Vehicle Standard (Australian Design Rule 59/00 – Omnibus Rollover Strength) 2006

I, JAMES ERIC LLOYD, Minister for Local Government, Territories and Roads, determine this vehicle standard under subsection 7 (1) of the Motor Vehicle Standards Act 1989.

Dated 26 April 2006

[SIGNED]

James Eric Lloyd

Minister for Local Government, Territories and Roads
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A.1. NAME OF STANDARD
A.1.1. This Standard is the Vehicle Standard (Australian Design Rule 59/00 – Omnibus Rollover Strength) 2006.
A.1.2. This Standard may also be cited as Australian Design Rule 59/00 — Omnibus Rollover Strength.

A.2. COMMENCEMENT
A.2.1. This Standard commences on the day after it is registered.

A.3. REPEAL
A.3.1. This Standard repeals each vehicle standard with the name Australian Design Rule 59/00 — Omnibus Rollover Strength that is:
(a) made under section 7 of the Motor Vehicles Standard Act 1989; and
(b) in force at the commencement of this Standard.
A.3.2. This Standard also repeals each instrument made under section 7 of the Motor Vehicles Standard Act 1989 that creates a vehicle standard with the name Australian Design Rule 59/00 — Omnibus Rollover Strength, if there are no other vehicle standards created by that instrument, or amendments to vehicle standards made by that instrument, that are still in force at the commencement of this Standard.

B FUNCTION AND SCOPE
B.1 The function of this Australian Design Rule is to specify the strength of an omnibus superstructure to withstand forces encountered in rollover crashes.

C APPLICABILITY AND IMPLEMENTATION
C.1 Subject to the following clauses, this ADR applies to the design and construction of vehicles as set out in the table hereunder.
C.2 This rule applies to single-decked vehicles constructed for the carriage of more than 16 passengers, whether seated or standing, in addition to the driver and crew.
C.3* ME category vehicle ‘Route Service Omnibuses’ need not comply with this rule until 1 July 1993.
C.4 Omnibuses are not required to comply with this rule if the following percentage of the area of the upper surface of the floor measured between its ‘Axles’, is not more than 550mm above the ground:

For a wheel base: 6.5 metres and over 75%
less than 6.5 metres 70%
less than 6.0 metres 65%
less than 5.5 metres 60%
less than 5.0 metres 55%
less than 4.5 metres 50%

The floor height of 550 mm is measured at the ‘Suspension Height’ corresponding to the ‘Unladen mass’ of the vehicle.”
## APPLICABILITY TABLE

<table>
<thead>
<tr>
<th>Vehicle Category</th>
<th>ADR Category Code</th>
<th>UNECE Category Code</th>
<th>Manufactured on or After</th>
<th>Acceptable Prior Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moped 2 wheels</td>
<td>LA</td>
<td>L1</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Moped 3 wheels</td>
<td>LB</td>
<td>L2</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Motor cycle</td>
<td>LC</td>
<td>L3</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Motor cycle and sidecar</td>
<td>LD</td>
<td>L4</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Motor tricycle</td>
<td>LE</td>
<td>L5</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Passenger car</td>
<td>MA</td>
<td>M1</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Forward-control passenger vehicle</td>
<td>MB</td>
<td>M1</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Off-road passenger vehicle</td>
<td>MC</td>
<td>M1</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Light omnibus</td>
<td>MD</td>
<td>M2</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>up to 3.5 tonnes <code>GVM</code> and up to 12 seats</td>
<td>MD1</td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>up to 3.5 tonnes <code>GVM</code> and more than 12 seats</td>
<td>MD2</td>
<td></td>
<td>1 July 1993</td>
<td>Nil</td>
</tr>
<tr>
<td>over 3.5 tonnes and up to 4.5 tonnes <code>GVM</code></td>
<td>MD3</td>
<td></td>
<td>1 July 1993</td>
<td>Nil</td>
</tr>
<tr>
<td>over 4.5 tonnes and up to 5 tonnes <code>GVM</code></td>
<td>MD4</td>
<td></td>
<td>1 July 1993</td>
<td>Nil</td>
</tr>
<tr>
<td>Heavy omnibus</td>
<td>ME</td>
<td>M3</td>
<td>1 July 1992*</td>
<td>Nil</td>
</tr>
<tr>
<td>Light goods vehicle</td>
<td>NA</td>
<td>N1</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Medium goods vehicle</td>
<td>NB</td>
<td>N2</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Heavy goods vehicle</td>
<td>NC</td>
<td>N3</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Very light trailer</td>
<td>TA</td>
<td>O1</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Light trailer</td>
<td>TB</td>
<td>O2</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Medium trailer</td>
<td>TC</td>
<td>O3</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Heavy trailer</td>
<td>TD</td>
<td>O4</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

### 59.1 DEFINITIONS

Refer to section 2 of Appendix A.

