CIRCULAR 22/00-9-1

TEST PROCEDURES

ADR 22/00-HEAD RESTRAINTS

“A Guide for Inspectors”

This Circular is relevant to the Third Edition of the
Australian Design Rules gazetted as
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1 SCOPE

This procedure, when read in conjunction with other Circulars issued by the Administrator provides sufficient information, without reference to other standards, to conduct and audit tests on Head Restraints to demonstrate compliance with Australian Design Rule 22/00. For convenience reference to the ADR clause number is quoted in brackets against each appropriate paragraph of this procedure.

The equipment, orders of accuracy and step by step actions described in this procedure are drawn from the standards and recommended practices quoted in the ADR and from accepted laboratory and testing practices. While conformance with this procedure is sufficient to demonstrate compliance with the ADR, other equipment, orders of accuracy and procedures may be used provided it can be shown that they demonstrate compliance with the ADR.

This ADR calls for tests which demonstrate that:
(i) The Head Restraint meets defined dimensional requirements.
(ii) The Head Restraint will limit, under simulated rear end impact conditions, the rearward displacement of a headform.
(iii) The Head Restraint meets specified strength criteria. Either static or inertia test methods may be employed.

Note that tests on head restraints to demonstrate compliance with ADR 22/00 - Head Restraints, are often conducted in conjunction with seat and seat anchorage tests - refer Circular 3/01-9-1 and ADR 3/00, 3/01.

This procedure is intended primarily as a guide for Officers of the Australian Department of Transport and Communications or Agents acting on behalf of the Administrator when they carry out audit inspections of Test Facilities or witness tests for compliance with the ADR. This and other Circulars dealing with Test Procedures for ADRs may also be useful to vehicle manufacturers and testing organisations.

Nothing in this Circular, however, absolves the manufacturers from complying with the requirements as specified in the ADR which always remains the primary reference.

2 SELECTION OF TEST COMPONENTS

This procedure applies to the Head Restraint/Seat combinations provided for all occupant positions specified in the ADR and on vehicles subject to the design rule, as shown in ADR Applicability.

For static tests the Head Restraint(s) must be mounted on a trimmed and structurally representative seat frame such that the deflection of the seat back relative to the seat frame mountings is reproduced. Seat adjusters need not be used to mount the seat frame but any seat back hinges or latches which are in the production vehicle must be fitted to the test seat.

For dynamic tests the complete Head Restraint/Seat system must be mounted on its seat adjusters in a vehicle body or section thereof large enough to ensure that during actual impact any body distortion due to head restraint/seat loads would be contained within such body section.

3 IDENTIFICATION OF TEST COMPONENTS

The seat frame and particularly the seat back adjusters, hinges and linkages shall be structurally representative of the design condition as specified in the production drawings.

Further if dynamic testing is employed the testing facility must ensure that kinematically the mechanisms are also representative of the design condition.

If production parts are being tested they should be drawn from a batch which has passed normal quality control procedures. They should then be identified against the production drawings. If prototype parts are being tested they should be individually inspected on a component by component basis for both dimensional and material (composition, heat treatment and finish) compliance with the drawing.

In both cases the revision status or issue status of the drawing to which the assemblies have been checked must be stated on all test records.

Finally, a build record should be prepared showing the source and status of all material used. Should any used or out of specification material be employed, the testing facility should record and justify such use. The record should be of sufficient detail to completely identify the subject material in the future.

4 NUMBER OF TEST ASSEMBLIES

At least one complete Head Restraint/Seat system is required for each condition determined for the program. Where complete symmetry exists between left hand and right hand Head Restraint/Seat systems only one hand need be tested.

5 EQUIPMENT

5.1 Dimensional Tests

5.1.1 Determination of H-Point. Both the dimensional and physical tests called for in this ADR are specified using the H-point as datum.

For this ADR (and others) the H-point is taken to be the Seating Reference Point as specified by the vehicle manufacturer using the 90th or 95th percentile 2D manikin - refer to Circular 0-12-6. Sufficient drawing information from the manufacturer is required to locate the Seating Reference Point in side view relative to the seat frame and to set the seat back at the design angle.

5.1.2 Measurement. Using as datum the loading arm in the basic rig described in Section 5.2.1 all required dimensions can be measured using steel rules, set squares and similar devices.

5.2 Static Testing

5.2.1 Basic Equipment. Typically the equipment used incorporates a substantial loading arm
Where the tests can be conducted

5.2.2 Control. Where the tests can be conducted using only one actuator each load can be conveniently varied manually and the load increased using a single readout device until the required load level is reached. Where, because of the Head Restraint/Seat configuration, more than one actuator is required, some form of automatic control for each actuator is desirable. Typically this comprises a separate hydraulic circuit for each actuator each with its own pressure limiting valve which can be pre-set to the desired value thus ensuring that the correct load is applied approximately simultaneously to each item under test.

