TECHNICAL REPORT

ISO TR 9790-1

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Road vehicles — Anthropomorphic side impact dummy —

Part 1 : Lateral head impact response requirements to assess biofidelity of dummy

Véhicules routiers — Mannequin anthropomorphe pour essai de choc latéral —
Partie 1 : Caractéristiques de réponse de la tête à un choc latéral permettant d'évaluer la biofidélité d'un mannequin

Reference number
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Foreword

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ISO/TR 9790-1, which is a technical report of type 3, was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

ISO/TR 9790 consists of the following parts, under the general title *Road vehicles — Anthropomorphic side impact dummy*:

— *Part 1: Lateral head impact response requirements to assess biofidelity of dummy*

— *Part 2: Lateral neck impact response requirements to assess biofidelity of dummy*

— *Part 3: Lateral thoracic impact response requirements to assess biofidelity of dummy*

— *Part 4: Lateral shoulder impact response requirements to assess biofidelity of dummy*

— *Part 5: Lateral abdominal impact response requirements to assess biofidelity of dummy*

— *Part 6: Lateral pelvis impact response requirements to assess biofidelity of dummy*

Printed in Switzerland

Road vehicles — Anthropomorphic side impact dummy —

Part 1 :
Lateral head impact response requirements to assess biofidelity of dummy

1.0 INTRODUCTION

The impact response requirements presented in this Technical Report are the result of a critical evaluation of data selected from experiments agreed to by experts as being the best and most up-to-date information available.

Two lateral head impact response requirements are defined, one based on the rigid surface cadaver impacts conducted by Hodgson and Thomas (1)* and the other based on the padded surface cadaver impacts of Association Peugeot-Renault (2). Padded surface impact tests of Hodgson and Thomas (1), McElhaney et al (3), Nahum et al (4), Nahum et al (5), Schneider et al (6) and Got et al (7) were not used since either the padding characteristics were not specified or a given piece of padding was subjected to multiple impacts changing its response characteristics. Detailed discussions of the influences of these factors on head acceleration data are given by Mertz (8), Mertz et al (9) and Mertz (10). The rigid surface impacts of McElhaney et al (3) were not used because the impact velocities were not given for each test. The rigid surface impact data of Got (7) were not used since significant skull fractures were produced.

2.0 SCOPE AND FIELD OF APPLICATION

This Technical Report is one of six reports that describe laboratory test procedures and impact response requirements suitable for assessing the impact biofidelity of side impact dummies. This Technical Report

*Numbers in parentheses denote papers in References, Section 6.0.

provides information to assess the biofidelity of lateral head impact response.

3.0 ISO REFERENCES

ISO DP 9790-2 Road Vehicles - Anthropomorphic Side Impact Dummy - Lateral Neck Impact Response Requirements to Assess the Biofidelity of the Dummy.

ISO DP 9790-3 Road Vehicles - Anthropomorphic Side Impact Dummy - Lateral Thoracic Impact Response Requirements to Assess the Biofidelity of the Dummy.

ISO DP 9790-4 Road Vehicles - Anthropomorphic Side Impact Dummy - Lateral Shoulder Impact Response Requirements to Assess the Biofidelity of the Dummy.

ISO DP 9790-5 Road Vehicles - Anthropomorphic Side Impact Dummy - Lateral Abdominal Impact Response Requirements to Assess the Biofidelity of the Dummy.

ISO DP 9790-6 Road Vehicles - Anthropomorphic Side Impact Dummy - Lateral Pelvis Impact Response Requirements to Assess the Biofidelity of the Dummy.

4.0 REQUIREMENT NO. 1

4.1 Original Data

Hodgson and Thomas (1) conducted a series of non fracture cadaver head impact tests. In their tests, cadavers were strapped on their sides to a pallet that was free to pivot about one end. The cadaver's head and neck were allowed to extend over the free end. The pallet was rotated upwards to achieve a prescribed distance between the head and the impact surface. Then the pallet was released producing the desired head impact. Rigid surface impact data for seven embalmed cadavers are summarized in Table 1. Listed in this table are the cadaver identifications, the head impact velocities, the equivalent free-fall drop heights

and the peak resultant accelerations measured on the side of the head opposite the impact site.

4.2 Response Requirement

Figure 1 is a plot of Hodgson's data in terms of the peak resultant head acceleration versus head impact velocity. For a linear spring-mass system dropped onto a rigid surface, the peak mass acceleration is directly proportional to the impact velocity. Assuming the head responds in a similar fashion, a corridor was drawn as indicated by the dashed lines shown in Figure 1. Note that all the data points lie within the dashed line boundaries. Based on these data, a reasonable response requirement is that the peak resultant head acceleration of a point on the nonimpacted side of the head should be between 100 G to 150 G for a 200 mm free fall drop onto a flat, rigid surface. This drop height will produce a 2 m/s impact.

