Procedure for Rating the Gross Combination Mass and Braked Towing Capacity of Light Duty Vehicles

Issued 16 February 2020

AUSTRALIAN AUTOMOTIVE
AFTERMARKET ASSOCIATION

Document reference number: AAAA-GCM-02

Document prepared by:

The Australian Automotive Aftermarket Association

Gross Combined Mass Technical Working Group

GCM Technical Working Group Members

ABMARC (Chair)
ARB Corporation Ltd
Bilstein Australia
Caravan Industry Association of Australia Ltd
Cruisemaster Australia
Custom Vehicle Services
Dobinson Springs and Suspension
Lovells Springs Pty Ltd
Motiv Engineering Pty Ltd
Pedders Suspension Pty Ltd
R.K. Findlay Pty Ltd
Sigmatech Engineering Consultants
Six Wheeler Conversions Pty Ltd
TJM Products Pty Ltd

DISCLAIMER

The Australian Automotive Aftermarket Association (AAAA) does not endorse this document. This document was developed by the above listed members of the GCM Technical Working Group in order to begin a constructive conversation with Government.

Contents

1. Rationale

This document provides an industry accepted procedure for the design and validation of aftermarket and second stage manufacturers' Gross Combination Mass (GCM) and Braked Towing Capacity (BTC) upgrade products. GCM and BTC ratings or re-ratings can be conducted safely, provided they are underpinned by sound engineering principles and design validation processes.

2. Introduction

This procedure was developed by a panel of Australian Automotive Aftermarket Association engineers and industry expertise to support sound industry practice and facilitate regulator approval of allowable safe vehicle modification.

3. Scope

This document outlines the minimum performance criteria and design validation processes for new and in-service vehicles to obtain or re-rate GCM or BTC values. This procedure applies to MA, MB, MC, MD, ME, NA and NB1 category vehicles up to 4.5 tonne GVM.

Three vehicle modification cases have been identified and are summarised in Table 1 below:

1. GCM upgrade with GVM increase, without changing the BTC
2. GCM upgrade with BTC increase, without changing the GVM
3. GCM upgrade with both the GVM and BTC increased

Table 1

Case	GVM Upgrade	BTC Upgrade	GCM Upgrade
1	●		●
2		●	●
3	●	●	●

4. Terms, Abbreviations and Definitions

The following terms are used throughout this document. Other related definitions can be found in the Motor Vehicle Standards Act.

Term	Definition
AAAA:	Australian Automotive Aftermarket Association.
ADR:	Australian Design Rules.
Aggregate trailer mass (ATM):	The total mass of the laden trailer when carrying the maximum load recommended by the *'Manufacturer'* (being the sum of GTM and coupling load).This will include any mass imposed onto the tow-vehicle when the *'Combination Vehicle'* is resting on a horizontal supporting plane.
Axle load:	Total load transmitted to the road by all the tyres of all the wheels whose centres may be included between two transverse parallel vertical planes less than one metre apart.
Braked towing capacity (BTC):	The maximum allowable towing capacity of a vehicle towing a trailer with its own brake system.
Combination vehicle:	Either a combination of a rigid goods vehicle and one trailer (other than a '*Semi-trailer*'); or an '*Articulated Vehicle*'
Coupling load:	Vertical load imposed by the trailer coupling on the towing vehicle.
DITRDC:	The Commonwealth Department of Infrastructure, Transport, Regional Development and Cities.
Gross axle load rating (GALR):	The '*Manufacturer's'* specified maximum '*Axle Load'* for each '*Axle'* for which compliance with applicable Australian Design Rules has been or can be established.
Gross combination mass (GCM):	Value specified for the vehicle by the '*Manufacturer*' as being the maximum of the sum of the 'Gross Vehicle Mass' of the tow-vehicle plus the sum of the 'Axle Loads' of any vehicle capable of being drawn as a trailer.
Gross trailer mass (GTM):	The mass transmitted to the ground by the '*Axle*' or '*Axles*' of the trailer when coupled to a tow-vehicle and carrying its maximum load approximately uniformly distributed over the load bearing area, and at which compliance with the appropriate Australian Design Rules has been or can be established.
Gross vehicle mass (GVM):	The maximum laden mass of a motor vehicle as specified by the '*Manufacturer*'.

ISO:	International Organization for Standardization.
Manufacturer:	The name of the person or company who accepts responsibility for compliance with the Australian Design Rules and/or to whom the *'Compliance Plate'* approval certificate is issued.
NATA:	National Association of Testing Authorities.
OEM:	Original Equipment Manufacturer.
SAE:	Society of Automotive Engineers.
Tare mass:	Mass of a vehicle ready for service, unoccupied and unladen, with all fluid reservoirs filled to nominal capacity except for fuel, which shall be 10 litres only, and with all standard equipment and any options fitted.
Vehicle categories:	As per the Australian Design Rules.
VSB:	Vehicle Standards Bulletin.

5. Documents Referenced

The following publications are referenced within this document. Note that:

- In the case of ADRs, the latest or relevant standard applies,
- In the case of VSBs, the relevant version applies,
- For all other documents the cited reference applies.

