



NATIONAL CODE OF PRACTICE

VEHICLE STANDARDS BULLETIN

VSB 11

**CERTIFICATION OF ROAD-FRIENDLY
SUSPENSION SYSTEMS**

Revision 1 - JULY 2004

Supersedes document dated April 1999

These Guidelines do not cover administrative requirements imposed by State,
Territory and Federal jurisdictions



NATIONAL TRANSPORT COMMISSION
DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

VEHICLE STANDARDS BULLETIN 11

ROAD-FRIENDLY SUSPENSION
Certification Requirements



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Outline of Amendment

This revision of the original April 1999 version of VSB 11 dated July 2004 covers:

- the change of the Federal Office of Road Safety (FORS) to Vehicle Safety Standards, DOTARS;
- the change of the National Road Transport Commission (NRTC) to the National Transport Commission (NTC);
- the incorporation of the Road Friendly Suspension forms into the Road Vehicle Certification System (RVCS);



- the inclusion of Section 8 in relation to “Modifications to approved Road-friendly Suspensions that may affect Road Friendly Certification Compliance”; and
- the inclusion of additional possible locations for the certification decal, label or plate.



1. OVERVIEW

This Vehicle Standards Bulletin provides information on the certification of Road-Friendly Suspensions.

To obtain certification that a suspension model is a Road-Friendly Suspension, the suspension supplier must submit to Assistant Secretary, Vehicle Safety Standards, Department of Transport and Regional Services:

- a) information to register themselves (see Section 5); and
- b) an electronic application, including the specified evidence of compliance and the applicable fee.

A certificate will be issued within 28 days of receipt of a complete and correct application.

The Road-Friendly Suspension certificate is issued under the condition that records are retained to verify that the certified suspensions are road-friendly.

State and Territory vehicle registering authorities may require marking and/or labelling of vehicles fitted with a Road-Friendly Suspension and may also conduct in-service checks to assess whether suspensions certified as road-friendly continue to perform as intended.

Where a certified suspension model is found to be not road-friendly or where there is insufficient assurance that it is road-friendly, the Road-Friendly Suspension certificate issued may be varied, suspended or cancelled.

This may also result in the removal of any increased mass previously permitted to be carried on the basis of the suspension being certified as road-friendly.

2. PERFORMANCE STANDARD

Road-Friendly Suspensions are required to meet the performance standard as published by the National Transport Commission (NTC) as 'Road-Friendly Suspension – Performance and Component Requirements, and Acceptable Test Methods'. This standard is reproduced in Appendix 1 & 2.



3. DEMONSTRATION OF COMPLIANCE

Demonstration that a suspension is road-friendly requires either results of testing or calculations to be provided in accordance with the procedures in Appendix 2. The formulae used in calculations must be validated by test.

4. WORST CASE SELECTION CRITERIA

Suspension suppliers may reduce the amount of testing required to demonstrate compliance of variants of a suspension model by testing a 'worst case' suspension. The supplier needs to submit technical arguments for selection of worst case to the Assistant Secretary, Vehicle Safety Standards for approval.

5. ROAD-FRIENDLY SUSPENSION CERTIFICATION PROCEDURES

The suspension supplier must register with Vehicle Safety Standards (VSS), GPO Box 594, Canberra City, ACT 2601, unless already registered in the Road Vehicle Certification System (RVCS) (refer Appendix 8). If not registered a form can be obtained by downloading it from the following website www.dotars.gov.au/rvcs (then opening "Register Here").

Vehicle Safety Standards will then issue a password to access the electronic templates for submitting an application and evidence of compliance which must be accompanied by a routing slip (refer Appendix 5), and the fee with the fee payment advice (refer Appendix 4). These templates are available on the RVCS website www.dotars.gov.au/rvcs, (then opening "Forms Downloads" to see the templates near the bottom). The above electronic documents must be completed and emailed to rvcs@dotars.gov.au

Any queries regarding this may be directed to (02) 6274 6549 or faxed to (02) 6274 6013 or email to the above address.

