

## AUSTRALIAN MOTOR VEHICLE CERTIFICATION BOARD

Comprising Commonwealth, State and Territory Authorities

### CIRCULAR NO. 38-2-2

### SKID LIMIT TESTING

#### INTRODUCTION

1. The characteristic of brake reactive load sharing suspensions which causes one axle's wheels to lock up before the others during braking is of vital importance when calculating the braking performance of a vehicle. The certification procedures for ADR 38 allows compliance to be demonstrated by calculations using the Compliance Mark Approval data obtained for approved sub-assemblies. One of these sub-assemblies is the suspension system and part of the data required for approval is the skid limits under service, emergency and parking braking conditions.
2. Brake reactive suspension systems, by definition, transfer axle load between the axles within the group during braking. At least one axle will have its vertical loading decreased and will therefore tend to suffer from wheel lock up at a reduced braking effort. The distribution of braking effort (brake torque) between axles in the suspension system determines the amount of load transfer from or to any axle in that group. The behaviour of any suspension design sufficiently complex to require road tests to be conducted to determine the characteristics of the suspension. However, non-brake reactive suspension systems will not have to be tested for skid limits.
3. Skid limits are an expression of the distribution of brake torque at which wheel lock occurs. They are used by trailer manufacturers demonstrating compliance by calculation to ensure that calculation conditions are not used which are equivalent to the conditions which would have resulted in wheel lock-up occurring in a road test. Once wheel lock-up occurs on an axle no increase in retarding force is available from that axle no matter how much the Control Signal to that axle is increased. The calculations in ADR 38 are valid only for conditions without wheel lock-up.
4. A set or range of skid limit values is valid only for the particular make and model of suspension and any changes to the suspension may invalidate the skid limit values. Changes in the axles fitted with emergency or parking brakes will affect the emergency or parking skid limits, which are valid only for the axles braked during the tests. Changes from underslung to overslung springing, changes in suspension spread or changes in spring rates may invalidate the skid limits. The responsibility for ensuring the validity of the skid limit values lies with the sub-assembly manufacturer.

#### TESTING PROCEDURES

##### Preliminary set-up

5. The suspension system must be installed on a trailer category and type number (refer Circular 0-7-5) which is typical of the type for which the suspension is to be marketed. For suspension testing purposes some trailer type numbers are considered to be equivalent to each other. A suspension tested on either a Type 1, a Type 3 or a Type 5 trailer can be used on any of these trailer types but no others. A suspension tested on a Type 2 trailer can only be used on a Type 2 trailer and a suspension tested on a Type 4 trailer can only be used on a Type 4 trailer. The installation details

should be carefully noted as they will form part of documentation to be forwarded with the Compliance Mark Approval Application. Installation slope is particularly important.

6. Each axle position in the suspension system must be fitted with a braked axle assembly. All the brakes used should be identical to each other and each brake assembly should be calibrated. This means that the output braking torque at a range of Control Signals (eg. air pressure) to the brake actuator (eg. booster) must be known for that particular brake assembly. The calibration may be in the form of brake torque curves supplied by the brake manufacturer from tests on that brake assembly. More conveniently existing braked axle assemblies may be calibrated using a rolling road brake dynamometer, a draw-bar dynamometer or by conducting a series of carefully measured road tests using only the brakes being calibrated. In any of these calibration tests it will be important to accurately measure the Control Signal level being applied to the brake actuator. This may be different from the Control Signal applied to the trailer front couplings. The brakes must be calibrated in order to provide a suitably accurate base for the calculations to be performed by trailer manufacturers using the suspension system sub-assembly.
7. During the Skid Limits tests it will be necessary to accurately measure and control the Control Signal applied to each brake actuator in order to vary the distribution of brake torques between the axles in the group. A coarse variation of distribution can be achieved by altering the brake actuator size and operating arm length (eg. booster and slack adjuster). However a much finer variation may be required. Where air regulators are used for this purpose, consideration should be given to any time delays introduced by the regulator. As excessive variations in the time delays to the brake actuators can cause erroneous results, every attempt should be made to use a form of regulation which introduces the minimum time delay (e.g. manually adjustable load proportioning valves).
8. All the tyres used should be identical and inflated to the manufacturer's recommended pressure.
9. All the brakes should be adjusted according to the manufacturer's recommended procedures.
10. The trailer shall be laden so that the load on the suspension system's axle group is at least half of the maximum axle group load for that system. In most cases it is expected that the maximum axle group load will be the statutory limit for that configuration (listed in ADR 38, Table 1).

#### TEST TRACK CONDITIONS

11. Braking tests shall be carried out on approximately level surfaces. Where the levels are unsurveyed, the test shall be completed in both directions, the brakes being applied over the same section, and the two results averaged to determine the final result. Where the difference in start and finish elevations for a brake test, expressed as a percentage of the stopping distance, is known then the brake test need only be completed in one direction and the result corrected for any difference in elevation exceeding 1%.
12. (i) The test surface shall be either concrete or bitumen pavement and shall be free from loose material.  
(ii) No tow vehicle braking system or other contrived means shall contribute to braking effort. The tow vehicle engine shall be declutched or have neutral engaged during the braking tests required by the Rule.  
(iii) The ambient temperature at the test site shall be greater than 0°C and less than 40°C.  
(iv) The wind speed difference between two tests in opposite directions, or against the direction of travel in the case of a single brake test, shall not exceed 15 km/h.

