BIC Two Axle Bus Operating Mass Calculations

to Access 18 Tonne Two Axle Allowances

Bus Industry Confederation

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Contents

Background

Prior to 1 July 2018 three of the States that are signatories to the *Heavy Vehicle National Law* being, NSW, Vic and Qld, allowed two axle buses to operate up to 18t via the *Multi-State Class 3 Bus Mass Exemption Notice 2014*, under Part 2 – 18 Tonne Exemption for Two axle buses. WA and NT, who are not signatories to the HVNL, also allowed two axle buses to operate to a maximum of 18t.

These notices provided exemption to specific clauses under the *Heavy Vehicle National Law* in the case of NSW, Vic and Qld, or exemption to State heavy vehicle laws in the case of WA and NT.

1. National Regulation Amended to Reflect Notices

From 1 July 2018, the *Heavy Vehicle (Mass, Dimension and Loading) National Regulation* will incorporate an amendment such that the Gross Vehicle Mass (GVM) of certain types of 2 axle buses (Eligible 2-axle buses[1]) will be increased from 16t to 18t. These eligible 2-axle buses operating in HVNL applicable jurisdictions will have access to all roads unless signposted. In Victoria, 2 axle buses will continue to be able to operate at 18t GVM under a notice.

The amendments to the national regulation will not affect WA and NT.

2. Simply What Does This Mean?

Although the HVNL is being updated, in NSW is no actual change in the requirements regarding which buses are eligible, the applicable routes or mass limits. In Qld the requirements regarding which buses are eligible are the same as are the mass limits, but with the new legislation the two axle 18 tonne limit applies across the entire network. In Vic nothing changes for the existing fleet, but from 1 July, new buses in Vic will need to have added safety features, ABS and EBS or ESC, to be eligible for the 18t. In the ACT, SA and Tas buses can now operate to the 18t limit.

In WA and NT, who are not signatories to the HVNL, there is no change.

[1] For more information about Eligible 2-axle buses refer to “Mass Limits for Eligible 2-axle Buses under the Heavy Vehicle National Law”.

3. Passenger Capacity

The increase in regulation mass limit to 18t has never been intended to increase the number of passengers in buses. The revised mass limit has been provided to operators to acknowledge the increase in the average mass of passengers as well as an increase in tare weight as a result of Government regulation or procurement requirements.

Tare has been increased by the Euro IV and V emission standards, requirements for air conditioning, accessible transport standards and other additional equipment required in specific States such as TS146 and soon to be TS155 for bus door safety, passenger information displays for the Transit Ways in NSW and fitment of fire suppression systems for example.

It should be noted that further increases to tare weight will result from the introduction of Euro VI emission standards and the mandating of seat belts in school buses in NSW. These increases in tare weight have been factored into the proposed passenger calculation to provide manufacturers flexibility to absorb these increases and have a little room for any future innovation or procurement requirements that will impact tare weight and keep eligible buses within the 18t operating GVM.

4. Non-Eligible Buses and Buses with 16 t GVM

For 2-axle buses that are not eligible 2-axle buses or have a chassis that is not rated to operate at the increased mass limit of 18t, passenger capacity will still be calculated using 65 kg per person for the two-axle bus mass limit of 16,000 kg. Suppliers can continue to use this calculation to support their passenger capacities.

5. Passenger Capacity Calculations for Eligible Buses

For buses that will operate at the limit of 18t GVM, BIC proposes that the passenger calculation be based on 80 kg to account for the actual average weight of passengers today and the increase in bus tare weight over time.

This position, which is supported by the NHVR, means that the 80 kg and 18t combination, when inputted into the existing calculations used to determine passenger capacity will ensure such figures are more realistic. As such suppliers now have two options when calculating passenger capacity when accessing the 18t regulation, which are:

a) Calculate passenger capacity at 65 kg and 16 t or,

b) Use the same calculation process, but at 80 kg and 18 t gross with the associated higher axle limits of 7 tonne front and 12 tonne rear.

It should be noted that regardless of the above, the regulations are such that it is the operator's responsibility not to exceed the respective in-service mass limits, and operators have to rely on the suppliers loading calculations. Therefore, it is strongly recommended that suppliers base their calculated capacities on the processes detailed in the following and that operators request copies of these calculations when purchasing new buses.

