STATUS REPORT OF THE PRODUCTION PROTOTYPE EUROSID's 1988

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Abstract.

The paper briefly describes the development of the EUROSID dummy and the progress made towards the production dummy EUROSID-1, which will be available early in 1989. The paper reviews experiences with the first production prototype EUROSID's, which has raised some real and apparent problems. These problems are discussed and changes in operating procedures or modifications to the dummies are presented.

1. Introduction.

The First Prototype EUROpean Side Impact Dummy (EUROSID), was fully described at the EUROSID seminar held in Brussels December 1986 (1). At that meeting results were presented on tests performed within the design laboratories on four dummies as part of an EEC validation programme. Following experiences gained in the validation programme minor improvements were made to the dummy. The Production Prototype EUROSID is described in separate EEVC documentation (2). Twenty five production prototype dummies have been made by a consortium of manufacturers. The purpose of the limited production was to enable a wider community to gain experience with the dummy prior to finalising the production version of the dummy; EUROSID-1. Full details of test results are not presented in this paper. The paper reviews a) The production situation of EUROSID, and b) Some of the real and apparent problems that have been reported by users, and discusses the measures that have and are being undertaken to resolve the difficulties experienced.

EUROSID has been developed to study impacts in a lateral direction. The dummy is possibly the most complex yet produced for use in crash testing within the automotive industry. The main reason for such a sophisticated dummy is that the dummy must monitor direct loading over many body elements in order to study full body protection with interactions. This same detailed body coverage is not as important in frontal impacts. Since the dummy is such a new and complex tool the expertise necessary to use it correctly is that much greater. In addition the handling and certification procedures are more comprehensive in order to maintain repeatability and reproducibility. TNO have compiled a comprehensive set of User's Manuals (3) for the dummy and have held two training courses for EUROSID users. Other training aids are detailed later.

The current Production Prototype EUROSIDs are very similar to the four First Prototype dummies. The principal areas of difference are:-

a) Arms with a flexible skeleton.

b) A productionised and modified thorax transducer system.

c) A modified rib design.

d) A symmetrical and positively located foam abdomen insert.

e) A skinned pelvic flesh system.

Some of the reasons for these changes are detailed Section 4 of the paper. Comments recieved from users of EUROSID have indicated that a few more improvements could usefully be made to the current Production Prototype dummy. The rest of the paper reviews progress of the Production Prototype dummy by body region and describes the improvements that will be incorporated in the production dummy EUROSID-1 and revised certification procedures.

2. EEVC Working Group 9.

The design and development of EUROSID has been overseen by a EEVC Ad-Hoc dummy group. The work of this Ad-Hoc group terminated early 1988. Experiences with the Production Prototype EUROSIDs are now being reviewed by a new EEVC Working Group on Side Impact. The new working group, WG9, has been created by the EEVC to give advice on a wide range of topics related to the Side Impact Test Procedure. The group does not envisage that there will be any major design changes between the current Production Prototype EUROSID and EUROSID-1. The terms of reference of the new group are :-

1. to act as a focal point for technical and research advice on EUROSID, and to provide technical support for its final production.

2. to evaluate and advise on side impact test conditions for legislation.

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

It is expected that the work of the group will be complete in two years but that a response to item 3 should be completed by early 1989.

3. Distribution and Support of EUROSID.

A joint venture between TNO in the Netherlands and Ogle Design Limited in the United Kingdom has been set up for the production and sales of EUROSID. In this partnership Ogle is responsible for the purchase and production of parts, as well as for quality control. TNO is responsible for the final inspection and certification of the dummy, documentation, marketing and sales. In 1987 and 1988 approximately 25 Production Prototype dummies have been delivered to governments, research organisations and car industry in Europe, North America and Japan. Furthermore dummy spares and certification equipment have been supplied to EUROSID users. Parts for stock are being produced to guarantee short delivery times.

The Production Prototype EUROSID dummies have and are being evaluated in extended research programs. It is known that several organisations are evaluating EUROSID in large numbers of full scale tests according to the European and American proposed side impact regulations. Furthermore the biofidelity of EUROSID has been assessed by several users in extensive research programs according to the ISO procedures. It appears that the Production Prototype EUROSIDs have now been tested in several hundred impactor, drop and sled tests as well as full scale vehicle impacts.