### 59.2 REQUIREMENTS

59.2.1. Omnibus superstructure strength shall comply with the requirements of this Rule.

59.2.2. Appendix A is an extract from the ECE document with administrative provisions not relevant to this Design Rule deleted or identified by cross-hatching. In the case of deletion of whole sections or annexes, that section’s or annex’s title will be cross-hatched and the words "Not Applicable" placed beside its title.

### 59.3 ALTERNATIVE STANDARDS

Provided that all the additional requirements as set out in inverse text in Appendix A are complied with, the technical requirements of ECE R 66/00, "Superstructure Strength of Large Passenger Vehicles", shall be deemed to be equivalent to the technical requirements of this Rule.
APPENDIX A

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM CONDITIONS OF APPROVAL AND RECIPROCAL RECOGNITION OF APPROVAL FOR MOTOR VEHICLE EQUIPMENT AND PARTS

done at Geneva on 20 March 1958

Addendum 65: REGULATION No. 66

Date of entry into force as an annex to the Agreement:
1 December 1986

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF LARGE PASSENGER VEHICLES WITH REGARD TO THE STRENGTH OF THEIR SUPERSTRUCTURE

UNITED NATIONS
Regulation No. 66

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF LARGE PASSENGER VEHICLES WITH REGARD TO THE STRENGTH OF THEIR SUPERSTRUCTURE

REGULATION
1. Scope
2. Definitions
3. Application for approval
4. Approval
5. General specifications and requirements
6. Test methods
7. Residual space
8. Interpretation of test results
9. Modifications and extension of approval of a vehicle type
10. Conformity of production
11. Penalties for non-conformity of production
12. Production definitely discontinued
13. Names and addresses of technical services responsible for conducting approval tests, and of administrative departments

ANNEXES
Annex 1 - Communication concerning the approval or refusal or extension or withdrawal of approval or production definitely discontinued of a vehicle type with regard to the strength of its superstructure pursuant to Regulation No. 66.
Annex 2 - Arrangement of the approval mark
Annex 3 - Roll-over test on a complete vehicle
Annex 4 - Roll-over text on a body section
Annex 5 - Pendulum test on a body section
Annex 6 - Verification of strength of superstructure by calculation
Regulation No. 66

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF LARGE PASSENGER VEHICLES WITH REGARD TO THE STRENGTH OF THEIR SUPERSTRUCTURE

1. SCOPE
This Regulation applies to single-decked vehicles constructed for the carriage of more than 16 passengers, whether seated or standing, in addition to the driver and crew.*

2. DEFINITIONS
For the purposes of this Regulation:
2.1. "Approval of a vehicle" means the approval of a vehicle type with regard to the construction features specified in this Regulation.
2.2. "Vehicle type" means a category of vehicles which do not differ essentially in respect of the constructional features specified in this Regulation.
2.3. "Passenger compartment" means the space intended for passengers’ use excluding any space occupied by fixed appliances such as bars, kitchenettes or toilets;
2.4. "Driver’s compartment" means the space intended for the driver’s exclusive use and containing the driver’s seat, the steering wheel, controls, instruments and other devices necessary for driving the vehicle;
2.5. "Unladen kerb mass" means the mass of the vehicle in running order, unoccupied and unladen but complete with fuel, coolant, lubricant, tools and spare wheel, if any;
2.6. "Residual space" means the space to be preserved in the passenger compartment during and after the structure has been subjected to one of the tests prescribed in paragraph 6 of this Regulation;
2.7. "Superstructure" means the parts of a vehicle structure which contribute to the strength of the vehicle in the event of a roll-over accident;
2.8. "Body section" means a section containing at least two identical vertical pillars on each side representative of a part or parts of the structure of the vehicle;
2.9. "Total energy" means the energy assumed to be absorbed by the complete structure of the vehicle. This may be determined as shown in appendix 1 of annex 5 to this Regulation.