Department of Infrastructure, Transport, Cities and Regional Development 2017, *Vehicle Standard (Australian Design Rule 31/.. – Brake Systems for Passenger Cars)*, Canberra, F2017L01214, www.infrastructure.gov.au/vehicles/design

Department of Infrastructure, Transport, Cities and Regional Development 2018, *Vehicle Standard (Australian Design Rule 35/.. – Commercial Vehicle Brake Systems)*, Canberra, F2018L00664, www.infrastructure.gov.au/vehicles/design

Department of Infrastructure, Transport, Cities and Regional Development 2017, *Vehicle Standard (Australian Design Rule 62/.. – Mechanical Connections Between Vehicles)*, Canberra, F2007L02226, www.infrastructure.gov.au/vehicles/design

International Organization for Standardization 2018, *Passenger cars -- Test track for a severe lane change manoeuvre -- Part 1: Double lane change*, ISO 3888-1:2018, www.iso.org

International Organization for Standardization 2010, *Road vehicles -- Passenger-car and trailer combinations -- Lateral stability test*, ISO 9815:2010, www.iso.org

National Heavy Vehicle Regulator 2019, *Vehicle Standards Bulletin 6*, Fortitude Valley, VSB6, www.nhvr.gov.au

SAE International 2016, *Performance Requirements for Determining Tow-Vehicle Gross Combination Weight Rating and Trailer Weight Rating*, SAE J2807_201602, www.sae.org

SAE International 2016, *Trailer Sway Response Procedure*, SAE J2664_200606, www.sae.org

U.S. Department of Transportation, *FMVSS 105: Hydraulic and Electric Brake Systems*, TP-105-03, www.nhtsa.gov

6. Additional Documents that Complement this Procedure

The following documents are available from the AAAA:

- Safe Towing Guide (AAAA-STG)

7. Design and Performance Requirements

This section details the design validation and performance requirements in order to rate or re-rate BTC and GCM limits.

Table 2 below specifies the criteria that apply in each of the modification cases (refer Table 1) considered.

Table 2: Validation and design requirements

Factor		**Case 1**	**Case 2**	**Case 3**
7.1	Startability	●	●	●
7.2	Gradeability	●	●	●
7.3	Handling		●	●
7.4	Braking		●	●
7.5	Thermal Loading	●	●	●
7.6	Chassis and Tow Connection		●	●

7.1. Startability

Vehicles shall demonstrate startability of a minimum grade of 13% (VSB 6). The following variation to VSB 6 is accepted; *a transmission efficiency factor of 1.42 may be utilised for automatic transmission vehicles.* Verification may be by physical testing, computer simulation or calculation, using the formulas:

$$GCM_{max} = \frac{T \times R \times M \times E}{19.87 \times g_s} \qquad \textit{Eq. 1}$$

$$g_{s_{max}} = \frac{T \times R \times M \times E}{19.87 \times GCM} \qquad \textit{Eq. 2}$$

Where:

T = Engine torque at clutch engagement RPM (Nm)

R = Overall gear reduction between engine and driven wheels

M = Tyre revolutions per kilometre

E = Transmission efficiency
for manual transmission, E = 1
for automatic transmission, E = 1.42

g_s = Maximum grade (%)

7.2. **Gradeability**

Vehicles shall demonstrate gradeability of a minimum grade of 23% (VSB 6). The following variation to VSB 6 is accepted; *a transmission efficiency factor of 1.42 may be utilised for automatic transmission vehicles.* Verification may be by physical testing, computer simulation or calculation, using the formulas:

$$GCM_{max} = \frac{K \times R \times M \times T \times E}{(g_g + 1)} \qquad \textit{Eq. 3}$$

$$g_{g_{max}} = \frac{K \times R \times M \times T \times E}{GCM} - 1 \qquad \textit{Eq. 4}$$

Where:

K = Drive efficiency constant for type of drive axle fitted to the tow-vehicle
for single drive axles, K = 0.055
for single drive tandem axles, K = 0.053
for dual drive tandem axles, K = 0.051

R = Overall gear reduction between engine and driven wheels

M = Tyre revolutions per kilometre

T = Maximum engine net torque (Nm)

E = Transmission efficiency
for manual transmission, E = 1
for automatic transmission, E = 1.42

$\mathbf{g_g}$ = Maximum grade (%)

7.3. **Handling**

For vehicles where the BTC exceeds 150% of the tow-vehicle tare mass, vehicles are to be tested in accordance with the Combination Handling test requirements in SAE J2807. Vehicles shall meet either of the following requirements:

- As prescribed in SAE J2807, or
- Results better than, or no more than 5% below the baseline results recorded from an unmodified vehicle. The baseline test speed used for comparison shall be the specified test speed in SAE J2807 or the maximum achieved by the modified vehicle.

7.4. **Braking**

The tow-vehicle and test trailer combination shall satisfy the combination braking requirements of SAE J2807. Testing may take place in an environment meeting the requirements of ADR 35/.. or ADR 31/..

7.5. **Thermal Loading**

Vehicles that have a re-rated GCM that is 10% or greater than the OEMs specification, shall satisfy the requirements of SAE J2807, with respect to thermal loading.

Any future industry-led procedures are to be included as an addendum to this document in the event of their creation.

7.6. **Mechanical Connections and Vehicle Structure (Chassis)**

Devices utilised for fastening trailer to tow-vehicle and relevant tow-vehicle structures shall satisfy the requirements of ADR 62/.. Mechanical Connections Between Vehicles.

8. Test Facility and Documentation

Tests shall be conducted in a facility that is either;

1. NATA or ISO 17025 accredited for the specific testing being undertaken,
2. DITRDC registered test facility,

or the following shall apply:

1. Written test procedures shall be used for each test, detailing the test conducted and including pass/fail criteria in accordance with the test standard.
2. The testing organisation shall verify that each test meets the requirements of the relevant standard.
3. Copies of calibration certificates for equipment used in testing shall be provided with the test documentation.
4. Test vehicle(s) shall be identified.
5. The test facility shall retain copies of test documentation and calibration certificates for a period no less than five years. Records may be retained in electronic or hardcopy formats.