An application consists of:

- a) identification information regarding the applicant;



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- b) identification information regarding the suspension;
 - c) payment for the application;
 - d) performance details to demonstrate that the suspension is road-friendly;
 - e) reference to applicable drawings of components, parts lists and installation instructions; and
 - f) an assurance that all the suspensions of the model comply with the specified performance requirements and agreeing to abide by all the terms and conditions of any certificate issued as a result of the application.

Any variation to the following parts of a suspension would require the submission of an application for its approval as a variant to the main model:

1. Type of suspension (Underslung/ Overslung);
2. Maximum Axle spread applicable to particular model certified;
3. Dampers (eg quantity/capacity/location);
4. Air Bag Diameter;
5. Damper Mounting geometry (eg Angle of damper to Vertical);
6. Any significant dimensional change, eg spring hanger to axle, axle to air bag dimension; and
7. Load Sharing configuration.

6. ISSUE OF CERTIFICATES AND POSTING ON INTERNET

A listing of certified Road-Friendly Suspensions will be posted on the Internet.

A typical Road-Friendly Suspension certificate including the conditions of approval is at Appendix 3.



7. CERTIFICATION PAYMENT

The certification payment required for processing the application is \$350. This fee would be applied each time information is submitted to the office for processing which requires issue of an approval.



8. MODIFICATION TO APPROVED ROAD-FRIENDLY SUSPENSIONS THAT MAY AFFECT ROAD-FRIENDLY CERTIFICATION COMPLIANCE

The following procedures are intended to provide a simple mechanism to allow modifications to approved Road-Friendly Suspensions that may affect Road-Friendly Certification Compliance without requiring prior approval from the Assistant Secretary, Vehicle Safety Standards Branch in relation to road friendly suspension certification. This is in recognition of the fact that in certain situations it may be necessary to modify approved Road-Friendly Suspensions to suit operational requirements.

Modifications to Road-Friendly Suspensions in relation to road friendly certification compliance (eg, items 1-7 in Section 5 above), including the replacement of any components, are acceptable if:

- a) continuing compliance with the road friendly performance standard for Road-Friendly Suspensions is demonstrated (see Section 3) ; and
- b) a permanent decal, label or plate is affixed to or as near as possible to the new part or modification giving the name of the supplier or modifier and the test report number of the test confirming continuing compliance.

The test report must include a picture(s) or drawing(s) to clearly identify the new part fitted or modification to the approved Road-Friendly Suspension and the name of the Professional Engineer or competent person who conducted the test. Failure to produce the test report identified on the label when required may result in the removal of any increased mass permitted for Road-Friendly Suspensions.

Holders of Road-Friendly Suspensions approvals may use the above method to modify their Suspensions or apply to the Assistant Secretary, Vehicle Safety Standards Branch, for amended approvals to cover the modifications.



Appendix 1

National Transport Commission

PERFORMANCE STANDARD FOR ROAD-FRIENDLY SUSPENSION

Performance and Component Requirements, and Acceptable Test Methods



Performance Standard for road-friendly suspension

A suspension system will be recognised to be road-friendly if it conforms to the following performance and component requirements:

Performance Requirements

During free transient low frequency vertical oscillation of the sprung mass above an axle or axle group, the measured frequency and damping with the suspension carrying its maximum legal load must fall within the following limits:

(i)

- The frequency of the sprung mass above the axle or axle group in a free transient vertical oscillation must not be higher than 2.0 Hz.
- The mean damping ratio DM must be more than 20% of critical damping (Co) for the suspension in its normal operating condition.
- The damping ratio DR of the suspension with all dampers (if fitted) removed or incapacitated must be not more than 50% of DM.

(ii)

- Static load share between axles in the axle group must be within 5%. (Multiple axle groups only). (See attached definition of load-sharing suspension system).

Components

- Dual tyres must be fitted on the axles. (See Note 1)

Note 1. For a six tyred tandem axle group, one axle in the group may have single tyres fitted.



Definitions

load-sharing suspension system means an axle group suspension system that:

- (a) is built to divide the load between the tyres on the group so that no tyre carries a mass more than 5% greater than the mass it would carry if the load were divided equally; and
- (b) has effective damping characteristics on all axles of the group.