3. APPLICATION FOR APPROVAL
NOT APPLICABLE

4. APPROVAL
NOT APPLICABLE

5. GENERAL SPECIFICATIONS AND REQUIREMENTS
5.1. The superstructure of the vehicle shall be of sufficient strength to ensure that during and after it has been subjected to one of the methods of test or calculation prescribed in paragraph 6:
5.1.1. No displaced part of the vehicle intrudes into the residual space, as specified in paragraph 7, and
5.1.2. No part of the residual space projects outside the deformed structure.
5.2. The requirements of paragraph 5.1. above shall apply to the vehicle including all its structural parts, members and panels and all projecting rigid parts such as luggage racks, ventilation equipment, etc. However, bulkheads, partitions, rings or other members reinforcing the superstructure of the vehicle and fixed appliances such as bars, kitchenettes or toilets shall be ignored for the purposes of paragraph 5.1.
5.3. In the case of an articulated vehicle each part of the vehicle shall comply with the requirements specified in paragraph 5.1. above.

6. TEST METHODS
6.1. Each type of vehicle shall be verified according to one of the following methods at the discretion of the manufacturer or according to an alternative method approved by the competent authority:
   Administrator of Vehicle Standards*
6.1.1. A roll-over test on a complete vehicle in accordance with the procedure set out in annex 3 to this Regulation;
6.1.2. A roll-over test on a body section or sections representative of a complete vehicle in accordance with annex 4 to this Regulation;
6.1.3. A pendulum test on a body section or sections in accordance with annex 5 to this Regulation; or
6.1.4. A verification of strength of superstructure by calculation in accordance with annex 6 to this Regulation.
6.2. If the methods prescribed in paragraphs 6.1.2., 6.1.3. or 6.1.4. cannot take account of a significant variation between one section of the vehicle and another, for example an air-conditioning installation on the roof, additional test methods or calculations shall be submitted to the technical service.

* Nothing in this Regulation shall prevent the Contracting Parties from restricting its scope to particular categories of vehicle.
In the absence of such additional information the vehicle may be required to undergo the method of test prescribed in paragraph 6.1.1.

7. RESIDUAL SPACE
7.1 For the purpose of paragraph 5.1 of this Regulation, the residual space means the volume within the passenger compartment which is swept when the transverse vertical plane defined in figure 1(a) of this Regulation is moved in a straight line or lines so that the point "R" in figure 1(a) passes from the "R" point of the rearmost outer seat, through the "R" point of every intermediate outer seat to the "R" point of the foremost outer passenger seat.
7.2 The position of the "R" point shown in figure 1(b) shall be assumed to be 500 mm above the floor under the passengers’ feet, 300 mm from the inside surface of the side of the vehicle and 100 mm in front of the seat back in the centre line of the outboard seats.

8. INTERPRETATION OF TEST RESULTS
8.1 If body sections are tested, the technical service responsible for conducting the test facility shall ensure that the vehicle complies with the conditions specified in appendix 2 of annex 5 to this Regulation which contains requirements for the distribution of the main energy absorbing parts of the superstructure of a vehicle.

9. MODIFICATIONS OF THE VEHICLE TYPE AND EXTENSION OF APPROVAL NOT APPLICABLE
10. CONFORMITY OF PRODUCTION NOT APPLICABLE
11. PENALTIES FOR NON-COMPLIANCE OF PRODUCTION NOT APPLICABLE
12. PRODUCTION DEFINITELY DISCONTINUED NOT APPLICABLE
13. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS NOT APPLICABLE
Figure 1
RESIDUAL SPACE
(all dimensions in millimetres)

1 (a) LATERALLY

Templates to be fixed on the floor of the vehicle

1 (b) LONGITUDINALLY
Section A-A of the vehicle in the verticle plane of the centre-line of the inboard seats.

The foremost passenger seat of the vehicle

Note: See requirements of paragraph 7.2. of the Regulation
ANNEX 3
ROLL-OVER TEST ON A COMPLETE VEHICLE

1. TEST CONDITIONS

1.1 While the vehicle need not be in a fully finished condition it shall be representative of production vehicles in respect of unladen mass, centre of gravity and distribution of mass as declared by the manufacturer.

1.2 Driver and passenger seats shall be placed with their backs, if adjustable, in their most upright position. The height of the seats, if adjustable, shall be the highest position.

