy Limits Project (Sleath and Pearson 2001, Transit New Zealand 2001) was undertaken to investigate options for operating larger and heavier vehicles on the network. Two scenarios were considered: one (scenario A) proposed heavier vehicles with the same dimension limits as current legal vehicles operating across the whole network while the other (scenario B) proposed longer and heavier vehicles operating on only the major highways. The programme of research was quite extensive and consisted of seven separate work streams looking at the impacts on:

- bridges;
- safety;
- geometry (scenario B only);
- pavements;
- environment;
- industry economics (i.e. changes in the freight task);
- overall economics;

The safety evaluation and geometry evaluation components of this study both used PBS assessment combined with experimental validation testing. Both scenarios showed favourable benefit-cost ratios, but neither was implemented at the time. There was some debate about the validity of some the underlying assumptions particular in relation to infrastructure costs and some follow up analysis was undertaken.

In 2002, the various legal vehicle size and weight requirements were consolidated into the Vehicle Dimensions and Mass (VDAM) Rule (Baas, Latto et al. 2000). Although the VDAM Rule requirements were primarily prescriptive, they did also include a performance requirement where most large heavy vehicles were required to meet a minimum level of rollover stability (de Pont, Baas et al. 2002). Some of the prescriptive requirements, such as a maximum trailer to truck mass ratio, were also based on performance analyses undertaken in the development of the Rule.

In 2010, the government amended the VDAM Rule to allow High Productivity Motor Vehicles (HPMVs). This amendment itself specified no dimensional constraints or maximum overall gross combination weight limit for HPMVs although there were specified limits on axle weights and axle group weights as well as a “bridge formula” table specifying maximum weights for different axle spreads. The primary limitations were that the New Zealand Transport Agency (NZTA) has a statutory obligation to ensure that vehicles are safe and fit on the infrastructure.

The approach that the NZTA took in implementing this amendment was to promote the use of pro-forma designs. These designs are templates for the main vehicle configurations used in New Zealand with acceptable ranges for the critical vehicle dimensions. These pro-forma designs were developed using PBS analysis. Because, initially, the pro-forma designs were longer versions of the standard legal vehicle configurations, the key performance issue was expected to be low speed turning performance, i.e., the road width required when turning at intersections and roundabouts. To characterise the performance on roundabouts a new PBS measure based on a 120° 12.5m radius wall-to-wall turn was introduced. A vehicle was not permitted to cross a concentric 4.9m radius inner circle. For high-speed performance, the Canadian RTAC measures were used.

In developing the pro-forma designs, the vehicles were modelled with generic suspensions of relatively poor performance, loaded to their maximum allowable weight and with the centre of gravity height of the load adjusted to give a Static Rollover Threshold (SRT) of 0.35g, which is the minimum level permitted by the VDAM Rule. The limit values for the key dimensions were determined by when the vehicle failed one or more of the other PBS measures. In practice, vehicles built to the pro-forma designs would have better performing suspensions, will not necessarily be operating at the worst-case SRT and will not necessarily be at any of the limit values for any of the critical dimensions. Thus, most vehicles built to the pro-forma designs will have performance characteristics that are superior to the PBS limit values.

Vehicles that complied with the requirements of the pro-forma designs could be issued with an HPMV permit without further assessment. These vehicles could operate at standard legal weights across the whole network and at higher weights on approved routes. Vehicle designs that did not comply with any of the available pro-forma designs could also obtain HPMV permits but were required to have a PBS assessment done for the specific design.

The initial pro-forma designs were 22m overall length (OAL) compared to 20m for standard legal vehicles, but it was soon found that 23m OAL was readily achievable within the PBS requirements. This typically represents an increase in deck length of nearly 20% and so the uptake for volume-constrained loads was strong. However, the uptake for higher weight permits was less strong because of difficulties in getting access to enough of the road network.

New Zealand’s road network is approximately 96,000km long with 11,000km of state highway and 85,000km of local roads. The operation of the state highway network is fully funded from the National Land Transport Fund (NLTF) which is generated primarily by Fuel Excise Duty (FED) for petrol-powered light vehicles and Road User Charges (RUCs) for heavy vehicles and diesel-powered light vehicles. RUCs includes a component for pavement wear which is based on the 4th power of the axle loads and so heavier HPMVs pay significantly more RUCs to offset the increase in pavement wear that they generate. However, local roads are, on average, only about 50% funded from the NLTF with the remainder of their funding coming from local ratepayers. Mainly for this reason, many local road controlling authorities were reluctant to allow the higher weight vehicles on their roads. For many operators, paying the higher RUC rates for HPMV weights but not being able to utilise these weights for transport links involving non-approved local roads was not economic.