Two EUROSID training courses have taken place in Delft. These three day courses, in June and December 1987, were attended by a total of 30 technicians and test engineers. More training courses will be organised in future aimed at appropriate users. At each course EUROSID User's Manuals (3) were supplied along with information and practical demonstrations on dummy design, instrumentation, assembly, handling and certification procedures. In the near future certification procedures will be summarised on posters or wall charts for permanent display in the user's laboratories. Furthermore a regular EUROSID newsletter will be sent to users with information on current production and sales, dummy problems and solutions, and updates.

4. Performance of Production Prototype EUROSID.

Following the end of the EEC validation programme several minor changes were made to EUROSID. All the dummies now in service are to this later specification. From the testing now taking place it has been concluded that the Production Prototype version requires a few further minor improvements before being finally specified. Mechanical breakage of a neck, wrist and thread damage to a rib modules have been reported. Tears in pelvic flesh has occurred as well as some permanent set in a couple of ribs. However there is no indication of any particularly weak areas in the dummy. The main trouble has been instrumentation of the thorax with more minor problems being associated with the abdomen and pelvis. Some of the failures that have been reported, both mechanical and instrumentation, are due to misuse of the dummy (eg:- tears in the abdominal flesh through incorrect assembly methods). Reviewing the dummy by body area the following improvements will be incorporated on all future dummies.

4.1. Head.

No major comments have been received regarding the head. Even so there is some concern that the head is not specifically manufactured for lateral impact. To improve the situation, attention is being directed towards a specification for the smoothness of the lateral surface of the aluminium skull and to the skin thickness over these surfaces. A Hybrid III head is still to be used with EUROSID-1.

4.2. Neck.

The basic design of the neck will not be changed. Improvements in manufacture should improve the reproducibility and biofidelity of the neck. In order to adjust the neck, to comply with the certification requirements, some replaceable parts will be made available.

An improved and simpler neck certification is being developed, based on the Part 572 neck pendulum, but using a symmetrical headform. Further details are described in Section 5.2.

4.3. Arms and Shoulder.

Several comments have been received on this part of the dummy, principally concerned with the adjustment of the joints and the stiffness of the wrist joint. The lack of adjustment is not considered to be important and no changes are to be incorporated. A stiffer wrist will to be incorporated to assist in the setting up of the arm in vehicle impacts.

4.4. Thorax.

4.4.1. Displacement Transducer.

The EUROSID thorax displacement transducer is a specially developed reflective opto transducer reading a code strip. The basic principle of a reflective head had been carried over from the French APROD dummy.

The transducer system supplied with the Production Prototype dummy is different from that used in the first four validation dummies (1). The measuring technique is the same, a repeated four bit gray code. The electronics for the first dummies were hand built and failed on several occasions, mainly due to heat dissipation and high 'g' levels. The transducer heads used fibre optic guides and were not interchangeable. To rectify these and other problems the unit was rationalised and compressed onto printed circuit boards. The transducer heads and electronics were modified to enable head interchangeability and reduce optical alignment difficulties.

Most of the Production Prototype EUROSIDs have experienced problems with this second generation thorax displacement measuring transducer. The components that are now giving trouble are different from those identified in the original units. Two problem areas with the current system have been reported by users. i) Unexplained DC offsets on the analogue ports occurring throughout the recording, and ii) Corrupt recordings. The former problem has only been seen on a couple of occasions and has not caused major trouble. It has had little effect on the displacement record apart from the signal being offset from its electrical zero position. The latter problem has caused major difficulties with resulting displacement records bearing, in the worst case, little resemblance to the actual event.

4.4.1.1. DC offset.

In a couple of tests, nearly all vehicle impacts, a DC offset signal has been observed on the analogue output from the electronics. The offset has occurred between the recording of the calibration pulse and the dummy or vehicle impact test. Since no recorders have been left running between calibration and test no records have been obtained from which an investigation into the problem could be made. Offsets have been observed if the power supply has not been correctly earthed. In addition the problem has also been seen to disappear if the dummy itself is earthed. It is therefore important to use good quality earthing on all parts of the system and any earth loops should be removed. A second possible cause of the offset may be due to voltage spikes cause by winch motors etc that power the impact. Unfortunately this mechanism of failure has not been confirmed but since the electronics continually scan for a peak event it could be a possible failure mode although the likelihood of this is slight. It appears that this apparatus may be sensitive to the electrical environment in which it is used. To minimise the risk of problems that could be caused by electrical interference it is important to ensure a good earth to the electronics and good screening on all instrumentation cables.

