ATTACHMENT 4

BUS INDUSTRY REPORT ON THE LOSS OF VEHICLE CAPACITY BECAUSE OF CHANGES TO LEGISLATION AND CHANGING NEEDS

BCA's IPART SUBMISSION 2003

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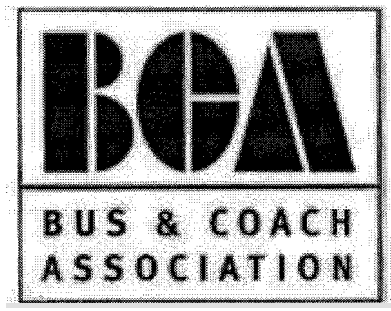

BCA

Bus and Coach Industrial Association (NSW)

Productivity Losses

Operating And Purchase Of New, Fully Complying DDA And Euro 3 Buses

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Prepared by:

Fritz Wehrmann

F. & A. Wehrmann Consulting Pty. Ltd.

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Introduction

The purpose of this paper is to put forward a case for an increase to mass limits for low floor buses operating in NSW.

The productivity, in particular passenger capacity, has been reduced as a consequence of:

a) the need to comply with DDA requirements in making provision for wheelchair passenger combinations;

b) the requirement for all new buses manufactured after 31 December 2002 complying with ADR 80/00 (Euro 3 emissions limits); and

c) improvements relating to passenger safety and comfort.

Compliance with these requirements increases the tare weight of vehicles with a resultant loss of passenger capacity.

Executive Summary

As a result of unavoidable specification changes to route and school buses in order to meet Euro 3 and DDA regulations, (apart from a purchasing cost penalty), the bus operators now face a productivity loss of up to 20% due to the reduction in Licensed Adult Seating Capacity (LASC) in these vehicles.

To compensate for losses due to these weight increases and to restore the former productivity level, operators need to make better use of the actual internal bus space available and the carrying capacity of buses in their fleet.

This need extends also for new buses to be purchased to maintain an acceptable (contracted) average bus fleet age, as well as providing safer and more attractive and comfortable passenger transportation.

An efficient, safe environmentally friendly and technically acceptable solution is an increase from the current 16,000 kg mass limit to 17,500 kg mass limit for all low floor vehicles operated in NSW.

Buses currently in operation in NSW are almost exclusively of European origin or to a lesser extent from Japan. Most of these buses have a manufacturers' axle carrying and mass limit rating in excess of the 17,500 kg.

The efficient operation of 2-axle rigid buses, to their design capacity within a permissible mass limit of 17,500 kg, will result in significant reductions of exhaust emissions, in particular the amount of Greenhouse Gases. If buses can operate to their full design capacity, up to a mass limit of 17,500 kg, fewer buses need to be on the road at any given time.

Furthermore, by introducing buses that can provide a higher safety standard and comfort level, additional patronage will be attracted to use public transport, which will result in fewer cars on the road, reduced traffic congestion and a further reduction in exhaust emissions.

1. Bus Weight Increase

1.1 Current Mass Limit – 16 Tonnes

The benchmark bus, at the time the current permissible axle loads and mass limits were introduced, was a conventional straight rail, high floor, Euro 1 complying unit.

NSW bus operators, with the support of the bus manufacturers, voluntarily introduced the environmentally cleaner Euro 2 complying engines and low floor options.

Whilst this did have a limited effect on the weight (increase) of those buses, the low floor or low entry concept resulted in unavoidable load transfers and a change in both the un-laden and laden conditions.

The introduction of Euro 3 complying engines (and buses) has resulted in an unavoidable increase in weight.

Further weight increases have resulted from:

- Meeting the needs of disabled passengers
- Air conditioning
- Operational safety and improved passenger comfort
- Alternative fuels.

1.2 Euro 3 Compliant

To meet the current exhaust emission regulation (ADR 80/00) especially the NO_x limit of 5g/kWh, the injection timing had to be adjusted accordingly. This has resulted in a substantially higher combustion temperature. Further, an increase in energy consumption (fuel) has resulted. The Euro 3 complying engines also emit higher combustion noises and to address these negative effects the available solutions resulted in the following:

1.2.1 Cooling

The cooling capacity needed to be increased by as much as 35 – 40%, and could only be achieved with radiators having a larger cooling area.

The combination of the larger radiators and inter-cooler increased cooling water volume resulting in a weight increase of up to 60kg. Some manufacturers selected exhaust gas re-circulation and exhaust gas cooling.

Whilst this reduces the otherwise unavoidable fuel consumption increase, the solution adds further weight to the engine and overall cooling system.