## SERVICE SKID LIMIT TESTING

13. The Service Skid Limit tests may be performed either dynamically or by low speed drag. The dynamic test requires a braked stop from a known speed above 40 km/h. The stopping times or distances are measured and the Established Retardation Coefficient (ERC) calculated using the expression in the ADR 38 Service Brake Effectiveness section. The drag test requires the trailer to be dragged forward whilst the trailer brakes are applied. The ERC can be calculated from the Control Signal to each brake actuator, the brake calibration data, the static radius of the tyre and the group load. (Refer to Service Brake Effectiveness by calculation in ADR 38). For either test a convenient way of recording the test readings may be to use the appropriate section of Form CB 38 - Submission of evidence.
14. An acceptable Service Skid Limit tests is one where the ERC is at least 0.45 and no wheel lock occurs.
15. The result of acceptable tests shall be reported as the ERC and the torque for each axle. The Service Skid Limit can then be calculated using the expression.

$$\text{Service Skid Limit} = \frac{\textit{Brake torque for axle}}{\textit{highest brake torque for group}}$$

16. A range of Services Skid Limit values may be obtained for any one axle in the suspension group by conducting a series of Service Skid Limit tests with the axle brake torque on that axle only being varied, the other axle brake torques being held constant. The range of Service Skid Limit values will be the maximum and minimum values obtained from acceptable Service Skid limit tests.
17. A range of Service Skid Limit values may be established for more than one axle in the suspension group, and therefore a set of Service Skid Limits may contain a range of values for more than one axle. Every permutation of extremes of each range of Service Skid Limit values must be used in an acceptable Service Skid Limit test before these ranges of values can be used as a set of Service Skid Limits.

18. An example of the results which may be obtained from acceptable Service Skid Tests is shown below.

(i) Total Combination Mass (as tested) : .....25..... tonne  
 Total Trailer Axle Load (as tested) : .....18..... tonne  
 Static loaded tyre radius : .....0.53..... m

ERC	Axle 1		Axle 2		Axle 3		Axle 4	
	Torque (Nm)	Skid Limit						
0.51	16,000	1.0	16,000	1.0	16,000	1.0	-	-
0.48	13,000	0.81	16,000	1.0	16,000	1.0	-	-
0.49	16,000	1.0	14,000	0.87	16,000	1.0	-	-
0.46	13,000	0.81	14,000	0.87	16,000	1.0	-	-
0.50	16,000	1.0	16,000	1.0	15,000	0.94	-	-
0.47	13,000	0.81	16,000	1.0	15,000	0.94	-	-
0.48	16,000	1.0	14,000	0.87	15,000	0.94	-	-
0.45	13,000	0.86	14,000	0.93	15,000	1.0	-	-

(ii) Service Skid Limit values

	Axle 1		Axle 2		Axle 3		Axle 4	
	From	To	From	To	From	To	From	To
Skid Limit	0.81	1.0	0.87	1.0	0.94	1.0	-	-

PARKING AND EMERGENCY SKID LIMITS TESTS

19. In these tests the Brakes used shall be the same as those used in the Service Skid Limit tests. However, only those axles deemed to be fitted with parking or emergency brakes should be braked for these tests. In most cases the axles which have emergency brakes will also have parking brakes. However the parking brakes would not normally be fitted to the rear axles of a group. Only one combination of braked axles should be reported on at a time. For example, in a triaxle group axles 1 and 2 may be braked in one test, and axles 2 and 3 in another. This would require two sets of results. It is feasible to brake all 3 axles. Trailer manufacturers demonstrating compliance by calculation will be able to use only the parking/emergency Skid Limits applicable to the combination of axles fitted with parking or emergency brakes on their trailer.
20. Parking and emergency Skid Limit tests can be performed by either dynamic test or low speed drag as per Service Skid Limits. However in this case the braking effort (torque) should be the same on each braked axle. The braking effort should be gradually increased for successive stops until wheel lock occurs. The results from that last stop without wheel lock are to be used to determine the Skid Limit, which in this case is determined by;

$$\text{Skid Limit} = \frac{\text{Retardation Force in Newtons}}{\text{Static axle load in Kg.}}$$

The same value shall be entered for each braked axle. Retardation force is calculated by either;

Total torque (in Newton-metre) divided by static tyre radius (in metre)

OR

ERC X Group Load (as tested) (in tonne) X 9810

21. Examples of the results to be entered from two emergency/parking Skid Limit tests and are shown below. The group had axles 1 and 2 braked for the first test and 2 and 3 for the second.

Test 1

	Axle			
	1	2	3	4
Retardation force required to lock any one wheel in the group (N)	70632	70632		
Static axle load (Kg)	6000	6000		
Emergency or Parking Skid Limit (Force in Newtons) (axle load in Kg)	11.77	11.77		

State whether test was conducted as a low speed drag : .....  
or dynamically: .....X.....

State the: Group Load as tested : ....18..... tonne  
Total Combination Mass as tested : ....25..... tonne  
Static loaded tyre radius : ...0.51..... m  
ERC (dynamic tests only) : ...0.40.....  
Total torque (drag tests only) : ....-..... (Nm)

Test 2

	Axle			
	1	2	3	4
Retardation force required to lock any one wheel in the group (N)		61803	61803	
Static axle load (Kg)		6000	6000	
Emergency or Parking Skid Limit (Force in Newtons) (axle load in Kg)		10.30	10.30	

State whether test was conducted as a low speed drag : .....X.....  
or dynamically:.....

State the: Group Load as tested : .....18.... tonne  
Total Combination Mass as tested : .....25.... tonne  
Static loaded tyre radius : ....0.51.... m  
ERC (dynamic tests only) : .....  
Total torque (drag tests only) : ...31519.... (Nm)