EEVC/CEVE

European Experimental Vehicles Committee

EEVC Working Group 9

Side Impact Test Procedures

Final Report 1993

EUROPEAN EXPERIMENTAL VEHICLES COMMITTEE
WORKING GROUP 9 - SIDE IMPACT TEST PROCEDURES

- FINAL REPORT -

EEVC Working Group 9 was created in 1988 with three objectives:

1) To act as a focal point for technical advice and research support for EUROSID which may be needed by its manufacturers to help towards its final production design and to resolve any problems or production difficulties that might arise.

2) To appraise and consider side impact conditions for legislation.

3) To consider the viability of sub-systems or component tests used as a basis for mathematical models for legislation in comparison with full scale tests for this purpose.

The first meeting was held in July 1988 under the first chairman, Mr I Neilson, and the eighteenth and final meeting was held in June 1992.

1 EUROSID 1

The work of the EEVC Ad-Hoc Group on Dummies had resulted in a prototype version of the EUROSID dummy designed so that it could be manufactured in a reproducible way. EEVC WG9 produced a Status Report to the 1988 IRCOBI Conference on the Production Prototype[1]. The Production Prototype version had been released to other research laboratories for testing and evaluation and some comments regarding the performance in comparison with the ISO Lateral Impact Dummy Performance Requirement were received. WG9 reviewed again the base cadaver data used for the design of EUROSID and which contributed to generating the ISO performance corridors and were not satisfied that the ISO corridors all represented reasonable requirements for side impact dummies. WG9 decided to produce a set of performance target for side impact dummies which it considered to be based on the best available data. These were presented to the 1990 IRCOBI Conference.[2]

Following the experiences within EEVC and at other laboratories with the Production Prototype EUROSID, the opportunity was taken to improve the biofidelity in the areas considered important by WG9, the thorax and the pelvis. In addition, the abdomen transducer was changed from a switch, which only indicated whether the performance limit had been exceeded, to a force measuring transducer so that the absolute force could be determined.

Following the research that led to the improved design, the specification of the production version was decided at the 6th meeting in May 89 and announced at the 12th ESV Conference. At this time the specification of EUROSID 1, in terms of the essential principles of the design and performance of the dummy, were frozen.[3] Only detailed design modifications to achieve consistent production and performance might be changed after this date.

Production of EUROSID 1 by TNO/Ogle commenced early in 1990 and the biofidelity and repeatability of the dummy were evaluated by WG9 and reported at the 13th.ESV Conference[4]. This report concluded that, for the high priority areas of the body the biofidelity of EUROSID 1 was considered to be good or adequate while it was considered to be sufficiently biofidelic in the low priority body areas. The repeatability was found to be good, having a Coefficient of Variation well below 10% in most tests. Overall it was considered to be satisfactory for use both for research purposes and for use in a legislative side impact test.

Other laboratories have also evaluated the biofidelity of EUROSID 1 and the results of these studies have led the ISO/TC22/SC12/WG5 to issue a unanimous Resolution accepting EUROSID 1 and the GM/SAE dummy, BIOSID, as suitable dummies for use in side impact test procedures.

Also at the 13th ESV Conference, a revised and shortened version of the EEVC paper on Biofidelity Targets for Side Impact dummies was presented as a written paper.[5]

In 1990, NHTSA indicated that they would be considering issuing a Notice of Proposed Rulemaking which would propose the use of alternative dummies in FMVSS 214 on side impact protection. They would be proposing BIOSID based on their own and MVMA test data and would consider EUROSID 1 if similar data could be provided with this dummy. At the request of the steering committee, EEVC WG9 agreed to add the extra testing required to the existing biofidelity test programme, which involved supplementary sled tests and tests to FMVSS using EUROSID 1 on 5 specified US cars. In addition, supplementary information regarding production capability, supply, costs and durability experience was requested by NHTSA. The US specification cars proved difficult to obtain. Nevertheless, the tests were performed and the data supplied to NHTSA for all sled tests and 3 of the vehicle tests. The results for the other 2 cars are expected to be sent before the end of the year. No report on this has been issued since NHTSA requested the raw data rather than a report but it is intended to publish the results of this test programme in a paper to the 1993 SAE International Congress.[6] In December 1991, NHTSA issued an Advanced Notice of Proposed Rulemaking asking for comments on the desirability and need for specifying alternative dummies in FMVSS 214, mentioning EUROSID 1 and BIOSID as possibilities. WG9, on behalf of the EEVC responded to the relevant questions in March 1992.[7]

2 Side Impact Test Procedure.

The essential principles of the EEVC Side Impact Test Procedure had been laid down before the creation of EEVC WG9. Consequently little development work on the test

procedure was necessary. However, considerable experience had been built up in using the test procedure and this was collated and reported at the 12th ESV Conference.[8] The reproducibility of the test procedure was demonstrated by the results of 4 tests at 3 test laboratories on a small European car. Except for the HIC values, all of which were well below the performance requirement, and the pubic symphysis force, the results were very consistent. Subsequently, the design of the pubic symphysis transducer, which was known to give problems, was changed. The dummy responses were shown to be sensitive to barrier impact speed but not very sensitive to barrier mass. Comparisons were made from tests at 3 establishments between the NHTSA and the EEVC test procedures. It was concluded that there was very little difference between the crabbed mode and the perpendicular mode of impact, the crabbed mode being marginally less severe. The NHTSA test procedure was seen to be more severe to the pelvis but less severe to the thorax than the EEVC test procedure. However, the same car impacted by another car produced similar pelvic responses but even higher thoracic responses than either the NHTSA or the EEVC test procedure. This last conclusion is likely to be dependent on the model selected for the bullet vehicle.