Frequency and Damping

In this definition a sprung mass M kg above a driving axle or bogie is considered. The axle or bogie has a total vertical stiffness between the road surface and the sprung mass of K Newtons/metre (N/m) and a total damping coefficient of C Newtons per metre per second (N.s/m). The vertical displacement of the sprung mass is Z . The equation of motion for free oscillation of the sprung mass is:

$$M \frac{d^2 Z}{dt^2} + C \frac{dZ}{dt} + kZ = 0$$

The frequency of oscillation of the sprung mass F (rad/sec) is:

$$F = \sqrt{\frac{K}{M} - \frac{C^2}{4M^2}}$$

The damping is critical when $C = C_0$

where

$$C_0 = 2\sqrt{KM}$$

The damping ratio as a fraction of critical damping is C/C_0 .

During free transient oscillation of the sprung mass the vertical motion of the mass will follow a damped sinusoidal path. The frequency can be estimated by measuring the time for as many cycles of oscillation as can be observed. The damping can be estimated by measuring the heights



of successive peaks of the oscillation in the same direction. If the peak amplitudes of the first and second cycles of the oscillation are A_1 and A_2 , then the damping ratio D is

$$D = \frac{C}{C_o} = \frac{1}{2\pi} \ln \frac{A_1}{A_2}$$

Note 2: With 'ln' being the natural logarithm of the amplitude ratio.

Critical Damping – The minimum amount of viscous damping required in a linear system to prevent the displacement of the system from passing the equilibrium position upon returning from an initial displacement.

Damping Ratio – The ratio of the amount of viscous damping present in a system to that required for critical damping.

Viscous Damping – Damping in which the force opposing the motion is proportional and opposite in direction to the velocity.

DM = Mean damping ratio.

DR = Damping ratio with all dampers removed or incapacitated.

C = Viscous Damping.

CO = Critical damping constant.

F = Frequency of oscillation of the sprung mass.

M = Sprung mass of suspension.

K = Total vertical stiffness between the road surface and the sprung mass.

Z = Vertical displacement of the sprung mass.

A1 = Peak amplitude of the first cycle of oscillation.

A2 = Peak amplitude of the second cycle of oscillation.



Note 3: Definitions from Annex II of the Council of the European Union, Council Directive 96/53/EC dated 25 July 1996, and Fundamentals of Vehicle Dynamics, T D Gillespie, SAE, 1992.



Appendix 2

Acceptable Test Methods for Road-Friendly Suspensions

Test methods to indicate compliance with the performance standard to determine the damping ratio 'D', the damping ratio with dampers removed and the frequency 'F' of the suspension should be in accordance with any of the methods described at Section 4 - Test Procedure of Annex II of the Council of the European Union, Council Directive 96/53/EC dated 25 July 1996 (Copy attached). Note: Council Directive 96/53/EC amends Council Directive 92/7/EEC of 10 February 1992 which amended Council Directive 85/3/EEC of 19 December 1984.

- Suitable equivalent methods such as calculation or simulation may also be used once approved by the certification body (Vehicle Safety Standards).
- Test conditions should be prepared for the worst case/application situation, ie for a particular suspension model/range.
- The appropriate tyre pressure should be selected for the load being tested and the system should be at room temperature for the test.
- The influence of other modes, eg pitching on the performance of the suspension should be reduced or eliminated during the road-friendly test.

Compliance Test Load

Compliance must be confirmed at a load of 10 tonnes for a single axle, 17 tonnes for a tandem axle group and 22.5 tonnes for a tri-axle group. (Test loads should be within $\pm 5\%$ of nominated test load).

Single axle suspension module Testing

If two single axle suspension modules are used in a tandem axle group assembly, the test load may be reduced to 8.5 tonnes for a single axle test and if three single axle suspension modules are used in a tri-axle group assembly, the test load may be reduced to 7.5 tonnes for the single axle test.

For a six tyred tandem, the test load shall be 14 tonnes.

Note: For the six tyred tandem, testing should be performed as a complete assembly. (Single axle suspension module testing not applicable)



Test Method

If the lift test method is used for certification testing, following stabilisation of the load, the ride height control (if normally fitted) may be disconnected (locked) for the duration of the test.

Static Load Share

Static load share determination may be by use of load scales or calculation.