1.3 Every door and opening window of the vehicle shall be closed and latched but not locked. Windows and glazed bulkheads or screens may be glazed or unglazed at the applicant’s discretion. If they are unglazed an equivalent weight shall be imposed on the vehicle at the appropriate positions.

1.4 Tyres shall be inflated to the pressure prescribed by the vehicle manufacturer and, if the vehicle has an air-spring suspension system, the air supply to the air springs shall be ensured. Any automatic levelling system shall be adjusted with the vehicle on a flat, horizontal surface to the level specified by the manufacturer. Shock absorbers shall operate normally.

1.5 Fuel, battery acid and other combustible, explosive or corrosive materials may be substituted by other materials provided that the conditions prescribed in paragraph 1.1 above are met.

1.6 The impact area shall consist of concrete or other rigid material.

2. TEST PROCEDURES (see figure 1 of this annex)

2.1 The vehicle shall be placed on a platform in order to be rolled over on one side. This side shall be specified by the manufacturer.

2.2 The position of the vehicle on the platform shall be such that when the platform is horizontal:

2.2.1 the axis of rotation is parallel to the longitudinal axis of the vehicle,
2.2.2 the axis of rotation is 0–200 mm from the vertical step between the two levels,
2.2.3 the axis of rotation is 0–100 mm from the side of the tyre at the widest axle,
2.2.4 the axis of rotation is 0–100 mm below the horizontal starting plane on which the tyres stand, and
2.2.5 the difference between the height of the horizontal starting plane and the horizontal lower plane on which impact takes place shall be not less than 800 mm.

2.3 Means shall be provided to prevent the vehicle moving along its longitudinal axis.

2.4 The test apparatus shall prevent the tyres from sliding sideways in the direction of roll-over by means of side walls.

2.5 The test apparatus shall ensure the simultaneous lifting of the axles of the vehicle.

2.6 The vehicle shall be tilted without rocking and without dynamic effects until it rolls over. The angular velocity shall not exceed 5 degrees per second (0.087 rad/sec).

2.7 High-speed photography, deformable templates or other suitable means shall be used to determine that the requirement of paragraph 5.1 of this Regulation has been met. This shall be verified by the test facility at not less than two positions, nominally at the front and rear of the passenger compartment, the exact positions being chosen to ensure that compliance is demonstrated in the worst position(s).

Templates shall be fixed to substantially non-deformable parts of the structure e.g. the floor of the vehicle.
Figure 1
ANNEX 4
ROLL-OVER TEST ON A BODY SECTION

1. TEST CONDITIONS
1.1 The body section shall represent a section of the unladen vehicle.
1.2 The geometry of the body section, the axis of rotation and the position of the centre of gravity in the same vertical and lateral directions shall be representative of the complete vehicle.
1.3 The mass of the body section, expressed as a percentage of the unladen kerb mass of the vehicle, shall be specified by the manufacturer.
1.4 The energy to be absorbed by the body section, expressed as a percentage of the total energy which would be absorbed by a complete vehicle, shall be specified by the manufacturer.
1.5 The percentage of total energy described in paragraph 1.4 shall not be less than the percentage of total kerb mass described in paragraph 1.3.
1.6 The test conditions specified in paragraph 1.6 of annex 3 and in paragraphs 2.1 to 2.6 of annex 5 shall apply.

2. TEST PROCEDURE
2.1 The test procedures shall be the same as the procedure described in annex 3, except that the body section described above shall be used instead of a complete vehicle.
ANNEX 5
PENDULUM TEST ON A BODY SECTION

1. ENERGY LEVEL AND DIRECTION OF IMPACT

1.1 The energy to be transmitted to a particular body section shall be the sum of the energies declared by the manufacturer to be allocated to each of the cross-sectional rings included in that particular body section.

1.2 The appropriate proportion of the energy prescribed in appendix 1 to this annex shall be applied to the body section by the pendulum such that at the moment of impact the direction of motion of the pendulum makes an angle of 25° (+0°; -5°) to the central longitudinal vertical plane of the body section. The precise angle within this range may be specified by the vehicle manufacturer.

2. TEST CONDITIONS

2.1 A sufficient number of tests shall be carried out for the technical service test facility conducting the test to be satisfied that the requirement specified in paragraph 5.1 of this Regulation has been met.