The EEVC test procedure specifies the mobile barrier deformable face in terms of a performance specification giving force/time corridors for the deformable elements This was an essential step in the development of the test procedure No design produced could meet the corridors exactly. Consequently GRSP modified the requirements to permit certain excursions from the corridors Tests using different barrier designs indicated that the small differences in force-time responses within the corridors could produce significantly different results in the test, probably due to differences in structural collapse patterns. This led WG9 to the conclusion that the MDB face design should be specified in a legislative test procedure. The original performance specifications had fulfilled their task in generating appropriate MDB face designs and now one of these should be selected as the barrier face for legislation in the interests of consistent test results and the practicality of reproducible and certifiable faces. The EEVC steering committee approved this decision in April 1990 and the Side Impact Test Procedure was revised and produced as an EEVC Report.[9]

Finally, a paper was presented in written form to the 13th ESV Conference describing the experiences of using EUROSID 1 in the EEVC test procedure, previous reports having relied on results using the Production Prototype.[10] This showed that, in 22 tests, there was a good spread of all injury parameters, usually distributed about the performance criteria. It demonstrated the differences in dummy responses between 2/3 door cars and 4/5 door cars and smaller differences between small, medium and large cars. It showed that the dummy and test procedure were sensitive to design differences and that it is practical to meet the requirements with all styles and mass groups tested.

In none of the tests reported in the paper did the HIC exceed 1000, the highest recorded value being 640. In the test procedure, it is extremely rare for the head to make contact with the interior of the vehicle However, this is known to occur in accidents to a significant degree. WG9 has examined a number of accident studies and has concluded that there is a wide range of contact positions resulting in serious head injury. These areas will not be evaluated by the current EEVC test procedure. Consequently WG9 has recommended the development of a headform lateral sub-systems impact test. This will be progressed by EEVC WG13.

3 MATHEMATICAL MODELLING AND COMPONENT TESTS.

EEVC WG9 sought advice and contributions from experts with considerable experience at modelling vehicle impact phenomena and others with expertise in legislative testing to review the potential for this type of approach in legislative approval testing of vehicle crashworthiness, particularly regarding side impact. The advantages of such an approach were clear, including repeatability, early application in the design sequence and the ability to evaluate a wider range of impact conditions, speed and sizes of occupant. However, the difficulties of combining the technical simplicity and 'black box' methods required for legislative testing with the very complex nature of side impacts requiring input data from multiple load paths and the ability to use quasi static test data under dynamic conditions led to the conclusion that it would not be possible to use this approach in the near future. Calculations suggested that claimed cost savings were not likely to be as great as had been claimed. WG9 took a very general view of the subject for its main report[1], considering the requirements for all aspects of modelling and sub-systems data generation.

In an Appendix to the Report, a set of requirements for a simulation model and a sub-systems test were listed together with the comments of WG9 regarding the degree to which the Composite Test Procedure, proposed then by the CCMC, fulfilled these requirements. Many of the requirements were not met or partially met, leading WG9 to conclude that the model used within the procedure was oversimplified and could not reproduce some of the phenomena observed in experimental full scale tests.

Since 1990, WG9 has maintained an interest in the developments of the CC-CTP, the computer controlled CTP, and some of the Working Group members are participating in the work of the GRSP Ad-Hoc Group that is developing a programme to evaluate the degree of equivalence between the Full Scale Test and the CTP.

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Chairman, EEVC Working Group 9.

1. EEVC WG9 Status Report of the Production Prototype EUROSID 1988. Proc IRCOBI/EEVC Workshop on the Evaluation of Side Impact Dummies. Bergish-Gladbach. 1988.

2. EEVC WG9 Review of Cadaver responses to Lateral Impact and Derived Biofidelity Targets for Dummies. Proc 1990 IRCOBI Conference, Lyon. Sept 1990.

3. EEVC. Specification of the EEVC Side Impact Dummy EUROSID 1. European Experimental Vehicles Committee. April 1990.

4. EEVC WG9 The Biofidelity of the Production Prototype Version of the European Side Impact Dummy 'EUROSID 1 '. Proc 13th. ESV Conference, Paris 1991.

5. EEVC WG9 Test Procedures for Defining Biofidelity Targets for Lateral Impact Test Dummies. Proc 13th. ESV Conference, Paris 1991.

6. EEVC WG9 Car Side Impact Tests and Sled Tests Comparing EUROSID 1 and SID. Submitted to 1993 SAE International Congress and Exposition, Detroit, March 1993.

7. EEVC WG9 EEVC Working Group 9 Response to ANPRM on Anthropomorphic Test Dummies; Side Impact Protection, Docket No. 88-07; Notice 4. *(Unpublished)* 6 March 1992.

8. EEVC WG9 Report on the Side Impact Test Procedure. Proc 12th ESV Conference, Gothenburg, May 1989.

9. EEVC. EEVC Report on the Side Impact Test Procedure. European Experimental Safety Committee. April 1990.

10. EEVC WG9 Experiences of Using EUROSID 1 in Car Side Impacts. Proc 13th.ESV Conference, Paris, 1991.

11. EEVC EEVC Report on the Viability of Component Tests used with Mathematical Models as a basis for a Legislative Side Impact Test Procedure. European Experimental Vehicles Committee. April 1990.

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