Note: In 3 for 2, or 5 across, seating configurations, only the adult seating positions are to be considered when determining passenger capacity, unless the operator is exclusively carrying children then a lower per passenger mass would be appropriate.

6. Comparison of Two Calculation Methods

The following table shows simplified calculations for passenger capacity for various two axle bus types using real tare figures and the options of 65 kg and 16 t compared to 80 kg and 18 t. The figures are simplified as they assume that for each combination, the mass is ideally distributed in that the respective front and rear axle limits are not exceeded, hence the full 16, or 18 t gross can be used. This is normally not the case as with most bus layouts, one of the axle limits will be reached prior to the full gross limit being reached.

The table below shows that the passenger capacities from the two methods are similar albeit that the 80 kg-based calculations includes an increase of 350 kg for Euro 6 and also potential for small tare increases to address the provision of other safety and or DDA compliance equipment.

Table 1 - Two Axle Bus Mass Analysis

Two Axle Buses	***Current ADR Processes***			***Proposed Gazette Change to 80 kg per person***		
	Based on Typical Current Tare Masses in kg			***Based on Typical Tare Mass Euro 6 (see note 1 and 2)***		
	Two Axle Low Floor Bus	High Floor No Seatbelts	High Floor with Luggage	Two Axle Low Floor Bus	High Floor No Seatbelts	High Floor with Seatbelts and Luggage
Typical Tare Mass Euro 5	11,300	11,400	11,500	11,650	11,750	12,350
Gross Limits	16,000	16,000	16,000	18,000	18,000	18,000
Effective Carrying Capacity	4,700	4,600	4,500	6,350	6,250	5,650
Passenger Mass	65	65	65	80	80	80
Luggage Allowance per Passenger Mass	0	0	15	0	0	15
Theoretical Gross Number of Passengers, (see note 3).	72	71	56	79	78	59
Potential Change in Number of Passengers based on similar mass distributions. (note 4)				7	7	3
Potential Change in Tare of the bus based on similar mass distributions.				601	625	274

Notes for Two Axle Buses
Note 1: Add 350 kg to the tare mass of each bus to account for Euro 6.
Note 2: Add 500 kg for seatbelts or if seat belts fitted, 500 kg for DDA wheelchair lift.
Note 3: To determine maximum increases, it is assumed that the passenger masses are able to be distributed throughout the bus such that the full gross limit of 18 tonne can be utilised with the available axle masses of 7 tonne front and 12 tonne rear. Plus, the per passenger standing area requirement of 6.25 persons per square metre has not been exceeded.
Note 4: In reality the bus is most likely to reach the rear axle limit before the full 18 tonne GVM is reached, so the real-world increases will be less than 7, the exact number needs to be determined based on the actual bus tare and axle splits and the full calculations has been undertaken.

7. Passenger Capacity Calculation Procedure

The following method is based on existing procedures from NSW and Qld and is intended to be used by suppliers to assist in ensuring that two axle bus designs can comply with the 18 tonne operating limits in NSW, Qld, Vic, WA and NT in terms of both gross and axle masses.

The following is provided in the same format as the old 703 forms, hence it is spread over several pages; it is recommended that suppliers convert these calculations and rules into a spreadsheet for ease of use.

8. Application of Procedure

APPLICATION

This form is divided into the following parts

A	-	UNLADEN (TARE) MASS
B	-	MASS OF SEATED PASSENGERS
C	-	MASS OF STANDING PASSENGERS
D	-	MASS OF LUGGAGE AND TOURING EQUIPMENT
E	-	SUMMARY OF MAXIMUM LADEN MASS
F	-	REGISTRATION OF DETAILS AND DECLARATIONS

NOTES ON PARTS B, C, D AND E:-

a) In these calculations, measurements shall be stated to the following orders of accuracy:

Mass to the nearest kilogram

Length to the nearest 5 mm

Volume to the nearest litre.

b) "Rear axle line" means the point from which rear overhang is measured.

8.1 Part B – Unladen Mass

For calculation purposes, the unladen mass or tare mass of the vehicle is its actual mass with all permanent equipment fitted, with all oil and water tanks filled and at least 10 litres of fuel but with no crew or passengers aboard. If the vehicle is to be used for camping tours, the mass of any camping equipment normally provided by the operator must be included in Part E Mass of Luggage.