4.3 Test Setup

This test is to be conducted using only the dummy's head. The dummy's head is to be positioned with a 200 mm spacing between it and a flat, rigid impact surface. The impact surface is to be horizontal and the head is to be oriented so that its midsagittal plane makes an angle of 35° with the impact surface and its anterior-posterior axis is horizontal. A "quick release" mechanism is required to drop the head onto the impact surface. The peak resultant head acceleration of a point on the non-impacted side of the head is to be compared to the response requirement. The peak resultant acceleration of the center of gravity of the head is to be recorded for future reference purposes.

4.4 Instrumentation

The dummy's head is to be instrumented with a triaxial accelerometer package located at its center of gravity. A second triaxial accelerometer package is to be located within the head cavity attached to the non-impacted side at a point on the transverse axis that passes through the center of gravity of the head. Accelerations are to be filtered using SAE Channel Class 1000.

5.0 REQUIREMENT NO. 2

5.1 Original Data

The Association Peugeot-Renault conducted a series of lateral head impact tests involving five cadavers. The first test involved dropping a cadaver 0.3 m onto a rigid impact surface. No data are given for this test. The remaining four cadavers were dropped from a height of 1.2 m onto a rigid surface covered by a 5 mm thick rubber pad. Two of these cadavers received skull fractures. Table 2 gives the peak resultant head accelerations for the two cadavers without skull fractures. Sufficient accelerometers (3-3-3 combination) were used to calculate the acceleration of the center of gravity of the head which are the accelerations given in Table 2. All acceleration data were processed using SAE Class 1000 filters. The padded surface data are compared to the rigid surface data in Figure 1. The padding that was used produced about a 20 percent reduction in peak head acceleration.

5.2 Response Requirement

The average of the peak resultant head accelerations given in Table 2 is 241 G. Allowing a plus and minus 10 percent deviation from the average gives a range of 217 G to 265 G for a 1200 mm drop onto the padded surface.

5.3 Test Setup

This test is to be conducted using only the dummy's head. The dummy's head is to be positioned with a 1200 mm spacing between it and the top of the padded impact surface. The head is to be oriented so that its midsagittal plane makes an angle of 10 degrees with the impact surface allowing the impact to the temporal/parietal region. The impact surface is to consist of a flat rigid surface covered with a 5 mm thick pad of natural rubber with the following characteristics:

Shore A Hardness = 50
Rupture Strength = 14 MPa
Tear Strength = 15 kN/m

The peak resultant acceleration of the head is to be compared to the response requirement.

5.4 Instrumentation

The dummy's head is to be instrumented with a triaxial accelerometer package located at the center of gravity of the head. Accelerations are to be filtered using SAE Channel Class 1000.

6.0 REFERENCES

1. Hodgson, V. R. and Thomas, L. M., "Head Impact Response", Vehicle Research Institute Report-VRI 7.2, Society of Automotive Engineers, 1975.

2. "APR Lateral Cadaver Drop Test Involving the Head," ISO/TC22/SC12/WG5 - Document N165, June 1986.

3. McElhaney, J. H., Stalnaker, R. L. and Roberts, V. L., "Biomechanical Aspects of Head Injury", Human Impact Response- Measurement and Simulation, Plenum Press, N.Y., 1973.

4. Nahum, A., Ward, C., Raasch, E., Adams, S. and Schneider, D., "Experimental Studies of Side Impact to the Human Head", SAE 801301, Twenty-Fourth Stapp Car Crash Conference, Oct. 1980.

5. Nahum, A., Ward, C., Schneider, D., Raasch, F. and Adams, S., "A Study of Impacts to the Lateral Protected and Unprotected Head", SAE 811006, Twenty-Fifth Stapp Car Crash Conference, Sept. 1981.

6. Schneider, D., Ward, C. and Newman, J., "ATD and Cadaver Head Response to Impact Loading", Proceedings of the 11th Workshop on Human Subjects for Biomechanical Research, San Diego, CA, Oct. 16, 1983. (Note: Data provided by Dr. Schneider).

7. Got, C., Patel, A., Fayon, A., Tarriere, C., and Walfisch, G., "Results of Experimental Head Impacts on Cadavers: The Various Data Obtained and Their Relations to Some Measured Physical Parameters", SAE 780887, Twenty-Second Stapp Car Crash Conference, Oct. 1978.

8. Mertz, H. J., "Biofidelity of the Hybrid III Head", SAE 851245, May 1985.

9. Mertz, H. J., Balser, J. S. and Mai, H. A., "Hybrid III and Part 572 Responses to Padded Forehead Impacts", NHTSA Docket 74-14, GM Submission USG 2380 - Attachment II, March 14, 1985.

10. Mertz, H. J., "A Critque of Schneider's Test Program to Compare the Head Impact Responses of a Part 572 Dummy, Hybrid III Dummy and Four Cadaver Specimens", NHTSA Docket 74-14, GM Submission USG 2380 - Attachment I, March 14, 1985.