1.2.2 Energy consumption

The increase of fuel consumption of Euro 3 complying engines varies from 5.0 – 22.5% at a NO_x level of 4g/kWh (max. permissible is 5g/kWh).

The difference in increase is controlled by the method applied by the various engine manufacturers (e.g. exhaust gas re-circulation). To maintain the operating range with Euro 3 complying engines, the onboard fuel capacity may need to be increased by up to 68 ltr (nominal 300 ltr. plus 22.5%).

1.2.3 Combustion and Engine Noise

To maintain the current permissible external noise level, as well as the internal level for passenger comfort, additional noise absorption material had to be fitted. Exhaust mufflers to address the internal combustion noise at the exhaust outlet became larger and heavier (5-10kg).

The above measures resulted in a weight increase of up to **138kg.**

Equivalent Passengers = 2

2. Disabled Passengers and Increasing Accessibility

2.1 Route Bus

A disability friendly route bus requires a low floor or low entry chassis with wheelchair provisions. Whilst this combination does not necessarily result in a sizeable weight increase, it does have a significant effect on the axle load distribution.

The necessary repositioning of batteries, air-tanks and especially the fuel tanks into a position behind the rear axle which has resulted in rear axle load increases of up to 800 kg.

2.2 Wheelchair Spaces

Provision has to be made for 2 wheelchairs and occupants with a combined weight of 300 kg each. If the provided space is taken up by 2 wheelchair dependant passengers as opposed to seated passengers, (3 per side in this space). the weight increase can be up to **210 kg**,

Equivalent Passengers = 3

3. Air-conditioning

3.1 Features

Air conditioning has now become a standard feature on almost all buses engaged in the public transport operations.

Whilst this is not mandatory, air conditioning adds substantially to the comfort of passengers and is essential in order to attract more people to use public transport in favor of private cars. For State Government Buses, air conditioning has become the standard specification, to improve the comfort and expectation of passengers and health and safety of drivers.

3.2 Air conditioning Equipment Weight

The air conditioning system has 3 main weight groups:

- Roof mounted equipment and body structure up to 265 kg
- Compressor, mountings, belts and pulley up to 90 kg
- Electrical equipment, pipes, water pumps And valves up to 65 kg

The total extra weight is up to **420 kg**

Equivalent Passengers = 7

4. Safety and Passenger Comfort

4.1 Operational Safety and Passenger Comfort

To improve the operational safety for the driver, as well as the level of comfort of the passengers, the standard route bus configuration now includes automatic transmission and integrated retarder.

4.2 Weight Penalty

A manual transmission has a weight of approx. 170 kg.

The automatic transmission with integrated retarder and extra cooling water (volume) has a weight of up to 320 kg.

The bus weight increase is 170 kg

Equivalent Passengers = 2

5. Alternative Fuel

5.1 CNG

CNG fuelled buses have become an alternative to Diesel. The NSW State Government (STA already has a substantial fleet of CNG powered buses). Whilst private operators have not yet introduced CNG powered buses, this may change in the not so distant future. Another alternative, possibly more attractive, is the use of LPG.

The Federal Governments incentive to use alternative fuels cannot be ignored and is supported by the bus industry in the effort to reduce Greenhouse emissions. However, the necessary equipment required to facilitate the use of these alternative fuels adds to the tare weight of the vehicle.

The productivity loss due to a substantial weight increase needs to be compensated, especially as there is also a substantial purchasing cost penalty.

In order to maintain an efficient operating range of 400 – 450 km or an 18 hour shift without re-fuelling, the bus needs to carry approx. 1000 – 1100 ltr compressed natural gas. The required storage system has a weight of up to 1,150 kg.

The extra weight is up to 850 kg

Equivalent Passengers = 13

5.2 LPG

A bus operating on LPG uses 1.8 times the amount of fuel (volume) compared to Diesel. This requires a roof mounted tank unit with capacity of at least 540 ltr. of LPG.

The weight increase is up to 300 kg.

Equivalent Passengers = 4- 5

6. Bus Specification

6.1 Current Specifications

Most buses currently purchased or already in service as route or school bus operation are of European origin. A small number are sourced from Asia (Japan). These buses are now almost exclusively equipped with road friendly air suspensions.

