

## APPLICABLE REGULATION SUMMARY

As an after market addition to a vehicle safety system the device must to not compromise the ADRs for a variety of cars of a variety of ages. For our purposes, the device must be considered part of the seatbelt assembly. It will have to comply with seatbelt requirements as stated in the ADRs. The applicable regulations are as follows:

### ADR 4/00 SEAT BELTS

The following clauses apply to the design of your device:

- Under ADR 4/03, Part 5.10, When installed the 'Seatbelt Assembly' webbing **must not contact any sharp edges which could abrade or cut the webbing during normal use or in an accident**. If necessary, the webbing must be protected.
- Under ADR 4/03, Part 6.1, Each 'Seatbelt Assembly' must be so designed that, with the adjustment provided, it must be capable of being 'Correctly Fitted' for:
  - o 6.1.1. in the case of the driver's seating position, a '5th Percentile Adult Female' with the seat in the rearmost driving position and a **'95<sup>th</sup> Percentile Adult Male' with the 'Seat' in the foremost driving position**; and
  - o 6.1.2. if installed at any other seating position, a '50th Percentile 6 Years Old Child' with the 'Seat' in the rearmost riding position and a '95<sup>th</sup> Percentile Adult Male' with the 'Seat' in the foremost riding position.
  - o 6.1.3. Furthermore, in the case of the fittings to the '95th Percentile Adult Male' in 6.1.1 and 6.1.2 above, the design must provide for at least 75 mm of additional 'Strap' in a 'Lap Belt' and **at least 75 mm of additional 'Strap' in both the lap 'Strap' and upper torso 'Strap' of a 'Lap-Sash Belt' or 'Harness Belt'**. The purpose of this clause is to accommodate a stouter person than represented by the 95<sup>th</sup> percentile anthropometric dimensions.
- Under ADR 4/03, Part 8.1, In all cases where the 'Strap' passes through another component, other than a 'Sash Guide' used in conjunction with an 'Emergency Locking Retractor', and there is relative movement between the 'Strap' and the component as a result of adjusting operations, the tensile strength of the webbing must not be reduced to less than 14.7 kN or 75% of the 'Dry Breaking Strength', whichever is the greater, after 2,500 cycles of relative movement under the following test conditions:
  - o 8.1.1. the tensile load in all parts of the test 'Strap' during the working stroke of the 2 strokes of each cycle must be not less than 13 N;
  - o 8.1.2. the working stroke must be not less than 150 mm nor more than 200 mm; and
  - o 8.1.3. the angle which the centreline of each end of the test 'Strap' makes with the component must be not less critical to 'Strap' abrasion than that nominated by the vehicle 'Manufacturer' as representative of such angle of the 'Strap' in use, when the assembly is correctly fitted for a '5th Percentile Adult Female' with the 'Seat' in the rearmost driving or riding position, except that in
    - o the case where the design provides for the centrelines of the straps to be separated when viewed normal to the plane of one 'Strap', then such angle of separation in the test may be any angle
    - o greater than 25°, and the angle of separation of the centrelines of the 'Straps' when viewed in the plane of one 'Strap' may be any angle less than 10°.

## ADR 5/04 ANCHORAGES FOR SEATBELTS

- Under ADR 5/04, Part 5.7. Strength of 'Anchorages',
  - 5.7.1. Testing of 'Anchorages' must be in accordance with the requirements of clause 8.
  - 5.7.2. **Each 'Anchorage' must be capable of supporting, for not less than one second, the load imposed on it by a body block** subjected to the appropriate load as specified in clause 5.7.4, the body block being attached to the 'Anchorage' under test and another 'Anchorage' as specified in clause 8.4.1.
  - 5.7.3. An 'Anchorage' may be tested in a test relevant to that 'Anchorage' only or in combination with tests on other 'Anchorages'.
  - 5.7.4. The loads to be applied to body blocks for testing of 'Anchorages' must be as specified in the following Table 3:

Table 3 The loads to be applied to body blocks for testing of 'Anchorages'