TABLE 1 - SUMMARY OF HODGSON'S RIGID SURFACE LATERAL HEAD IMPACT DATA (1)

CADAVER I.D.	IMPACT VELOCITY (m/s)	EQUIVALENT FREE FALL DROP HEIGHT (mm)	PEAK RESULTANT HEAD ACCELERATION (G)
2864	1.92	188	107
2953	1.74	154	108
3030	1.92	188	135
3042	1.92	188	118
3083	1.92	188	96
3116	1.65	139	121
3184	1.74	154	101

TABLE 2 - SUMMARY OF APR PADDED SURFACE LATERAL HEAD IMPACT DATA (2)

CADAVER I.D.	IMPACT VELOCITY (m/s)	DROP HEIGHT (mm)	PEAK RESULTANT HEAD ACCELERATION* (G)
3	4.85	1200	230
4	4.85	1200	253

* Calculated C.G. accelerations.

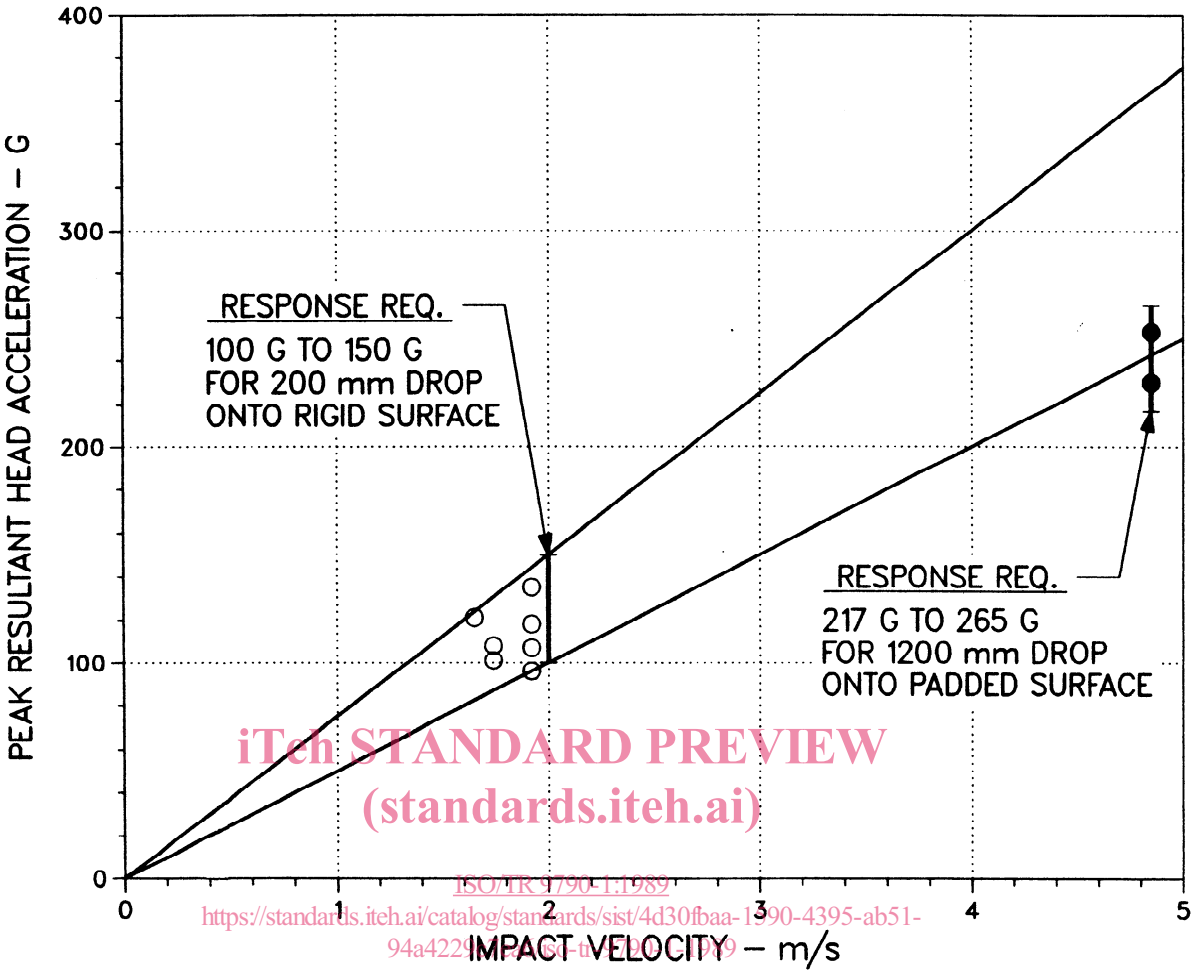

FIGURE 1. PEAK HEAD ACCELERATION RESPONSES FOR RIGID AND PADDED SURFACE LATERAL IMPACTS COMPARED TO THEIR RESPECTIVE PERFORMANCE REQUIREMENTS