Typical specifications are:

Engine (Diesel or CNG)	7 – 12 ltr. volumetric capacity
Power	150 – 205 kW
Torque	800 – 1100 nM
Transmission	4-5 speed automatic
Suspension	full air – front and rear
Brakes	full air, ABS optional
Axles	front = 6500 – 8200 kg capacity rear =11,000 – 13,000 kg capacity
Tyres	295/80R 22.5 or 275/70 R 22.5
Overall Length	12.5 meters
Un-laden Weight	11-11,300 kg

6.2 Europe

Buses with the above specification in Europe have a mass limit rating of 17,600 – 18,000 kg. With low profile tyres (275/70R 22.5) the max. permissible axle loads are:

Front – 6,600 kg Rear – 11,500 kg

6.3 Australia

In Australia, with a maximum permissible tyre pressure of up to 825 kpa, the manufacturers axle ratings could be:

Front - 6620 kg Rear - 11750 kg with 275/70 R22.5 tyres

Front – 6930 kg Rear – 12300 kg with 295/80 R 22.5 tyres

The actual permissible loads may depend on the brand of tyres fitted and the chassis manufacturers specifications.

In Europe, the carrying capacity of a 2 door route bus is up to 101 passengers (37 seated + 64 standees). In this configuration there is provision for 1 wheelchair only.

A typical route bus in NSW, prior to Euro 3 and DDA regulation, had mass limit load controlled capacity of up to 83 passengers (55 seated + 28 standees). A similar low floor bus, Euro 3 and DDA complying has the load capacity reduced to 65 passengers (47 – 49 seated + 18 standees).

By utilising the internal space available, this same type of bus could carry comfortably up to 87 passengers. In a 2 door version, with wheelchair entry through the front door, the seated passenger capacity will be reduced to 44 (no wheelchairs on board) or 38 seated passengers when both wheelchair parking areas are utilised.

In a diesel version, the total weight would increase to approx. 16,800kg with a front axle load of 5800 kg and a rear axle load of 11,000 kg.

The same bus in CNG, could weigh up to 17,700 kg and axle loads of 6,400 kg front and 11,300 rear.

A LPG fuelled bus would be proportionally lighter having an all up weight of up to 17,250 kg.

7. Alternative Options

7.1 2-Axle Rigid Buses

To compensate for the productivity loss of up to 20% and operating the buses within the current 16,000 kg mass limit, additional buses are required to provide the necessary passenger capacity. A 20% decrease in passenger load capacity means 16 passengers per bus, or 5 Euro 3 and DDA complying buses in place of previously required 4 buses. In other words, 1 extra bus for every 4 buses currently in a fleet.

The purchasing cost penalties and operating cost difference are obvious and the
additional energy consumption will increase exhaust emissions accordingly.

7.2 3-Axle Rigid Buses

With a 3 axle route or school bus, 12.5 meter in length and equivalent passenger capacity in place of a 2-axle rigid unit, the pre-Euro 3 load and passenger carrying capacity could be maintained.

However, there is a substantial purchasing cost penalty as well as higher maintenance and operating costs and a significant weight penalty.

- The tyre maintenance alone can increase by up to 50%
- Extra weight
- Unavoidable increased fuel consumption
- Exhaust emissions.

Based on current specifications, a 3-axle rigid bus is at all times approx. 1,500 kg heavier than an equal sized 2- axle unit.

- The minimum fuel consumption increase will be approx. 3.75 ltr/100km.

7.3 Articulated Buses

Articulated buses would have a capacity equal or better than a fully utilised 12.5 meter 2 axle rigid unit at 17,500 kg mass limit.

Unrestricted operation of an 18.0 meter long bus may however not be possible, especially in built up areas.

The extra road space required may not suit all current bus route infrastructure, which include bus stops, sharp corners, roundabouts and calming devices.

An articulated bus is at all times at least 2000 kg heavier and the fuel consumption in comparison with a 2-axle bus will increase by approx. 5.0 ltr./100 km.

8. Economic Arguments

8.1 Purchasing Cost

A fully compliant Euro 3 and DDA 2-axle route bus with automatic transmission and air conditioning currently cost approx. $340,000.

The equivalent 3-axle ridged bus would cost approx. $380,000 each.

An 18.0 meter articulated bus would cost approx. $ 500,000 each.

8.2 Operating costs

In addition to the purchasing cost penalty, the operating and maintenance cost of a 3-axle rigid bus would increase due to the extra axle, tyres, brakes and higher fuel consumption. Based on 2.5 ltr of diesel fuel usage for every 1000 kg bus weight per 100 km, the annual fuel usage increase can be up to 3000 ltr per 3- axle bus compared with a 16/17,500 kg mass limit 2 axle unit.

Articulated buses are best suited and operate economically on specific routes with a high passenger demand.