THE COUNCIL OF THE EUROPEAN UNION COUNCIL DIRECTIVE 96/53/EC OF 25 JULY 1996

ANNEX II

CONDITIONS RELATING TO EQUIVALENCE BETWEEN CERTAIN NON-AIR

SUSPENSION SYSTEMS AND AIR SUSPENSION FOR VEHICLE DRIVING AXLE(S)

1. DEFINITION OF SUSPENSION

A suspension system is considered to be air suspended if at least 75 % of the spring effect is caused by the air spring.

2. EQUIVALENCE TO AIR SUSPENSION

A suspension recognized to be equivalent to air suspension must conform to the following:

- 2.1. During free transient low frequency vertical oscillation of the sprung mass above a driving axle or bogie, the measured frequency and damping with the suspension carrying its maximum load must fall within the limits defined in paragraphs 2.2 to 2.5.
- 2.2. Each axle must be fitted with hydraulic dampers. On tandem axle bogies, the dampers must be positioned to minimize the oscillation of the bogies.
- 2.3. The mean damping ratio D must be more than 20 % of critical damping for the suspension in its normal condition with hydraulic dampers in place and operating.
- 2.4. The damping ratio D of the suspension with all hydraulic dampers removed or incapacitated must be not more than 50 % of D .
- 2.5. The frequency of the sprung mass above the driving axle or bogie in a free transient vertical oscillation must not be higher than 2.0 Hz.
- 2.6. The frequency and damping of the suspension are given in paragraph 3. The test procedures for measuring the frequency and damping are laid down in paragraph 4.



3. DEFINITION OF FREQUENCY AND DAMPING

In this definition a sprung mass M kg above a driving axle or bogie is considered. The axle or bogie has a total vertical stiffness between the road surface and the sprung mass of K Newtons/metre (N/m) and a total damping coefficient of C Newtons per metre per second (N.s/m). The vertical displacement of the sprung mass is Z . The equation of motion for free oscillation of the sprung mass is:

$$M \frac{d^2 Z}{dt^2} + C \frac{dZ}{dt} + kZ = 0$$

The frequency of oscillation of the sprung mass F rad/sec is:

$$F = \sqrt{\frac{K}{M} - \frac{C^2}{4M^2}}$$

The damping is critical when $C = C_0$, where

$$C_0 = 2\sqrt{KM}$$

The damping ratio as a fraction of critical damping is C/C_0 .

During free transient oscillation of the sprung mass the vertical motion of the mass will follow a damped sinusoidal path (Figure 2). The frequency can be estimated by measuring the time for as many cycles of oscillation as can be observed. The damping can be estimated by measuring the heights of successive peaks of the oscillation in the same direction. If the peak amplitudes of the first and second cycles of the oscillation are A_1 and A_2 , then the damping ratio D is

$$D = \frac{C}{C_0} = \frac{1}{2\pi} \ln \frac{A_1}{A_2}$$

“ln” being the natural logarithm of the amplitude ratio.

4. TEST PROCEDURE

To establish by test the damping ratio D , the damping ratio with hydraulic dampers removed, and the frequency F of the suspension, the loaded vehicle should either:



- a) be driven at low speed ($5\text{km/hr} \pm 1 \text{ km/hr}$) over an 80 mm step with the profile shown in Figure 1. The transient oscillation to be analysed for frequency and damping occurs after the wheels on the driving axle have left the step; or
- b) be pulled down by its chassis so that the driving axle load is 1,5 times its maximum static value. The vehicle hold down is suddenly released and the subsequent oscillation analysed; or
- c) be pulled up by its chassis so that the sprung mass is lifted by 80 mm above the driving axle. The vehicle hold up is suddenly dropped and the subsequent oscillation analysed; or
- d) be subjected to other procedures in so far as it has been proved by the manufacturer, to the satisfaction of the technical department (VSS), that they are equivalent.

The vehicle should be instrumented with a vertical displacement transducer between driving axle and chassis, directly above the driving axle. From the trace, the time interval between the first and second compression peaks can be measured to obtain the frequency F and the amplitude ratio to obtain the damping. For twin drive bogies, vertical displacement transducers should be fitted between each driving axle and the chassis directly above it.