4.4.1.2. Record corruption.

Record corruption has been observed in many of the Production Prototype dummies. Most problems have been observed in vehicle, drop and sled impacts. Few failures have been noted in pendulum and certification tests. In most cases the fault results in an end of record displacement error of plus or minus 8 mm, or multiples of 8 mm. As well as a final offset signal one or more discontinuities are found in the transducer record during the impact.

4.4.1.3. Record correction.

TNO have developed two techniques to recompile a corrupt displacement recording depending upon the filtering level of the recorded data. The techniques involve shifting the signal by 8 mm about the point of failure and deriving the pulse shape through the failure from information obtained from the good parts of the pulse. The recompilation techniques produce displacement records that are good enough for derivation of rib velocity and the parameter of Viscous

Criteria (VC). The derived records have been validated by comparison with integrations of acceleration records obtained from struck and non struck side rib accelerometers. Full details of these procedures are not included in this paper but are available from TNO.

4.4.2. A new Transducer head.

It is believed that the occasional DC offset problems can be overcome by improved handling procedures. The corrupt record problem can only be overcome by design change. Virtually all errors have occurred in vehicle impacts and in tests in which the dummy was rapidly accelerated or decelerated. Few if any errors have been reported in component tests with a direct localised impact. These test conditions have directed effort into examination of the transducer head itself rather than the processing electronics. A new code strip, giving a very high black and white contrast signal still failed during vehicle impact. Research has indicated that the problems lie in the principle of a reflected signal transducer and in the levels of acceleration applied to the optical devices. To overcome these major problems a new head has been developed and successfully tested. The new head directly replaces the existing head and uses the existing electronics. The principle of the cycled four bit gray code is retained giving a resolution of 0.5 mm. All the optical electronics and scales are contained within the new transducer head. The biggest difference between the old and new heads is that the optics are transmissive and not reflective thus reducing to a minimum the problems of optical alignment and scale contrast. Displacement of the rib is now measured parallel to the piston rather than directly from it. The point from which displacement is now read is the location of the rib accelerometer. A facility is retained for fitting accelerometers to the ribs. The new transducer head has been thoroughly tested on a vibration table at a wide range of frequencies and accelerations without fault. Nine of the new heads have been tested in several dummies by different organisations with no reported failures.

4.4.3. Rib Piston Cylinder.

4.4.3.1. Mechanical Performance.

Few mechanical failures have been reported concerning the rib module. A few dampers have been found to leak slightly but a small improvement in the design of one of the damper components has overcome this problem. In a few severe vehicle impacts some of the thread inserts in the end of the piston have failed. This was caused by insufficient screw engagement in the thread insert. Longer screws on the struck side of the rib attaching it to the piston will overcome this problem, also improved thread inserts will be used on all future dummies. In a couple of severe vehicle impacts some permanent distortion of the ribs has been observed.

4.4.3.2. Overall Performance.

Some rib displacement verses time records from car impacts have indicated that peak rib compression has remained constant for, what might be considered, an excessively long period, possibly up to 30 ms (ie. the response has been very flat topped). In addition the transition between rib movement and non movement has been rapid, even though it has occurred at displacements of less than 50 mm, before bump stop involvement. This event has led some users to the conclusion that the rib had stuck during the test, either due to piston bending and binding in the bearings or due to excessive friction within the bearings. It should be noted though that the rib has never been found to remain compressed at the end of the impact. To resolve this potential area of difficulty two paths of research are currently being progressed. 1) to isolate the reason for the flat topped displacement record. and 2) to examine other bearings to determine if the current bearing is the best available for this application. Unfortunately neither line of research has been completed but some preliminary observations can be made.

The flat topped displacement record observed in some impacts has not been observed in component or rib certification tests. To determine if the flat topped displacement could be a real event within a vehicle impact rather than a dummy phenomena some computer simulation work has been carried out using the TRRL model developed by Langdon (4). The standard Langdon simulation model simulates either with a fixed or free spine. The fixed spine model simulates the certification test environment. The output from this computer model is in good agreement with the rib test giving a response that is not flat topped. One basic difference between certification and car impact is that the spine is allowed to move. The computer model of the rib module was modified to include a spring between the spine mass and ground. The spine spring can be considered to represent the lumbar and neck components as well as the dummy to seat interaction. This model, which did not include any modelling of piston friction, indicated that under certain conditions long periods in which there was little change in displacement could occur, and the transition to these periods could be quiet rapid. The certification equipment was subsequently modified to incorporate a sprung spine permitting movement the rib module as well as the rib. The displacement traces from this modified certification equipment gave repeatable flat topped records in agreement with the computer predictions. Work is still being carried out to further clarify the conditions for flat topping.