5.2.3 Determination of Displaced Torso Line. Provision must be made for recording the location of the displaced torso line when the specified rearward moment is applied about the seating reference point. Typically this is achieved geometrically by measuring the distance between a point on the arm and some datum on the test rig plate.

5.2.4 Determination of Headform Displacement. The dimensions to be measured is the distance between the rearmost point of the headform and the displaced torso line. Typically this is also achieved geometrically by measuring the distance between a point on the headform load applicator with the load applied and calculating the required distance given the measurement in Section 5.2.3 and other geometric data from the test rig.

5.2.5 Instrumentation. Each required load actuator must be provided with its own independent load indicator. Again, where the tests can be conducted using only one actuator a simple single indicator is adequate. Where, because of the Head Restraint/Seat configuration more than one actuator is required, instrumentation with multi-channel recording is usually required to give the necessary level of confidence.

5.2.5.1 Measurement. Usually two parameters - load and deflection are measured. This is typically achieved by a load cell and associated electronic equipment which is suitable for multi-load actuation cases as it provides both individual load monitoring during application and multi-channel recording. A simple readout device, such as a pressure gauge, may be used and each reading recorded manually. In this case however adequate calibration under quasi static conditions to determine the effect of seal friction etc must be made.

The deflection measurement is determined by two position measurements. These may be performed manually using hand held instruments such as steel rules or tapes or using protractors. Alternatively they may be performed automatically using linear potentiometers and associated electronic equipment.

5.2.5.2 Recording. Where automatic recording is used multi-channel light beam or pen recorders are suitable as they allow immediate reading to ensure that the required loads are achieved simultaneously in all actuators. One recording channel is required for each actuator. A system response of 10 Hz is satisfactory. Where single channel manual recording is used the data should be entered directly into an appropriate data sheet.

5.2.5.3 Order of Accuracy. Except where specified in the ADR or referred documents, the following order of accuracy is considered to be commercially achievable and should be taken as a guide. Instrumentation of lesser accuracy is
acceptable provided it is taken into account in determining the certainty of results. System accuracy for load and/or moment determination should be within ±5%. The order of accuracy of location measurements will depend on the geometry of the measuring system. If a protractor was used to determine displaced torso line positions an accuracy of ±10 minutes of arc would be required. If, however, linear dimensions were taken at a larger radius than the line of action of the load then ±3 mm would be adequate. In general the system of measurement should be capable of determining the displacements of the headform beyond the displaced torso line (after all measurements are considered, including those of the rig itself) within ±5 mm.

5.2.5.4 Calibration. Routine calibration of load cells and electronic elements and recording equipment is to be carried out in accordance with Circular 0-12-3. Prior to each series of tests it is desirable that the complete load measuring system be calibrated against a known standard, e.g. deadweight, universal testing machine or transfer calibration system at a number of points.

5.2.6 Fixtures. Each Head Restraint/Seat combination will require a set of adaptor brackets to allow the seat to be mounted to the test rig with the Seating Reference Point located co-incident with the pivot axis of the loading arm.

5.3 Dynamic Testing

5.3.1 Basic Equipment. Sled system capable of:
- Mounting a complete body (or part thereof) to which the complete test Head Restraint/Seat is mounted and to which a lap/sash seat belt can be attached.
- Accelerating the complete sled and body/seat system in which the dummy defined in Annex B has been installed with a pulse which falls between two half sine waves having amplitudes of 8’g’ (78.4 m/s\(^2\)) and 9.6’g’ (94 m/s\(^2\)) for deviations of 80 ms and 96 ms respectively.

5.3.2 Instrumentation. Sufficient equipment is needed to give a high level of confidence that the required acceleration levels have been achieved. High speed photography is typically used to allow analysis of the behavior of the dummy’s head during the test.

5.3.2.1 Measurement. Time and deceleration of the vehicle in the seat anchorage area are the only parameters requiring direct measurement. In practice this means measuring the deceleration at the base of the “B” post of the vehicle body. A minimum of 2 decelerometers, one on each side is required which together with their associated electronic systems should have a flat frequency response within ±5% to 1000 Hz. Extra accelerometers and other transducers, e.g. speed may be used at the discretion of the test facility. Dynamic displacement of the dummy’s head reference line is usually measured using a high speed photographic camera operating at 500 frames per second minimum. Where this approach is used it may be necessary to remove a section of the “B” post of the vehicle body to give an adequate field of view for the camera. This removed section can be replaced by additional struts in the body structure.

The dummy has a line painted clearly to identify the torso line and the head reference line (torso line extended).

The camera is located prior to the test such that its field of view covers the dummy’s path during the whole of the acceleration pulse. The photographic frame which shows the maximum relative displacement of the head reference line is used for measurement using a suitable protractor.