Figure 1

Step for suspension tests

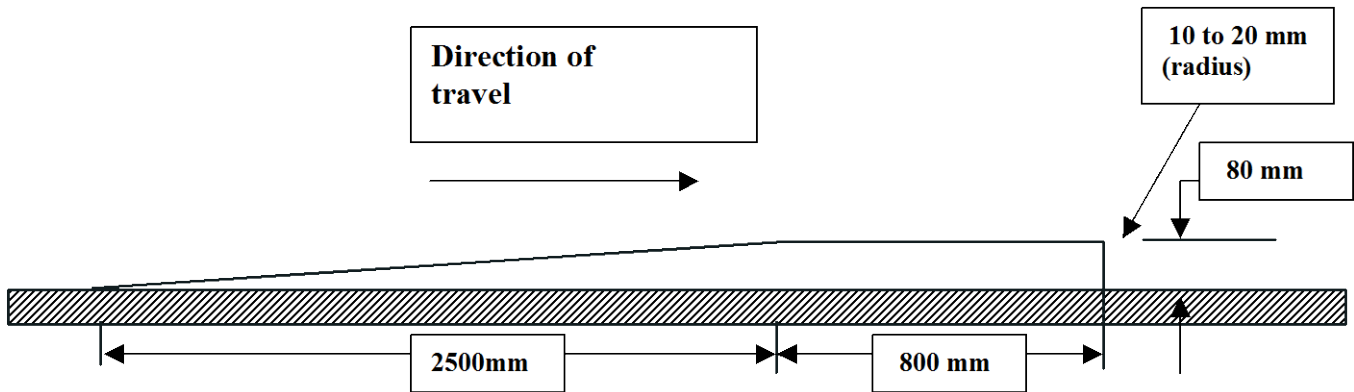
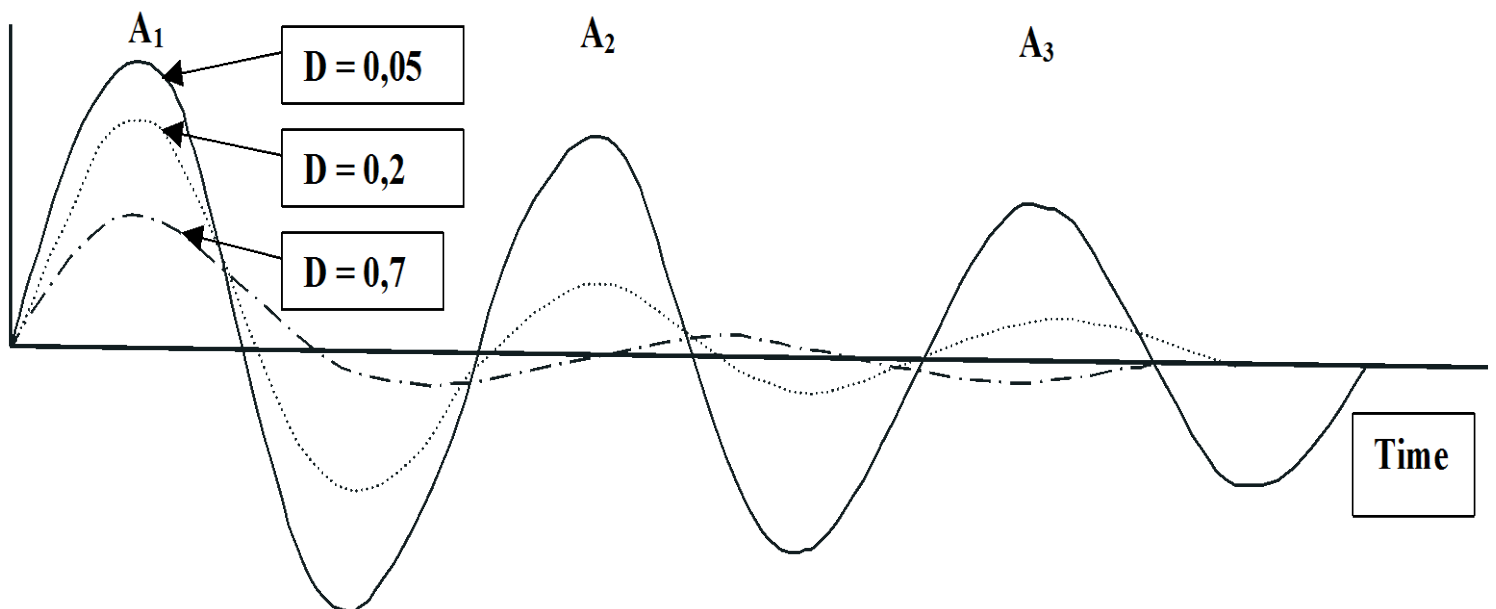