The bus must be weighed at a registered public weighbridge to determine the actual loads on the front axle and rear axle (or axle groups).

ATTACH WEIGHBRIDGE TICKET HERE

VEHICLE MANUFACTURERS SPECIFICATIONS TO BE ATTACHED

Details to include make, model, year of manufacture,

front and rear axle manufacturers and specifications.

WRITE AXLE LOADS IN BOXES BELOW FROM WEIGHBRIDGE TICKET OR AS ESTIMATED

Front Axle Tare Mass (FAx) = ……………….………… kg

Rear Axle Tare Mass (RAx) = …………………………… kg

Aggregate Weight = …………………………………… kg

For the purposes of determining laden mass of the vehicle, the mass of two thirds of the fuel tank capacity is included.

Capacity of fuel tank	(Ff) = ………………..l
Volume of fuel when weighed	(Fw) = ………………l
Wheelbase of vehicle	(Wb) = …………..…m
Distance from rear axle line to centre of fuel tank	(Df) = ………………m

Density of fuel: Diesel = 0.85kg/l

Additional front axle load due to fuel is given by:

FFu = ((.66 Ff – Fw) x 0.85 x Df) ÷ Wb

= ((.66 x ….. - …..) x ….. x …..) ÷ …..

FFu = …………… kg

Additional rear axle load due to fuel is given by:

Rfu = (.66 Ff – Fw) x 0.85 - FFu

= (.66 x ….. - …..) x ….. - …..

Rfu = …………… kg

ADD THE TARE MASS TO THE FUEL MASS

TO OBTAIN TOTAL UNLADEN MASS

Front Axle Tare Mass plus Added Fuel Load Front Axle		Rear Axle Tare Mass plus Added Fuel Load Rear Axle
FAx + FFu		RAx + RFu
FRONT ………………kg FUn	UNLADEN MASS	DRIVE ………………kg RUn

8.2 Part C – Mass of Seated Passengers

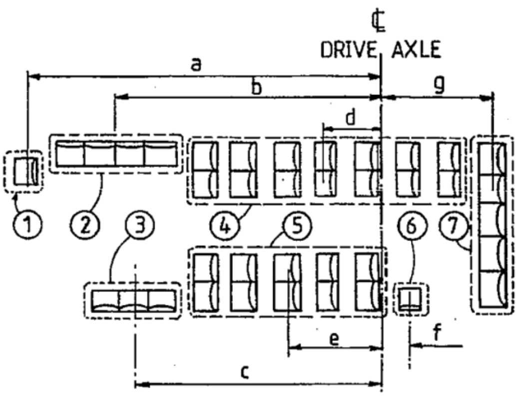
Draw a plan of the seating arrangements in the space below, including the driver's seat. Mark in the position of the rear axle line.

Number each seat, row or group of seats (include the driver's seat as number one). Enter at the top of the table overleaf, the wheelbase of the vehicle, and then the number of seating positions for each seat, row or group.

Enter the longitudinal distance measured from one rear axle line to the seating reference point for each seat (i.e. On the centre of the seating position and 150mm towards the front of the seat from the intersection of the seat cushions and seat back).

Note: that only one entry is required for each transverse row of seats if they are the same distance from the rear axle line. If a group of transverse seats are evenly distributed along the bus, only one entry is required, the longitudinal measurement being the average of the distance to the foremost seating reference point and to the rearmost seating reference point of the group. Similarly, longitudinal seats need only one entry, the longitudinal measurement being to the centre of the seat. See following example of seat grouping.

Example:



Determine the seated loading factor separately for those seats in front of and those behind the rear axle line, by multiplying the number of seating positions by the longitudinal distance from the rear axle line and adding to get a sub-total.

Subtract the sub-total for the rear seats from that for the front seats.

If any seating reference point is above the rear axle line, that seat should be considered in front of the rear axle line, but the distance and load factor will be zero.