'ANCHORAGE' UNDER TEST	MINIMUM TOTAL LOAD TO BE APPLIED TO BODY BLOCK OR BLOCKS
'Lap Anchorages' provided for 'Lap Belt' system only.	22.0 kN for front-facing and side-facing seating positions. 9.0 kN for rear-facing seating positions.
'Anchorage' common to both pelvic and upper torso restraint in a 'Lap-Sash Belt' or 'Harness Belt' system.	22.0 kN for front-facing seating positions. 9.0 kN for rear-facing seating positions.
'Lap Anchorages' provided for pelvic restraint only in a 'Lap-Sash Belt' system.	13.3 kN for front-facing seating positions. 5.3 kN for rear-facing seating positions.
'Final Torso Anchorages' and 'Harness Torso Anchorages'.	17.7 kN for front-facing seating positions. 7.0 kN for rear-facing seating positions.

- Under ADR 5/04, Part 7.1. Lap 'Anchor Points'
  - 7.1.1. The two lap 'Anchor Points' provided for a particular seating position must lie on opposite sides of the 'Seating Reference Plane' in such a way that the sum of distances measured normal to the 'Seating Reference Plane' is not less than 165 mm.
  - 7.1.2. The lines joining the lap 'Anchor Point' to the extreme points on the 'Pelvis Reference Locus' must be inclined to the horizontal at angles of not less than 25° nor more than 80° when viewed normal to the 'Seating Reference Plane'.
  - 7.1.3. In cases where the line representing the centreline of the 'Strap' is not a straight line when viewed normal to the 'Seating Reference Plane' then:
    - 7.1.3.1. with the 'Seat' in its foremost driving or riding position the line passing through the foremost point on the 'Pelvis Reference Locus' and extending 'Rearward' to the first point of contact with the 'Seat' or other device **must be inclined to the horizontal at an angle of not less than 25°**; and
    - 7.1.3.2. with the 'Seat' in the rearmost driving or riding position the distance from the 'Pelvis Reference Point' to the lap 'Anchor Point' measured along the centreline of the 'Strap' must not exceed by more than 60 mm the distance from the 'Pelvis Reference Point' to the lap 'Anchor Point', except in the cases where the system is so designed that when tested in accordance with the load requirements of clause 5.7 the components of the vehicle or 'Seat' which cause the centreline of the 'Strap' between the lap 'Anchor Point' and the 'Pelvis Reference Point' to vary from a straight line, do not deflect or fail in such a manner that the effective length of the 'Strap' measured along the centreline between the lap 'Anchor Point' and the 'Pelvis Reference Point' is reduced by more than 60 mm.

The hook must withstand a load imposed on the lap belt portion of the restraint system of 13.3 kN. Fit tests will have to be carried out to check that the belt system still provides for 150 mm of additional webbing when fitted to a 95<sup>th</sup> percentile occupant in the foremost seating position. Additionally, the lab-belt angle remain at least at 25° in this configuration.

## ADR 69/00 FULL FRONTAL IMPACT OCCUPANT PROTECTION

### - Under 2 FUNCTION AND SCOPE

The function of this national standard is to specify vehicle crashworthiness requirements in terms of forces and accelerations measured on anthropomorphic dummies in outboard front seating positions in full frontal test crashes so as to minimise the likelihood of injury to occupants of those seating positions.

### - Under 3 APPLICABILITY

- 3.1 Applicability Summary
  - 3.1.1 This ADR applies to the design and construction of vehicles as required by clauses 3.1.2 and 3.1.3. and as set out in clause 3.2 .
  - 3.1.2 This rule is binding:
    - 3.1.2.1 from 1 July 1995 on all new model MA vehicles.

### - Under 5.1 Impact Velocity

The vehicle must be impacted at 48 km/h, into a fixed collision barrier that is perpendicular to the line of travel of the vehicle.

#### ○ 5.2 Test Dummy

A 'Test Dummy' in accordance with the following schedule must be placed at each designated front outboard seating position.