Note that, in theory, with RUCs there is no need to have legal axle weight limits because there is full cost recovery of the pavement wear generated by the vehicles. Because the pavement wear component of RUCs is based on the 4th power of axle weight, RUC rates rise very steeply with increasing axle weights and so it is not economic for operators to run vehicles at high axle weights. In fact, transport operators typically use vehicles with more axles than are necessary to achieve their maximum gross weight limit because the lower RUC rates associated with the extra axles offset the loss of payload capacity due to the higher tare weight. However, it is far from certain that all operators would behave in an economically rational manner and thus there are legal limits for axle weight.

Non pro-forma HPMV designs were able to achieve higher overall length limits and several vehicles with an overall length of approximately 25m were permitted. These vehicles were all operating at the higher weights, 59-61 tonnes gross combination weight (GCW), on approved routes. However, a study undertaken in Australia (Elischer, Eady et al.) found that crash risk on general access routes increased substantially for vehicle lengths over 23m. This increase in risk was primarily because of traffic engineering considerations rather than vehicle performance factors. Although the results of this study do not necessarily apply directly to New Zealand, the NZTA determined that, as a general principle, the overall length of HPMVs should not exceed 23m. Exceptions may occur for specific freight tasks on short, specified routes where an assessment of the traffic engineering implications has been undertaken.

To increase the uptake of higher weights the NZTA developed a concept called 50MAX vehicles. These are 23m HPMVs with nine axles operating at maximum gross weight of 50 tonnes. This solution is not optimal. Based on New Zealand's axle load limits only seven axles are needed for 50 tonnes although most operators would typically choose to have eight axles because the lower RUC rates offset the reduction in payload capacity. However, it can be shown that these nine-axle vehicles generate no more pavement wear per payload-tonne than comparable standard legal vehicles and so that NZTA was able to convince most local road controlling authorities to permit widespread access by these vehicles.

The New Zealand PBS requirements have since been reviewed and formalised. Because of the observed lane width requirements of some limit case vehicles on lower speed highway curves, the low speed turning maximum allowable swept width requirement was reduced. As a result, all the pro-forma designs were redone. A typical current pro-forma design is shown in Figure 1. The full set of current pro-forma designs is published on-line (Waka Kotahi New Zealand Transport Agency 2023). Existing vehicles built to the previous proforma designs retain "grandfather" rights including, for example, when the truck or tractor in the combination is replaced with a new vehicle.

One-off design permits for non-pro-forma designs do cause complications when, for example, the truck or tractor needs to be replaced and the dimensions of the replacement vehicle are not identical to those on the original permit. In this situation a new PBS assessment is usually required. The NZTA's "grandfathering" allow this to be done using the PBS requirements that applied when the initial permit was granted but it still imposes costs on the operator which are often unexpected because the operator may not have owned the vehicle when the original permit was issued.

Also, these one-off permits are for a specific combination of vehicle units and do not, for example, allow the specified truck to be used with other HPMV trailers in the operator's fleet. With pro-forma designs, it is relatively simple to generate bulk permits that allow a set of trucks to be used in combination with a set of trailers. Thus, the NZTA is now aiming to have most vehicles fit within the pro-forma design framework. If there is demand within the industry for a vehicle configuration that is not covered by the existing pro-forma designs, then the NZTA will facilitate the creation of a new pro-forma design in preference to approving one-off design permits. One-off design permits are now only intended for specialised vehicles on limited routes.

The simplified approach taken in New Zealand has led to a strong uptake of HPMV vehicles. By 2015, only five years after the initial introduction of HPMVs, it was reported (Ministry of Transport 2015) that 25% of the combination vehicle fleet were HPMVs. No updated data has been published but the growth in market share has continued and my estimate is that it now over 50%.