2.2 For the purposes of the test body sections shall have sections of the normal structure fitted between the pillars in relation to the floor, underframe, sides and roof. Sections of such items as luggage racks, ventilation ducting, etc. where fitted, shall also be included.

2.3 Every door and opening window of the body section shall be closed and latched but not locked. Windows and glazed bulkheads or screens may be glazed or unglazed at the applicant’s discretion.

2.4 Where appropriate seats may also be included, at the option of the manufacturer, in their normal position in relation to the structure of the body section. The normal fixings and joints between all members and attachments shall be incorporated. The backrests if adjustable shall be in their most upright position and the height of the seats if adjustable shall be the highest position.

2.5 The side of the body section to be impacted shall be at the discretion of the manufacturer. Where more than one body section is required to be tested both shall be impacted on the same side.

2.6 High speed photography, deformable templates or other suitable means shall be used to determine that the requirement specified in paragraph 5.1 of this Regulation has been met. Templates shall be fixed to a substantially non-deformable part of the structure.

2.7 The body section to be tested shall be firmly and securely attached to the mounting frame through the cross-bearers or parts which replace these in such a way that no significant energy is absorbed in the support frame and its attachments during the impact.

2.8 The pendulum shall be released from such a height that it strikes the body section at a speed of between 3 and 8 m/s.

3. DESCRIPTION OF THE PENDULUM

3.1 The striking face of the pendulum shall be made of steel, or plywood 20 mm ± 5 mm thick, and the mass of the pendulum shall be evenly distributed. Its striking face shall be rectangular and flat, having a width of not less than the width of the body section being tested and a height of not less than 800 mm. Its edges shall be rounded to a radius of curvature of not less than 15mm.

3.2 The body of the pendulum shall be rigidly attached to two rigid bars. The axis of the bars shall be not less than 3,500mm from the geometric centre of the body of the pendulum.
CALCULATION OF TOTAL ENERGY ($E^*$)

ASSUMPTIONS

1. The shape of the cross-section of the body is assumed to be rectangular.
2. The suspension system is assumed to be rigidly fixed.
3. The movement of the body section is assumed to be pure rotation about point "A"
CALCULATION OF TOTAL ENERGY (E*)
If the fall of the centre of gravity (h) is determined by graphical method E* may be taken to be given by the formula:

\[ E^* = 0.75 \cdot M \cdot g \cdot h \] (Nm)

Alternatively, E* may be calculated by the formula:

\[ E^* = 0.75 \cdot M \cdot g \cdot \left( \sqrt{\frac{W^2}{2}} + H^2 - \frac{W}{2H} \sqrt{H^2 - 0.8^2} + 0.8 \frac{H_s}{H} \right) \] (Nm)

where:
- \( M \) = the unladen kerb mass of the vehicle (kg)
- \( g \) = 9.8 m/s\(^2\)
- \( W \) = the overall width of the vehicle (m)
- \( H_s \) = the height of the centre of gravity of the unladen vehicle (m)
- \( H \) = the height of the vehicle (m)
Annex 5 - Appendix 2

REQUIREMENTS FOR THE DISTRIBUTION OF THE MAIN ENERGY ABSORBING PARTS OF THE SUPERSTRUCTURE

1. A sufficient number of tests shall be carried out for the technical service test facility to be satisfied that the complete vehicle meets the requirements of paragraph 5.1 of this Regulation. This shall not necessarily require more than one test.

2. Calculations based on data obtained from a test on a body section may be used to demonstrate the acceptability of another body section which is not identical with the body section already tested if it has many structural features in common with it.

3. The manufacturer shall declare which pillars of the superstructure are considered as contributing to its strength and shall also declare the amount of energy (E_i) that each pillar is intended to absorb. These declarations shall meet the following criteria:

\[
\sum_{i=1}^{m} E_i > E^* 
\]

Where \( m \) is the total number of declared pillars

\[
\sum_{i=1}^{n} E_{iF} \geq 0.4E^* 
\]

Where \( n \) is the number of declared pillars forward of the centre of gravity of the vehicle

\[
\sum_{i=1}^{p} E_{iR} \geq 0.4E^* 
\]

Where \( p \) is the number of declared pillars to the rear of the centre of gravity of the vehicle

\[
L_F > 0.4 \ 1_f 
\]

\[
L_R > 0.4 \ 1_r
\]

\[
\frac{d_{\text{max}}}{d_{\text{min}}} \leq 2.5
\]

This shall apply only where \( d_{\text{max}} \) is greater than 0.8 \( \times \) maximum deflection permitted without intrusion of the residual space.