The bearings used in the rib module are plain unlubricated bearings using a PTFE based material. (Glacier DQ bearing material). An unlubricated bearing was selected to reduce contamination by foreign matter which could reduce bearing life and cause jamming of the piston. Three other types of bearing are now being evaluated. A different PTFE aluminium based plain bearing and two designs of linear roller bearing. It is acknowledged that the velocities and accelerations in the rib are well outside the specifications for roller bearings but it is thought that this type of bearing could be used if a much reduced bearing life was accepted. The three new bearings are being compared to the existing bearings in the modified certification rig described above. Only the plain bearing has so far been evaluated. In an unlubricated condition piston jamming frequently occurred, with the rib remaining compressed after the impact. In addition the bearing exhibited severe 'slip - stick' movement. Bearing operation improved when it was well lubricated but the displacement records were quiet variable depending upon the amount of lubrication present. Lubrication with the roller bearing may also be a problem area. A full analysis of the tests with the alternative plain bearing have not yet been carried out. No changes are being proposed to the rib module for EUROSID-1 unless the current research identifies a major fault.

It should be noted that both TTI and VC peak before the displacement time record becomes flat topped.

4.4.4. Rib acceleration.

Several users of EUROSID have reported that their data processing software has indicated that the peak rib acceleration has occurred at the end of the rib rebound phase and not during the loading impact. This has shown that in some cases rib accelerations are greater in padded tests than in non padded tests. Three peaks in rib acceleration can be observed in rib acceleration. Firstly the main impact onto the rib. Secondly, if maximum rib displacement is reached, an impact occurs as the rib contacts the bump stop at the end of rib stroke. Thirdly an impact occurs as the rib expands again and the guide pin reaches the end of the slot in the rib cylinder. The largest of these accelerations can be the third of the impacts. This high 'g' impact could be attenuated if the damper was connected to the rib in tension as well as compression. Technically this is not easy to achieve within the space envelope available while still permitting setting up adjustment. During development of the thorax this feature was addressed, but it was considered more important to concentrate development resources into the loading phase of the impact, since it was considered that this would be the injury producing phase. It is therefore important when analyzing EUROSID test data to examine the time of events in the impacts and to determine the cause of the signal rather than to simply rely on plus and minus peak readings from computer software. The connection of the damper in tension is being examined, but there is no proposal to make changes in future dummies.

4.4.5. Rib stroke.

Several comments have been made concerning the length of stroke of the rib module. The distance of 50 mm was determined in the original design specification from the early work of the Association Peugeot Renault organisation (APR). The proposed thorax tolerance limit relating to compression is 42 mm. This is within the overall compression capability of the thorax. Subsequent biomechanical research has indicated that a compression range of about 75 mm would be more desirable. EUROSID users have indicated that they would prefer more than the 8 mm of over travel currently provided. It is not possible within the existing design to provide more than the 50 mm of stroke plus bump stop compression and still allow tuning of the rib module for reproducibility. The bump stop compression allows for a couple of extra millimetres of rib stroke but this compression is of unknown performance. Since the proposed tolerance limits suggested for use with the thorax are within the scope of the existing design no changes are to be incorporated in the production version of the dummy.

4.5. Abdomen and Lumbar spine.

4.5.1. Instrumentation.

The EEVC considers the current design and performance of the event switches in the abdomen sufficient for legislative testing. These switches produce a positive signal if a fixed penetration limit and force has been exceeded. However for vehicle development it appears to be important to know the magnitude of the failure. TNO is therefore developing an alternative instrumentation system with continuous force measuring capabilities. This alternative instrumentation should fit in the current design without affecting the abdomen's performance. Research is now taking place on pressure foils, load cells and strain gauges.

4.5.2. Performance.

Abdomen's have performed well in all the tests that have been reported. Two problem areas have been identified. Firstly in the flesh system. Some tears in the sagittal plane of the flesh insert have occurred. The tears have not been caused by impact but by insert removal in a manner not recommended in the operating procedures detailed in the User's Manual (3). When the insert is correctly removed tears should not occur. The second problem has been one of premature switch contact. This was caused by the incorrect soldering of the wires onto the tape switches, reducing the effective gap in the switch. No changes are to be made to the abdomen flesh or tape switches for future dummies.