5.3.2.2 Recording. A multi-channel high speed recorder is required. If a light beam recorder is used a paper speed of 1.5 m/s minimum is usually satisfactory with galvanometers having a flat frequency response of 1 to 1000 Hz. One channel is required for each transducer. The recorder may have inbuilt timing line generation facilities to produce lines at 10 ms intervals. Alternatively an external time base source may be used.

5.3.2.3 Order of Accuracy. Timing lines should be within ±1% accuracy. Total deceleration measurement system accuracy should be within ±5%. Camera resolution should allow relative angular displacement of the head reference line with ±2 degrees to be measured.

5.3.2.4 Calibration. When decelerometer, amplifier and recorder accuracy are all taken into account achieving the required accuracy for deceleration measurement will mean calibration against a known standard, eg shaker table or reference accelerometer. This is over and above the routine calibration for each element in the system which should be carried out in accordance with Circular 0-12-3.

5.3.3 Fixtures. For dynamic testing the only fixtures required are those to allow the body shell (or part thereof) to be mounted to the sled to produce the equivalent of a forward acceleration.

6 PROCEDURE

6.1 Dimensional Tests

6.1.1 Setting Up. Using vehicle package drawing or specific ADR 22/00 compliance drawing information, determine suitable dimension to allow the Seating Reference Point and torso line to be located relative to the seat frame both vertically and horizontally. Also, from this drawing determine the design back angle relative to the seat base.

Using the adjustments provided in the basic rig described in Section 5.2.1 above, set the seat so that the pivot axis of the rig is co-incident with the Seating Reference Point. Mount the seat base.
rigidly to the rig base. Set the seat back to the design back angle relative to the seat base. Pivot the loading arm around the axis and clamp it at the angle which represents the torso line relative to the seat back.

### 6.1.2 Measurement
Make the following measurements by projecting normal to the loading arm and ensure that the following requirements are met:

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Requirement</th>
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<tr>
<td>Upper boundary of Head Restraint to SRP for any position of adjustment</td>
<td>700 mm minimum (Clause 22.2.2.2)</td>
</tr>
<tr>
<td>Upper boundary of Head Restraint to lower boundary</td>
<td>115 mm minimum (Clause 22.2.2.1)</td>
</tr>
<tr>
<td>Minimum width of Head Restraint between heights of 585 mm and 635 mm (individual seats) above SRP</td>
<td>170 mm minimum</td>
</tr>
<tr>
<td>Minimum width of Head Restraint (bench seats)</td>
<td>250 mm minimum (Clause 22.2.3)</td>
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### 6.1.3 Contour
Check that the construction and contour of the Head Restraint will decelerate horizontal movement of the head without concentration of load on it. (Clause 22.2.4).

### 6.1.4 Reporting Results
The results of each test are to be recorded in a complete internal report giving a full description of material tested, equipment used, results and order of accuracy. For submission to the Administrator the determined results for loads are to be recorded together with the internal report number in the appropriate section of the Summary of Evidence Report. See Section 8.

### 6.2 Static Tests

#### 6.2.1 Preparation for Test
Confirm that the mounting attitude for the seat assembly (or assemblies) is in accordance with the vehicle layout, that the production fixings at minimum production torque are used and that the back has been set to the design back angle. Mount the manikin back pan to the loading arm ensuring it is correctly located relative to the Seating Reference Point.

#### 6.2.2 Test
Apply a load to the loading arm which produces a 370 Nm rearward moment about the Seating Reference Point to the seat back through the manikin seat pan. Note that this moment is the maximum allowed and any instrument uncertainty should be deducted from the nominal figure in establishing set point. Measure the angular position of the loading arm with the moment applied. The centre line of the arm in this position represents the displaced torso line. (Clause 22.5.3). Remove the back pan and set the headform load applicator to act at right angles to the displaced torso line through a point 635 mm along that line up from the Seating Reference Point. Apply a rearward load through the headform which produces a 370 Nm moment about the Seating Reference Point. Note that this is a minimum figure and any instrumentation uncertainty must be added to the nominal figure to establish set point. Note also that for seats with more than one head restraint - e.g. bench seats - all restraints must be tested concurrently. (Clause 22.5.3).

Measure the position of the headform. Increase the load steadily until a load of 890 N (allowing for instrument uncertainty) is applied at the head form. Record if the head restraint or the seat frame fails before the 890 N load is achieved (Clause 22.5.4).

#### 6.2.3 Determination of Results
The only result to be determined is the dimension from the rearmost point of the headform to the displaced torso line. This is done geometrically using the two position measurements in Section 6.2.2 for displaced torso line and headform and using geometric data from the test rig.