AXLE LOADS DUE TO SEATED PASSENGERS Vehicle wheelbase: ……………..metres			
(i) Seating Position	(ii) Number of Occupants	(iii) Distance from Rear Axle (m)	(iv) Load Factor (ii) x (iii)
Seating Reference Point in front of rear axle line			
1. Driver	1		
Sub-Total			A=
Seating Reference Point behind rear axle line			
Sub-Total			B=
Total Occupants		Seated Loading Factor, (SLF) = A – B =	

The front axle load due to seated passengers is based on an average passenger mass of 80kg and is calculated below:

Front Axle Load (Seating) = Seated Loading Factor x 80kg / Wheelbase

= …… x 80 / …………

FSe = ……………………………….kg

The rear axle load due to seated passengers is the total person mass minus the front axle load.

Rear Axle Load (Seating) = (Total Occupants x 80kg) - FSe

= (……… x 80 - ……….)

RSe = ……………………………….kg

WRITE FRONT AND REAR AXLE LOADS DUE TO SEATED PASSENGERS HERE

FRONT	SEATED	REAR
……………..kg		……………..kg
FSe	MASS	RSe

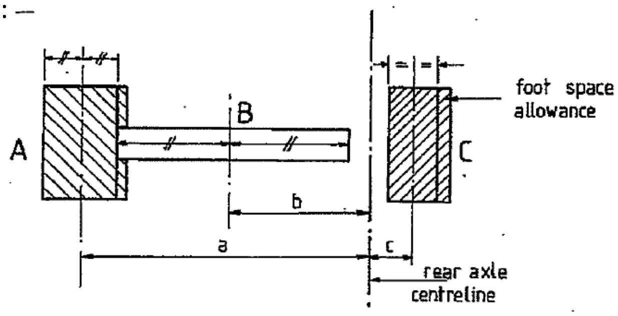
8.3 Part D – Mass of Standing Passengers

This section is to be completed only if application is being made for assignment of a standing capacity.

Draw a plan of the standing spaces in the rear section in the spaces below, excluding 200mm allowance in front of each seat for foot space for seated passengers. Mark each space that is to be used by standing passengers in rectangular portions. Mark in the position of the rear axle line.

Measure the length and width and calculate the area of each rectangular standing space. The table on the next page can be used for calculations. Measure the distance from the rear axle line to the centre of each standing space.

For example: –



Calculate the maximum standing capacity by summing the total standing area and multiplying by 6.25 persons/m^2. Take the nearest whole number less than this value for maximum standing capacity. The nominated capacity must not be more than this.

Calculate the effective passenger density by dividing nominated capacity by total standing area.

(i) Standing Space	(ii) Length, l (m)	(iii) Width, w (m)	(iv) Area (m^2) (ii)x(iii)	(v) (iv)xED	(vi) Distance from Rear Axle (negative if behind rear axle)	(vii) Standing Loading Factor (v)x(vi)

		Total Area		m^3		

(sum column vii)

Total Standing Area (TSA) = ... m^2

Maximum Standing Capacity = TSA x6.25 = ... persons

Nominated Standing Capacity (NSC) =

.... persons

Effective Density (ED) = NSC/TSA = ……. / ……

ED = ... persons/ m^2

Standing Loading Factor = ...

The axle loads due to standing passengers are based on an average passenger mass of 65kg and are calculated below:

Front Axle Load (standing) FST = Standing Loading Factor x 80kg / Wheelbase

= …… x 80 / …………

FSt = ………………………………kg

Rear Axle Load (standing) RST = (Nominated Standing capacity x 80) - FSt

= (……… x 80 - ……….)

RSt = ………………………………kg

WRITE FRONT AND REAR AXLE LOADS DUE TO STANDING PASSENGERS HERE

FRONT	STANDING	REAR
……………..kg		……………..kg
FSt	MASS	RSt

8.4 Part E – Mass of Luggage and Touring Equipment

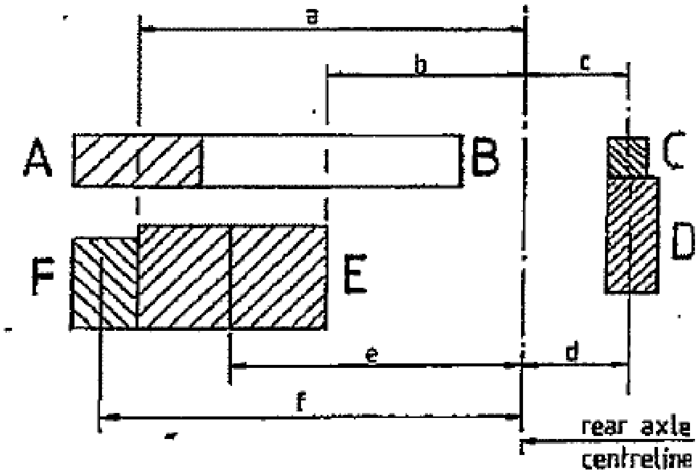
This section is to be completed only if the vehicle is equipped with specific areas for the loading of passengers' luggage and in any special touring equipment.