Figure 2

A damped transient response



Note: The Council of the European Union Council Directive 96/53/EC of 25 July 1996 amended Council Directive 85/3/EEC of 19 December 1984 (As amended by Council Directive 92/7/EEC of 10 February 1992).

Council directive 96/53/EC of 25 July 1996 may be obtained from the European Union's Australian Publication distributor, Hunter Publications, P O Box 404, Abbotsford Victoria 3067, Tel: 03 9417 5361, Fax: 03 9419 7154.

A copy can be viewed at the office of the National Transport Commission (NTC), Level 15, 628 Bourke Street, Melbourne, Victoria, 3000, Australia, Telephone: 03 9236 5000, Facsimile: 03 9642 8922, Internet: www.ntc.gov.au, or at Vehicle Safety Standards (VSS).

Also, copies of European Union Legislation/Directives may be available at some State Public Libraries. A copy can also be downloaded from:

http://europa.eu.int/eur-lex/en/consleg/pdf/1996/en_1996L0053_do_001.pdf



APPENDIX 3



Department of Transport and Regional Services

Vehicle Safety Standards

Road-Friendly Suspension Certificate Number (RFCN):

Issue Date:

The Assistant Secretary, Vehicle Safety Standards, VSS has assessed the information in Schedule 3 for the suspension described in this Road Friendly Certificate, which the Supplier identified in Schedule 1 has submitted, as complying with the road-friendliness requirements as specified in NTC publication 'Road-Friendly Suspension – Performance and Component Requirements, and Acceptable Test Methods'. This information will be acceptable for use as evidence of compliance with the requirements specified in the above NTC publication. Provided the suspension is installed according to the Supplier's nominated installation instructions identified in Schedule 3.

The issue of this Certificate is subject to the following conditions:

1. The Supplier shall not quote the Road-Friendly Certificate Number in respect of a suspension which is not the suspension certified in the Road-Friendly Suspension certificate with that number.
2. The Supplier shall not quote Road-Friendly Certificate Number in respect of a suspension, without the prior approval of Assistant Secretary, Vehicle Safety Standards, VSS that is in any way different from the suspension described in the final form of the application for this Suspension Certificate Number. The application includes reports and other information relating to the application.
3. The Supplier shall by detailed quality control and test ensure continuing compliance with the requirements.
4. The Supplier shall maintain records of detailed quality control and test documentation.
5. The Supplier shall supply upon request, to the Assistant Secretary, Vehicle Safety Standards, VSS any additional information requested for the purpose of demonstrating compliance.
6. The Supplier shall not quote the Road-Friendly Certificate Number in respect of a suspension on or after the Expiry date specified in the certificate.
7. The Supplier shall indicate by an appropriate method (decal, label or plate) the Road-Friendly Suspension Certificate Number (RFCN) on the suspension system, or on a suitable location on the vehicle near the installed suspension or the vehicle compliance plate.



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8. On cessation of marketing the specified suspension in Australia, the Supplier shall notify the Assistant Secretary, Vehicle Safety Standards, VSS of the date of manufacture of the last specified suspension supplied to the market in Australia.
 9. In case the requirements for Road-friendliness are changed by National Transport Commission, a new approval may be required.



Certificate No:
Issue Date:
Expiry Date:

Supplier Name: **SCHEDULE 1**
Supplier ID:

Supplier Address: **SCHEDULE 2**

Make:

Model:

SCHEDULE 3

	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
Overslung/ Underslung					
Maximum Axle spread (m)					
Dampers Part Numbers					
Smallest Tyre Size Designation					
Highest tyre pressure (Kpa)					
Airbag Diameter (mm)					
Reference Drawings No of suspension (parts list & assembly details)					

Assistant Secretary
Vehicle Safety Standards

Date