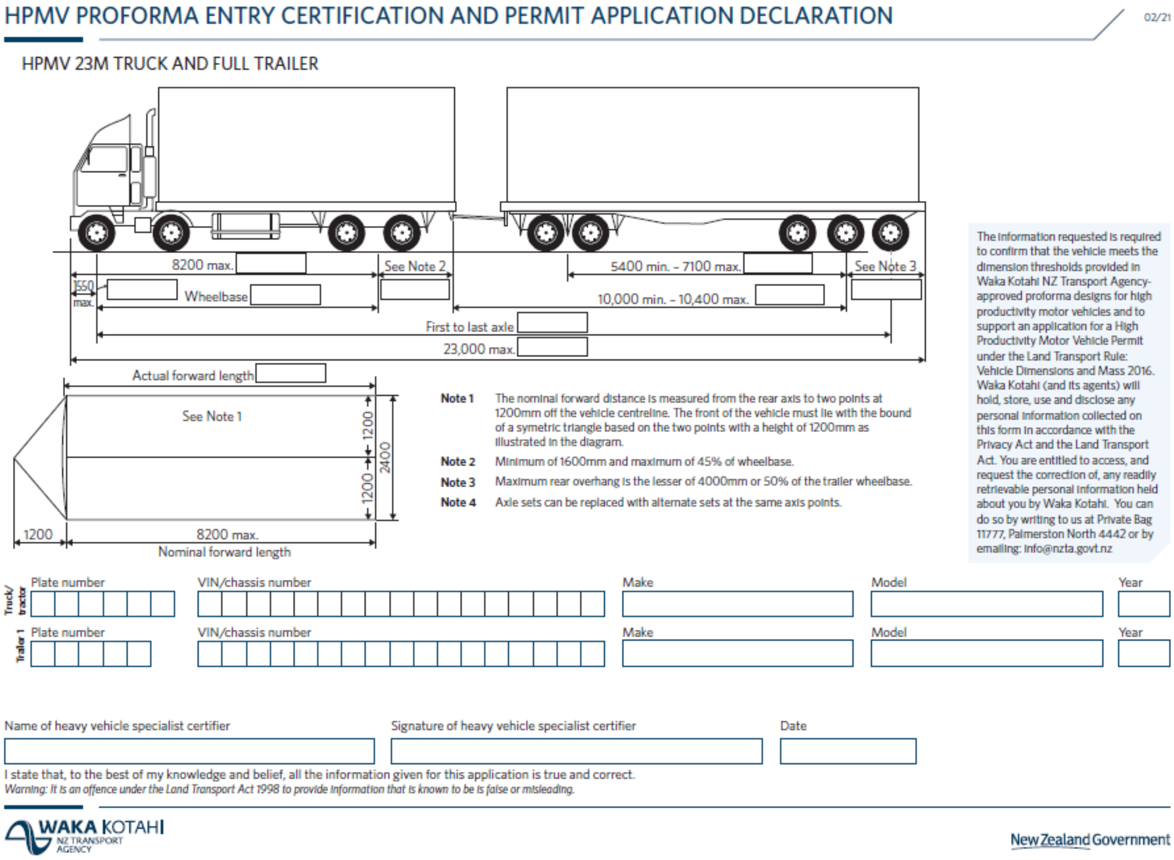


Figure 1. Typical HPMV pro-forma design.

3. PBS in Australia

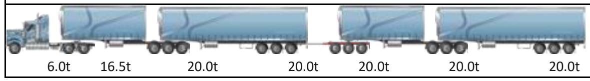
The road transport regulatory environment in Australia is far more complex than in New Zealand. Australia has six states and two territories who each have the power to set their own size and weight rules. They do now have a National Heavy Vehicle Regulator (NHVR) whose role is to try to ensure harmonisation of regulations between the states and territories.

The infrastructure situation is also complicated. There are four levels of infrastructure access that are hierarchical:

- General access (19m OAL up to 57 tonnes)
- B-double routes (26m OAL up to 68 tonnes)
- Type 1 road train routes (36.5m OAL up to 113 tonnes)
- Type 2 road train routes (53.5m OAL up to 135.5 tonnes)

Some examples of the common vehicle configurations that operate at these various access levels in Australia are shown in **Error! Reference source not found.**. **Error! Reference source not found.** has been extracted from a much more comprehensive list on the NHVR website (NHVR 2019). Even without PBS vehicles, Australia allows some exceptionally large and productive vehicles to operate as of right on specified routes.

Table 1. Examples of common heavy vehicle combinations in Australia.