#### 6.2.4 Reporting Results
See Section 6.1.4

### 6.3 Dynamic Tests

#### 6.3.1 Preparation for Test
Arrange the body (or part thereof) on the sled so that it is accelerated while moving forward. Confirm that the mounting arrangements of the seat assembly (or assemblies) are in accordance with the vehicle layout, that the production fixings at minimum production torque are used and that sufficient body structure in the area of the mountings is included in the test setup. Install the dummy in the seat and fit and adjust the lap sash seat belt. (Clause 22.4.2.) Review the instrumentation to ensure that all scales and zeros are correctly set and carry out any feasible insitu calibration. Conduct a series of pre-test trials with the seat and dummy removed and the equivalent mass added to the sled to adjust the rig to give an acceleration pulse within the limits stated in Section 5.3.1 (Clause 22.4.3). Re-install seat for test. It may be latched in its rearmost, highest position.

#### 6.3.2 Test
Start the camera and operate the test rig.

#### 6.3.3 Determination of Results
The deceleration-time profile is read from the recorder charts. Deceleration peaks of less than 3
milliseconds duration may be disregarded if they can be shown to be due to ‘ringing’ of the instrumentation. This should be done as soon as possible after the tests, re-checking that instrument scales etc are correctly set. Any charts etc are to be retained as original data. The photographic records of the maximum dynamic displacement of the head reference line with respect to the torso line of the dummy is to be selected. By enlarging this to a suitable scale the displacement angle is to be measured with a protractor.

6.3.4 Recording Results. See Section 6.1.4.

7 ANALYSIS OF RESULTS
The Head Restraint system is deemed to conform with ADR 22/00 if:-
The dimensional requirements in Section 6.1.2 are met,
The contour requirements in Section 6.1.3 are met, and
The head restraint does not fail before the 890 N load is achieved or the seat frame fails - whichever occurs first (Section 6.2.2) and the displacement of the headform as determined in Section 6.2.3 does not exceed 102 mm after allowing for measurement uncertainty, or
The angular displacement of the head reference line as determined in Section 6.3.3 does not exceed 45 degrees after allowing for measurement uncertainty.

8 SUMMARY OF EVIDENCE REPORT
The Summary of Evidence Report SE 22/00 is the only document to be sent to the Administrator for demonstration of compliance to ADR 22/00. The original test report identification number, the location of the test report, the test facility identification number and the determined results are to be recorded in the appropriate place in the SE 22/00 form for each relevant clause of the ADR.

9 PROCEDURE FOR DESIGNS WITH CERTIFICATION TO ALTERNATIVE STANDARDS
Where a copy is held of an official communication from the Administrative Department (of the approving government) giving no less information than that specified in Annex I to United Nations ECE Regulation No. 25/01 or 25/02 or where test results which would demonstrate compliance with FMVSS 202-33F.R.15065 are presented the head restraint will be deemed to be equivalent to the technical requirements of ADR 22/00 provided that the following Clauses of ADR 22/00 are met: 22.2.2, 22.2.3, 22.2.4 (Clause 22.6).
In addition ECE R 17/03 is acceptable subject to the above conditions for ECE R25/01 or 25/02. For vehicles which have an ECE approval to R17 the approval must be of the form 17 RA 03 xxxx indicating that the seat was approved to ECE R 17/03 and that at least one seat was fitted or was capable of being fitted with a head restraint.(Circular 22/00-3-1)

For ECE approvals the relevant section of Evidence Summary of form SE 22/00 shall be completed.

10 SUMMARY OF REFERENCES

ADR References
ADR Definitions
ADR 22/00 - Head Restraints
ADR 3/00,01 - Seat Anchorages

Circulars
Circular 0-12-2 - General Requirements for Test Facilities
Circular 0-12-3 - General Requirements for Calibration of Test Equipment and Instrumentation.
Circular 0-12-6 - Devices for use in Defining and Measuring Motor Vehicle Seating accommodation
Circular 22/00-3-1 - Interpretations.

Other References
SAE J211 (June 80) - Instrumentation for Impact Tests.
SAE - J826 (Apr 80) - Manikins for Use in Defining Seating Accommodation

Other Standards
ECE Regulation No. 25/01 and 25/02 - Head Restraints (Headrests)
FMVSS 202-33F.R. 15065. - Head Restraints - Passenger Cars
ANNEX A

(a) Determining Displaced Torso Line.
ANNEX A

(b) Determination of Head Form Displacement.

--- Initial position  --- Position at end of test

Force "F" to achieve 370 Nm moment about Torso Reference Point

Head Form options:---
165 mm Diameter Spherical
or:---
165 mm Diameter Cylindrical, 150 mm High.
ANNEX  B

Dynamic Test Dummy Data
1 Height and seating height of 95th percentile male.
2 Approved representation of a human articulated neck structure.
3 Clearly visible marks (for high speed photography) representing the torso line on the body and the head reference line on the head. The head reference line is the extension of the torso line when the dummy is placed horizontal on a flat surface with both the torso and the rear of the head in contact with the surface.