Where \( E_i \) is the declared amount of energy that can be absorbed by \( i^{\text{th}} \) pillar of the superstructure.

\( E_{iF} \) is the declared amount of energy that can be absorbed by \( i^{\text{th}} \) pillar forward of the centre of gravity of the vehicle.

\( E_{iR} \) is the declared amount of energy that can be absorbed by the \( i^{\text{th}} \) pillar to the rear of the centre of gravity of the vehicle.

\( E^* \) is the total energy to be absorbed by the complete structure of the vehicle.

\( d_{\text{max}} \) is the greatest amount of deflection measured in the direction of impact of any section of the body structure after it has absorbed its own declared impact energy.

\( d_{\text{min}} \) is the least amount of deflection, measured in the direction of impact and at the same point on the bay as \( d_{\text{max}} \), of any section of the body structure after it has absorbed its own declared impact energy.

\[
L_R = \frac{\sum_{i=1}^{p} E_{iR} \ 1_{IR}}{\sum_{i=1}^{r} E_{iR}} = \left( \text{Weighted mean distance of the declared pillars to the rear of the centre of gravity of the vehicle} \right)
\]
\[ L_x = \sum_{i=1}^{i=p} \left( \frac{E_{iR} l_{iR}}{\sum_{i=1}^{i=p} E_{iR}} \right) \]

Where \( L_x \) is the weighted mean distance of the declared pillars to the rear of the centre of gravity of the vehicle.

\( l_{if} \) is the distance from the centre of gravity of the vehicle of the \( i^{th} \) pillar forward of the centre of gravity.

\( l_{ir} \) is the distance from the centre of gravity of the vehicle of the \( i^{th} \) pillar rearward of the centre of gravity.

\( l_f \) is the distance of the front of the vehicle from the centre of gravity of the vehicle.

\( l_r \) is the distance of the rear of the vehicle from the centre of gravity of the vehicle.
ANNEX 6
VERIFICATION OF STRENGTH OF SUPERSTRUCTURE BY CALCULATION

1. A superstructure or sections may be shown to meet the requirement specified in paragraph 5.1 of this Regulation by a calculation method approved by the technical service responsible for conducting the tests.

2. If the structure is likely to be subject to deformations beyond the elastic limit of the materials used then the calculations shall simulate the behaviour of the structure when undergoing large plastic deformations.

3. The technical service test facility responsible for conducting the tests may require tests to be carried out on joints or parts of the structure to verify the assumptions made in the calculation.

4. PREPARATIONS FOR CALCULATION

4.1 Calculations cannot be started until the structure has been analysed and a mathematical model of it produced. This will define the separate members to be considered and identify the points at which plastic hinges may develop. The dimension of the members and the properties of materials used must be stated. Physical tests must be made on the hinge points to determine the force (moment of rotation) - deformation characteristics in the plastic mode as this is essential data for the calculations. The strain rate and the dynamic yield stress appropriate for this strain rate must be determined. If the calculation method will not indicate when a significant fracture will occur it will be essential to determine, by experiment separate analysis or appropriate dynamic tests that significant fractures will not occur. The assumed distribution of loading along the length of a vehicle shall be stated.

4.2 The calculation method shall include the deformations up to the elastic limits of the materials followed by the identification of where plastic hinges will form and the subsequent formation of other plastic hinges unless the position and sequence of formation of plastic hinges is known from previous experience. The method shall accommodate the changes of geometry of the structure that take place, at least up to the stage where the deformations have passed the acceptable limits.

Unless otherwise approved for the purposes of demonstration of compliance to this rule it is acceptable for the computer programme to exceed the measured force (moment of rotation) as determined by physical test by 10%.

The calculations shall simulate the energy and the direction of impact which would occur if that particular superstructure were to be submitted to the roll-over tests prescribed in annex 3. The validity of the calculation method shall have been established by comparison with the results of physical tests, which need not necessarily have been made in connection with the vehicle now being approved.

5. When a calculation method is used for a section of a complete structure, the same conditions shall apply as stated above for the complete vehicle.

Notes
1. Name of administration
2. Strike out what does not apply