Example Heavy Freight Vehicle Configurations					
	Description	Maximum Length (metres)	Maximum Regulatory Mass under GML (tonnes)	Maximum Regulatory Mass under CML (tonnes)	Maximum Regulatory Mass under HML (tonnes)
COMMON COMBINATIONS - GENERAL ACCESS					
	6 Axle Semitrailer	≤ 19.0	42.5	43.5	45.5
	3 Axle Truck and 3 Axle Dog Trailer	≤ 19.0	42.5	43.5	-
	3 Axle Truck and 4 Axle Dog Trailer	≤ 19.0	42.5	43.5	-
	7 Axle B-double	≤ 19.0	55.5	57.0	57.0
COMMON COMBINATIONS - B-DOUBLE ROUTES					
	8 Axle B-double	≤ 26.0	59.0	61.0	62.5
	9 Axle B-double	≤ 26.0	62.5	64.5	68.0
COMMON TYPE 1 ROAD TRAINS					
	12 Axle A-double	≤ 36.5	82.5	84.5	90.5
	12 Axle B-triple	≤ 36.5	82.5	84.5	90.5
	15 Axle AB-triple	≤ 36.5	102.5	104.5	113.0
	11 Axle Rigid Truck and 2 Dog Trailers	≤ 36.5	88.5	90.5	91.0
COMMON TYPE 2 ROAD TRAINS					
	18 Axle A-triple	≤ 53.5	122.5	124.5	135.5
	18 Axle BAB-Quad	≤ 53.5	122.5	124.5	135.5

In the late 1990s, Australia initiated a large research project to develop an alternative compliance regime based on PBS (Edgar, Prem et al. 2002). The approach used was rigorous and quite fundamentalist. The original concept was that all vehicle requirements would be performance-based with no prescriptive requirements at all. All performance measures were to be able to be evaluated by both computer-simulation and experimental testing. There were to be four levels of pass/fail criteria which were intended to align with the four levels of infrastructure access described above.

The project started by identifying a field of all possible performance measures and then reducing these based on relevance and redundancy (Prem, Ramsay et al. 2001). Thus, if two performance measures were found to be highly correlated one could be eliminated. The pass/fail criteria were determined from published results and from the performance characteristics of the Australian fleet at the time. PBS vehicles were required to have better performance than general fleet and so, for most measures, the pass/fail thresholds were set at levels that the worst-performing vehicles in the fleet at the time were not achieving.

The final set of PBS consists of four infrastructure standards and sixteen safety standards and was implemented in 2008. Although it was originally intended that there would be no prescriptive limits, in practice this has not been possible. Although maximum width and OAL limits are not specified in the PBS requirements, they are in the PBS Route Classification Guidelines and thus apply to PBS vehicles. The infrastructure standards for pavement vertical loading are effectively the same axle load limits that apply to standard legal vehicles. Axle load limits in Australia are complex with three levels, General Mass Limits (GML), Concessional Mass Limits (CML) and Higher Mass Limits (HML) applying in different situations.

The PBS system was included into the National Heavy Vehicle Law (NHVL) in 2014. Currently Australia is the only country in the world which has a fully comprehensive set of PBS regulations in the law.

The direct mapping of route access for the four levels of PBS vehicle to the existing four levels of infrastructure access also did not occur seamlessly. Road access is controlled primarily by the state roading authorities who went through a process of evaluating routes to assess whether they were suitable for PBS vehicles and at what level. This slowed the uptake of PBS.

Each PBS vehicle design needs to be assessed and permitted individually. These assessments are usually based on the specific dimensions and vehicle parameters of vehicle which, originally, even included makes and models of tyres. With this level of specificity, it is possible to utilise the full range of performance permitted by the PBS rules. Recently, the NHVR has implemented the use of generic tyre data based on load rating which has eliminated the situation where satisfactory performance was based on using specific tyres.

Although this permitting regime is rigorous, it is also costly. A PBS assessment undertaken for a particular vehicle design cannot be used for another vehicle unless that vehicle is identical in all respects which has limited the uptake by standard designs. The NHVR have now introduced provisions for PBS variations and amendments that provide options for an easier process.

Nevertheless, the uptake of PBS uptake in Australia has exceeded predictions. The Regulatory Impact Statement (RIS) in 2004 predicted 3200 combinations in the first 10 years. By 2018, 10 years after the introduction of PBS, there were 8,000 PBS vehicles.

An updated RIS in 2012 predicted around 14000 PBS combinations by 2030. In 2020, it was reported (NHVR and ARTSA 2020) that over the previous three years 20% of new vehicle registrations were PBS vehicles and that the number of PBS vehicles operating had just exceeded 10,000. The Australian Bureau of Statistics reports that in 2020, there were 105,137 articulated trucks registered in Australia, so this indicates that, in 2020, PBS vehicles made up about 10% of the fleet. Currently NHVR has 17,000 PBS combinations on their books (Bruzsa 2023).