Draw a plan of spaces on the bus that are set aside for the carriage of luggage (disregard compartments that are intended only for lightweight personal effects such as hat racks). Mark in the position of the rear axle line.

Measure the average length, width and height of each luggage compartment. In the cases where the compartment is a non-rectangular shape, it may be easier to divide the compartment into smaller box-like sections. The table on the next page can be used for calculations.

Measure the distance from the rear axle line to the centre of volume of each luggage compartment or section. Where the section has a consistent height, the centre will be the centre of the floor area.

For example:



Calculate the effective luggage density by summing the total passenger luggage mass (i.e. number of occupants including the driver times 15kg/person) and the mass of any touring equipment provided by the operator.

Calculate the mass of luggage in each luggage space by multiplying the volume of each space by the effective luggage density, ED. (see NOTE ON EFFECTIVE DENSITY, ED.) This is then multiplied by the distance from the rear axle line to the centre of each luggage space. These values are then added together to determine the Principal Luggage Factor. Note if the entre of any luggage space is behind the rear axle line, the loading factor is subtracted rather than added.

(i) Luggage Space	(ii) Length (m)	(iii) Width (m)	(iv) Height (m)	(v) Luggage Volume (m^3) (ii)x(iii)x(iv)	(vi) (v)xED Or (v)x100 SEE NOTE	(vi) Distance from Rear Axle (negative if behind rear axle)	(vii) Luggage Loading Factor (vi)x(vii)

Total Luggage Volume (TLV) ____ m^3 PLF = ____

(sum column viii)

Total Luggage Mass = No. of occupants including driver x 15kg/person plus mass of equipment

= (………………… x 15) + ………………

TLM = ……………………… kg

Effective Density = Total Luggage Mass (TLM) / Total Luggage Volume

= ………………… / …………………

ED = ………………………… kg/m^3 **SEE NOTE**

Principal Luggage Factor (PLF) = …………………………………… kg/m^2

NOTE ON EFFECTIVE DENSITY, ED

An allowance has been made in the determination of Effective Density to provide for inevitable inefficiencies in packing passenger luggage into the luggage space. A maximum value of 100kg/m^3 has been established allowing for packing irregularities, structural interference in the luggage space and inaccessibility to the full luggage space.

If the calculated Effective Density is less than or equal to 100kg/m^3, the calculated figure must be used in column 6. If the calculated Effective Density is greater than 100kg/m^3, two options are available:

(i) All luggage will be considered as stored in the luggage space and the calculated figure for Effective Density must be used; or

(ii) Some of the luggage will be considered as distributed amongst the seated passengers, in which case the figure of 100kg/m^3 must be used for Effective Density in column 6. Distribution of the Residual Luggage is calculated over the page.

Note: Complete this section only if the calculated Effective Density is greater than 100kg/m^3, some of the luggage is to be considered as distributed amongst the seated passengers, and you have used 100kg/m^3 in the previous table instead of the calculated Effective Density.

Residual Luggage Mass	=	Total Luggage Mass – (Total Luggage Volume x100kg/m^3)
	=	TLM – (TLV x 100)
	=	……… - (…….. x 100)
RLM	=	………kg
Residual Luggage Factor	=	Residual Luggage Mass / number of occupants including driver

	=	……… / ………
RLF	=	……….

The axle loads due to passenger luggage and equipment are calculated below:

Front Axle Load (Luggage)

= Front Axle Residual Luggage + Front Axle Principal Luggage

= (Seated Loading Factor (page 11) x Residual Luggage Factor)

+ Principal Luggage Factor / Wheelbase

= (SLF x RLF) + PLF

Wb

= (…… x ……..) + ………

…………

FLu = ………………………………kg

Rear Axle Load (Luggage)

= Total Luggage Mass – Front Axle Load (Luggage)

= TLM – Flu

= ………. - ………..