4.5.3. Specification of Lumbar spine.

No published biomechanical data has yet been found on which to base a lumbar spine certification for the lateral direction. It is becoming apparent that it is important to have a well specified lumbar as its performance could affect the performance of associated body segments. The lumbar used in the EUROSID is the same as that used in the Part 572 dummy. This lumbar was developed for frontal impacts. The Part 572 lumbar will be retained in EUROSID until further biomechanical research has been performed on which to develop a full lateral specification. From the research so far performed with EUROSID and computer simulation it has become necessary to develop an interim lateral lumbar certification, in order to ensure dummy reproducibility. A review of a number of Part 572 lumbars will shortly commence using a pendulum test procedure described in Section 5.5. A simple certification test will then be developed for lumbars to be used in EUROSID. This work will be completed by the end of 1988.

4.6. Pelvis.

4.6.1. Instrumentation.

The EUROSID pelvis is designed to measure the lateral compressive force in the pubic area. It was proposed to use a strain gauge force transducer (Model FTM 10 made by G.S.E.). It has been found that this transducer is sensitive to off-axis loads which may occur during impact. The output of the transducer can vary by as much as 30% depending upon its rotary position. Two improved transducers have been found that will resolve this problem.

The original force transducer was a conventional full resistive bridge transducer. A new piezo-electric transducer has been found that can be fitted into the existing pelvese replacing the original transducer. The proposed transducer is Model 202 A from P.C.B. Six calibration tests performed on 3 different pelvese have shown a great repeatability of the pubic force value, average pubic force 2071 N, standard deviation 93 N (or 4.5 %). All the test results are within plus or minus 9% of the average. The test results show a smaller variation in the pubic force value than in any other parameter (pendulum acceleration, pendulum force, pelvic acceleration).

Different load washers are required around the new transducer since the new transducer is not exactly the same size as the old one.

Controlled precompression of the pubic load cell has been found necessary to avoid nonlinear output. It is recommended that this is achieved by the use of disc springs under the screw that clamps the two wings of the pelvis together through the pubic load cell.

The second type of transducer capable of solving the problem of off axis loads is a Type 31-5000 from RDP Electronics UK, a conventional resistive full bridge device. This transducer cannot be fitted into the existing pelvis due to its size and method of attachment, but future pelvese will accept both designs of force transducer. The appropiate force transduer will not be selected until further comparative tests have been performed.

4.6.2. Sorbothane insert and Pelvic flesh.

Tears have occurred in the pelvic flesh in several of the production prototype dummies. This has mainly been caused during handling of the dummy in ways not recommended in the User's Manual. It is possible to partially relieve this problem by changing the manufacturing process. The present skin is made by spraying on a polyurethane based material whereas a moulded skin would improve the durability.

The skin and reinforcement around the sorbothane insert has had a detrimental effect on the stiffness of the flesh system at this point, since the insert needs to spread laterally to absorb energy. Different cored shapes of insert are now being evaluated to reduce the stiffness of the flesh at this point.

Future dummies will have this new shape of insert and a moulded PVC skin.

4.7. Legs.

4.7.1. No comments have been received regarding the legs therefore no alterations are being planned.

5. Certification.

The certification of EUROSID is detailed in the User's Manual (3), and in the proceedings of the Brussels Seminar (1). From experiences gained using the Prototype Production dummies some changes have been found to be necessary to the current certification procedures. The following changes to the certification of EUROSID will be adopted for all future dummies.

5.1. Head.

No changes are proposed to the current head certification drop test which is similar to the Part 572 dummy head drop test, but with the impact to the side of the head. There is some concern as regard to the performance limits since the heads are not manufactured and specified for lateral impact. (Section 4.1). The performance limits will be reviewed as more test data becomes available.

5.2. Neck.

Neck certification is based on the analysis of the kinematic of the head related to T1 vertebra in a vertical plane perpendicular to the sagittal plane. It was originally proposed that the kinematic parameters be measured using high speed photography. The procedure is accurate, but the results are delayed because of film processing and analysis. It is not possible to use the measurement system developed for neck certification in frontal impact, because motion of the dummy head is not symmetrical about the left/right plane because the test induces a head rotation around a vertical axis. To solve this problem an "artificial" head has been developed. This head has the same mass and inertial properties in the left/right plane as the Hybrid III head but is symmetrical.