The biggest issue is around route access. To address this the NHVR has now introduced some "blueprint" vehicles which are similar in concept to the New Zealand pro-forma designs. These blueprints provide access certainty around those combinations.

More than half of the PBS vehicles are truck and dog trailer combinations. Referring to **Error! Reference source not found.**, we see that under the standard size and weight rules, the maximum allowable gross combination weight for truck and dog trailer combinations is substantially less than the sum of the axle group weight limits. This is unlike most other combinations. Table 2 shows the weights that can be achieved by PBS truck and dog trailer combinations. Thus, the opportunity for productivity gains on truck and dog combinations are substantial.

Table 2. PBS Truck and dog trailer combinations.

NHVR National Heavy Vehicle Regulator
PBS Vehicle Configurations

Disclaimer: This chart shows some of the NHVR-approved PBS heavy vehicle combinations used in Australia. Other heavy vehicle configurations may not be represented. The mass and length limits shown are from the Heavy Vehicle (Mass, Dimension and Loading) National Regulation (the MDL Regulation) and are provided for general guidance only. These limits are available only to vehicles that comply with all other regulatory requirements (e.g. width and height limits, tyre width, vehicle standards, load restraint, suspension type etc.). In some circumstances, other mass concessions and length limits may also be available. The NHVR website provides links to the MDL Regulation and to national and state Notices that may apply, depending on individual circumstances. For further information, contact the NHVR on 1300 MYNHVR (1300 696 487) at info@nhvr.gov.au or www.nhvr.gov.au/contact-us

Common PBS vehicle configurations	Description	PBS level	Maximum length† (m)	Maximum permitted mass GML (t)	CML (t)	HML (t)
PBS TRUCK AND DOG TRAILERS						
1	3-axle truck and 3-axle dog trailer	1 2	20.0 20.0	48.5 48.5	- 49.5	- 49.5
2	3-axle truck and 4-axle dog trailer	1 2	20.0 20.0	50.5 56.0	- 57.5	- 57.5
3	3-axle truck and 5-axle dog trailer	2	26.0	59.5	61.5	63.0
4	3-axle truck and 6-axle dog trailer	2	26.0	63.0	65.0	68.5
5	4-axle truck and 3-axle dog trailer	1 2	20.0 20.0	50.0 53.0	- 54.0	- 54.0
6	4-axle truck and 4-axle dog trailer	1 2	20.0 20.0	50.0 60.5	- 62.0	- 62.0
7	4-axle truck and 5-axle dog trailer	2	26.0	64.0	66.0	67.5
8	4-axle truck and 6-axle dog trailer	2	26.0	67.5	69.5	73.0

4. Summary of the Key Differences

The two operating environments are significantly different. Size and weight regulation in New Zealand is controlled by a central government agency, Waka Kotahi NZ Transport Agency, and there are no subsidiary vehicle regulators. New Zealand also has only one level of road access with some minor exclusions. Thus, all PBS vehicles are required to meet the same manoeuvrability standards. Having said that, the local road controlling authorities are able to restrict access to their network based on weight and thus Waka Kotahi has had to develop vehicle configuration options that are acceptable to them.

In Australia, the NHVR approves the PBS vehicle combinations, but access is provided by road authorities and road managers. NHVR could approve a combination, but it might not get access as they must obtain a consent from a road manager before an operational permit can be issued.

They must also cope with various levels of access for different levels of PBS vehicle. Although there was an attempt to fast-track this process by aligning the PBS levels with the performance characteristics of the vehicles using the current infrastructure levels, this was not entirely successful and a process of establishing route access for the different PBS levels had to be undertaken for each state.

The New Zealand approach of using pro-forma designs is much lower cost than the Australian approach of requiring each design to be assessed and this is reflected in the uptake of PBS in New Zealand which is proportionately much higher. The downside of using pro-forma designs is that it does not allow the maximum possible productivity gains to be extracted from the designs.

The Australian approach is more rigorous and does provide the vehicle designer with more opportunity to maximise productivity gains, but the process is more costly, and the uptake has been slower. The other factor that is likely to be influencing uptake is that non-PBS vehicles, particularly at level 3 and 4 are highly productive and so the potential productivity gains from using PBS vehicles are less. This is unfortunate because the NHVR have shown that the safety benefits of PBS vehicles are substantial. A study published in 2020 showed 46% fewer crashes (NHVR and ARTSA 2020) for PBS vehicles while a more recent study (CILT and NTARC 2021) has shown 60% fewer crashes.

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