- 5.2.1 Until 1 January 1998, demonstration of compliance may be done with either 'Hybrid II' or 'Hybrid III' 'Test Dummies'.
- 5.2.2 From 1 January 1998 all vehicle models are be required to demonstrate compliance using 'Hybrid III' 'Test Dummies'.
- 5.3 Injury Criteria
- The 'Test Dummies' must meet the following injury criteria:
- 5.3.1 The resultant acceleration at the centre of gravity of the head must be such that the maximum value of the expression:

$$\left[ \frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a dt \right]^{2.5} (t_2 - t_1)$$

- must not exceed 1,000 where a is the resultant acceleration expressed as a multiple of the acceleration due to gravity, and t1 and t2 are any two points in time during the crash of the vehicle which are separated by not more than a 36 millisecond time interval.
- 5.3.2 The resultant acceleration calculated from the output of the thoracic instrumentation must not exceed 60 times the acceleration due to gravity, except for intervals whose cumulative duration is not more than 3 milliseconds.
- 5.3.3 Compression deflection of the sternum relative to the spine must not exceed 76.2 mm. This requirement only applies when a 'Hybrid III' 'Test Dummy' is used.
- 5.3.4 The force transmitted axially through each upper leg (femur) must not exceed 10 kN.
- 5.3.5 When there is no evidence of head contact with any part of the vehicle in front of the original 'Test Dummy' head position, other than with the seatbelt system or of head contact with the 'Test Dummy's' femur and/or knee, as determined in accordance with Clause 11, then the

- requirements of Clause 5.3.1 may be met by any of the following:
- 5.3.5.1 If a 'Hybrid II' 'Test Dummy' is used, the resultant acceleration measured at the centre of gravity of the head shall not exceed 75 g, except for intervals whose cumulative duration is not more than 3 milliseconds, when measured by the accelerometer whose sensitive axis is oriented to record inferior-superior accelerations.
- 5.3.5.2 If a 'Hybrid III' 'Test Dummy' is used, the neck injury measurements shall not exceed 3300 N of tension force in the inferior-superior direction.
- 5.3.5.3 If either 'Hybrid II' or 'Hybrid III' 'Test Dummies' are used, the maximum value of the expression in Clause 5.3.1 shall not exceed 700 when calculated between two points in time not separated by more than 15 milliseconds.

## DEVICE PROTOTYPE TESTING

### OBJECTIVES

The two major objectives to be met by the engineering analysis for the project can be summarized as:

- To ensure that the device complies with current regulations, and
- To ensure that the device is suitable for its intended use.

### TEST METHODOLOGY

A preliminary analysis of the design of the device was made to ensure that it was capable of meeting the requirements of ADR 4/00 Seat Belts and ADR 5/04 Anchorages of Seat Belts. A limited number of prototypes were manufactured for the various testing.

The prototypes have been subjected to the following testing:

- A prototype was subjected to material testing to check that the correct alloy and heat treatment had been used in the manufacture of the prototypes.
- A prototype was subjected to a simple static pull test by a seat belt webbing loop on the hook to ensure that it met the static test requirements of ADR 4/00 Seat Belts and ADR 5/04 Anchorages of Seat Belts.
- Four prototypes were subjected to dynamic sled testing based on the dynamic test requirement of ADR 4/00. This testing was conducted by Crashlab and used the test setup and sled pulse for testing to the AS/NZS 2596 Seat Belt Assemblies for Motor Vehicles. This test was designed as a test of the dynamic strength of the seat belt systems fitted to motor vehicles in Australia. The dummy used, normally a TNO 10, was exchanged for an instrumented Hybrid III test dummy of similar weight. The Hybrid III is used for the full barrier test in ADR 69/00 and ANCAP testing and is capable of being fully instrumented for the purposes of investigating the dummy responses fully.

For the test series the Hybrid III dummy was fitted with the following instrumentation, to allow comparison with the dummy reference values required by ADR 69/00 Full Frontal Impact Occupant Protection:

- Trial axial head accelerometers
- Chest displacement transducer
- Trial axial chest accelerometers
- Trial axial pelvis accelerometers
- 6 Channel femur load cells.

In addition the sled acceleration and the loads in the lap belt and the shoulder belt were recorded. Using the 6 Channel femur load cells for the legs allowed the test femur anterior/posterior bending moments to be recorded.