RLu = ………………………………kg

WRITE FRONT AND REAR AXLE LOADS DUE TO LUGGAGE HERE

FRONT	LUGGAGE	REAR
………………kg		………………kg
FLu	MASS	RLu

8.5 Part F – Maximum Laden Mass

If this vehicle is to be used as a Motor Omnibus (ROUTE SERVICE) complete the following where applicable: (in most cases luggage mass will not be applicable)

	FRONT AXLE GROUP	REAR AXLE GROUP	TOTAL
UNLADEN MASS (Page11)	FUn ………….	RUn ……….	……….
SEATED MASS (Page 12)	FSe ………..	RSe ………..	……….
STANDING MASS (Page 15)	FSt…………..	RSt ………..	……….
LUGGAGE MASS (Page 19)	FLu ………..	FLu ………..	……….
(A) GROSS LADEN MASS (kg)	……….	………	……….
(B) CHASSIS MANUFACTURER'S LOAD LIMITS	……….	……….	………. (GVM)
TYRE DESIGNATION	……x……	……x……	
PLY TYPE/RATING	Radial/……Bias	Radial/…Bias	
NO. OF AXLES/NO. OF TYRES	……/……	……/……	
(C) RECOMMENDED TYRE LOAD LIMITS		……….	……….
(D) IN-SERVICE AXLE MASS LIMITS		……….	……….

Is the GROSS LADEN MASS (A) less than or equal to the above limits (B, C, D)?

If YES, this vehicle is suitable for registration for ROUTE SERVICE:

Seated capacity ……….. Standing capacity ………… Luggage YES/NO

If this vehicle is to be used as a Service Omnibus / Special Purpose Omnibus complete the following where applicable: (in most cases standing mass will not be applicable)

	FRONT AXLE GROUP	REAR AXLE GROUP	TOTAL
UNLADEN MASS (Page 11)	FUn …………..	RUn ………..	………..
SEATED MASS (Page 12)	FSe ………..	FSe ………..	………..
STANDING MASS (Page 15)	FSt……………	RSt ………..	………..
LUGGAGE MASS (Page 19)	FLu ………..	FLu ………..	………..
(E) GROSS LADEN MASS (kg)	………..	………..	………..
(F) CHASSIS MANUFACTURER'S LOAD LIMITS	………..	………..	……….. (GVM)
TYRE DESIGNATION	……x……	……x……	
PLY TYPE/RATING	Radial/……Bias	Radial/…Bias	
NO. OF AXLES/NO. OF TYRES	……/……	……/……	
(G) RECOMMENDED TYRE LOAD LIMITS		………..	………..
(H) IN-SERVICE AXLE MASS LIMITS		………..	………..

Is the GROSS LADEN MASS (E) less than or equal to the above limits (F, G, H)?

If YES, this vehicle is suitable for registration for NON-ROUTE SERVICE:

Seated capacity ……….. Standing capacity ………… Luggage YES/NO

9. Part G – Vehicle Details and Declarations

Vehicle Owner's Details					
Name					
Company / Business					
Address					
Vehicle Information					
Make		**Model**		**Date of Manufacture**	
VIN					
Chassis No *(If applicable)*		**Engine Number**			
Engine Capacity		**Number of Cylinders**		**Fuel Type**	
Body Type		**Body Colour**			
Overall Body Length		**Front Overhang**		**Rear Overhang**	
Axle Specifications					
Front Axle Make		**Capacity**			
Drive Axle Make		**Capacity**			
Rear Axle Make		**Capacity**			
Tag/Tandem Axle Make *(if applicable)*		**Capacity**			
Only for previously registered vehicles					
Registration		**State/Territory**			
Name and Address of Most Recent Owner					

The vehicle described in this form has been assessed for axle load compliance with the following passenger capacities					
Motor Omnibus (Route Service)					
Seated		**Standing**		**Luggage**	**Yes / No**
Service/Special Purpose Omnibus (Non-Route Service)					
Seated		**Standing**		**Luggage**	**Yes / No**
Officer who examined and approved vehicle					
Name					
Company / Business					
Signature		**Date**			