Operations outside of these specific routes result into substantial higher operating costs.

The extra weight, laden or empty results into an annual fuel consumption increase of approx. 4000 ltr.

Operating this alternative configuration of 2 axle units, or the concept of 1 extra bus for every 4 in a current fleet of a 2 axle buses with an increased permissible mass of 17,500 kg to maintain the equivalent capacity will result in significant efficiency losses.

9. Operational Impact

9.1 Road surface damage

Whilst it can be argued that buses with a higher mass limit and higher individual axle loads could cause higher road surface damage, the actual effect would be less than caused with any of the alternative solutions.

The tyre rubbing effect of a 3-axle bus causes more road surface damage then a 2-axle bus with slightly higher axle loads.

Based on a survey conducted by 2 independent consulting engineers on behalf of a local council, the highest road surface damage occurred as a result of traffic calming devices and round -a-bouts.

A 3-axle bus would therefore cause additional surface damage, as would an increase in the number of 2-axle buses, an increase in the number to meet current passenger capacity.

9.2 Road friendly Suspension

All new Euro 3 and DDA compliant buses have road friendly air suspensions and tubeless tyres. Actual tests carried out in Europe have clearly demonstrated that axles with air suspension (road friendly) can carry up to 1,000 kg higher loads and cause no more road structure or road surface damage than axles with conventional suspensions. A similar result emerged comparing tubeless tyres with a conventional tube type.

9.3 Bus Loadings

Tests carried out by STA and a large regional private bus operator clearly demonstrated that route buses do not regularly operate at their full capacity.

On the most heavily patronised route, a STA bus registered a full load at only 4.5% of the total length of this particular run. A full load comprised of 60-65 passengers in total at any given time. At over 50% of the route operation the loading was below 32 passengers, or 50% of maximum capacity.

The regional operator registered a full load only on the last 3 km of the morning school run and again on the first 3 km on the afternoon run. This represents 6.4% of the one way run of 47 km in length.

A full load, within the permissible 16000kg mass limit, consists of 49 seated passengers and up to 18 standees.

On the remaining run the loading varied between 6 – 28 passengers, this equals between 6.2 and 43 % of the available capacity, or a mass limit of between 11590 and 13150 kg.

10. Environmental Impact

10.1 Exhaust Emissions:

Whilst exhaust emissions of modern engines in general are very low, the amount of particle emission and Greenhouse Gas (CO_2) in particular is directly linked to the amount of fuel being used. The following example clearly demonstrates the environmental impact difference between an operation of 5 buses at 16,000 kg mass limit compared to 4 buses at 17,500 kg mass limit.

A 16,000 kg mass limit bus, if fully laden, will use on average 40 ltr of diesel fuel per 100 km. Based on 80,000 km annually a consumption of 32,000 ltr. per bus.
5 buses therefore 160,000 ltr.

A 17,500 kg mass limit bus, if fully laden, will use on an average 43.75 ltr. of diesel fuel per 100 km. Based again on 80,000 km annually, a consumption of 35,000 ltr. per bus
5 buses therefore 140,000 ltr.

Operating 5 buses at 16,000 mass limit in comparison to 4 buses at 17,500 kg will result into a Greenhouse Gas Emission Increase of 52,000kg per year for every 5 buses in any fleet.

The increase of particle emissions and other gases would be proportional.

11. Conclusion

The productivity losses resulting from operating Euro 3 emission and DDA compliant buses within the current permissible mass limits are clearly evident.

The unavoidable bus weight increase is caused by technical measures necessary to meet current regulations and specifications.

To further improve the operational safety and address expected passenger comfort levels, additional weight is unavoidable. Air conditioning and automatic transmissions have the greatest impact.

Alternative configurations, such as the 3 axle bus, or an increase in fleet size by 20% (5 buses in place of 4) cannot be justified, for economical reasons alone.

Operating articulated buses on routes where a full load can only be achieved for a relative short distance is also totally uneconomical. In addition, the environmental impact, as a result of any of the alternative solutions, does not justify consideration of these concepts any further.

The effect, if any, slightly heavier loaded 2 axle buses could have on the road structure and road surface have to be seen as negligible.

The most effective, technically and environmentally responsible solution, is the increase from the current 16,000 kg mass limit up to 17,500 kg. Within a 17,500 kg mass limit rating the individual axle loads should be limited to:

Front axle = 6,600 kg and
rear axle = 11,500 kg.

This provides a necessary flexibility in cases of unfavorable passenger load distribution.

Operators must always comply with manufacturers or chassis suppliers' specifications, including tyres.