The new head allows a motion strictly in one plane. It is proposed to measure the 3 kinematic parameters with 2 potentiometers. Other head displacement transducers used in existing neck certification tests with other dummies could also be used.

5.3. Shoulder.

No changes are proposed to the current shoulder pendulum certification test procedure. The performance corridor has now been set to 11-14 g.

5.4. Thorax.

The thorax certification is based on a set of simple drop tests onto a rigidly mounted rib module. Each rib module is individually certified outside of the dummy. No changes in the certification procedure are being planned. It is thought that the current performance corridors may be too narrow. The implications of a wider corridor are being reviewed and if considered desirable they may be slightly relaxed.

5.5. Abdomen.

The abdomen certification uses the standard Part 572 pendulum with a modified impact face. No changes in the certification procedure are being planned.

5.6. Lumbar.

No specific EUROSID lumbar certification has yet been developed. A lateral certification procedure is envisaged similar to the new EUROSID neck certification, using the neck pendulum and possibly the new symmetrical headform. A full lumbar certification procedure and performance corridor should be available for the production dummy EUROSID-1 by the end of 1988.

5.7. Pelvis.

The certification of the pelvis is based on the value of the pubic force measured during a standard test in which a complete EUROSID is hit by a standard Part 572 pendulum at the H point.

The original transducers used may give wrong pelvic force values (See Section 4.6.1.). In addition small modifications in the production prototype dummies, such as the symmetrical abdomen, which is heavier, and the skinning of the flesh may have changed the pelvic response. The proposed value of the pelvic force for the certification test using the new piezo-electric transducer would be 2.2 kN plus or minus 0.2: this value has to be confirmed.

6. Test procedure.

The seating of EUROSID in a vehicle requires a special seating procedure different to that used with frontal dummies. The dummy must be placed in a standardised position relative the side structure of the vehicle and with the arms in a standard position relative to the torso. The full seating procedure is given in the EUROSID User's Manual (3). There can be some problems in determination of the angle of the arms since the arm joints cannot be fixed to the '1 g' setting by tightening the joint screws. It is expected that the positioning of the arms onto the steering wheel will be eased with the stiffer wrists to be fitted onto future dummies.

In order to identify a possible tilted seating position of the dummy pelvis, a water-level gauge has been developed to check and ensure the level positioning of the H-point line.

The seating procedure has been tested on 20 completely different models of car. Only in one case, a Japanese van, was it not possible to achieve the nominal forearm angle for the reason of the excessively flat position of the steering wheel. In all other cases the EUROSID could be seated in the test vehicle according to the seating procedure described in the User's Manual.

7. Summary and Conclusions.

7.1. The Production Prototype EUROSID has been seen to be a robust dummy and with no major mechanical weakness, if used as recommended in the User's Manual.

7.2. Many of the problems reported by users of EUROSID could be overcome if operating procedures detailed in the User's Manuals were followed.

7.3. EUROSID-1 the production version of EUROSID will be very similar to the existing production prototype dummy. The only changes will be of a minor nature. The changes will not significantly affect the dummies' current performance.

7.4. The EUROSID thorax displacement measurement transducers have given major problems. New transducer heads, interchangeable with the existing heads, have been developed and overcome these problems.

7.5. The Pubic Symphysis transducer is to be changed from the current force transducer to improve repeatability.

7.6. Current certification procedures for most body parts are good. Performance corridors are being reviewed and may be slightly amended for the production dummy, if found necessary.

7.7. An improved neck certification procedure is being developed using a symmetrical headform.

7.8. A dynamic lumbar certification is being developed.

7.9. Two training courses have been held in Delft for EUROSID users. Further courses are being planned. In addition to direct user training other tutorial aids to assist in correct dummy use are being prepared.

7.10. The Working Group 9 of the EEVC is satisfied that EUROSID-1, the production version of the European side impact dummy, has been developed into a satisfactory device, and is suitable for use in Vehicle Regulations. The final version of the dummy will be available mid 1989.

8. References.

1) The European side-impact dummy 'EUROSID'. Proceedings of the seminar held in Brussels 11 December 1986. EEC Report EUR 107779 EN.

2) The requirements, design and use of EUROSID with proposed performance criteria. EEVC report December 1987.

3) EUROSID User's Manual. Version 1. Update A. June 1987. IW-TNO Netherlands.

4) Modelling the Lateral Impact of the Thorax in Car Side Impact Accidents. Langdon M.G. Page 114. 10 th ESV Conference - Oxford England 1985.