

AHEG- 24/Rev.1.  
15 February, 2002

## **REPORT**

about the Ad-Hoc Expert Group (AHEG) meeting dealing with the development of  
Regulation 66  
(Frankfurt, 22-23, November, 2001)

### 1. The participants of the meeting

|                       |                        |
|-----------------------|------------------------|
| Belgium (VAN HOOL)    | Ms. Reyntjens, Pascale |
| Czech Republic (UVMV) | Dr. Hanke, Miroslav    |
|                       | Mr. Pavlata, Petr      |
| France (UTAC)         | Mr. Minne, Francois    |
| Germany (EVOBUS)      | Mr. Becker, Michael    |
|                       | Mr. Steinmetz, Gregor  |
| Hungary (GTE)         | Dr. Matolcsy, Mátyás   |
| Nederlands (TNO)      | Mr. Huibers, Jos       |
| Poland (MTI)          | Mr. Kownacki, Jerzy    |
| Spain (IDIADA)        | Mr. Lafuente, Ignacio  |
|                       | Mr. Ruiz, Salvador     |
| (INSIA)               | Mr. Sanchez, Miguel    |
| UK (DTLR)             | Mr. Corfield, Ian      |
|                       | Mr. Burch, Malcom      |
| (CIC)                 | Dr. Sadeghi, Majid     |

The following persons indicated that they cannot attend this AHEG meeting, but they are continuously participating in the work of the expert group and they need further information and documents:

|        |                           |
|--------|---------------------------|
| France | Mr. Diet, Serge           |
| Italy  | Mr. Mendogni, Giulio      |
| Spain  | Prof. Aparicio, Francisco |
| OICA   | Mr. Biver, Michael        |

The host of the meeting was VDA (Verein Deutsche Automobil Ingenieure) and the chairman was Dr. Matolcsy.

### 2. Documents

The Annex of this Report contains all the AHEG documents emphasizing the documents discussed during this meeting. Also the documents presented by AHEG to GRSG are listed.

### 3. Agenda of the meeting

The following subjects were discussed and commented during the meeting (the related documents are in brackets)

3.1. General exchange of information

- 3.2. Consolidated document of the new draft of Regulation 66. (AHEG-13, AHEG-18)
- 3.3. Determination of CG's height (AHEG-19)
- 3.4. Annex [X<sub>7</sub>]: Quasi-static loading test of body sections (AHEG-14)
- 3.5 Annex [X<sub>6</sub>]: Quasi-static calculation based on laboratory tests of components (AHEG-15)
- 3.6 Pendulum test of body sections
- 3.7 Modification of Annex [X<sub>2</sub>]: View-points to the structural description of the superstructure (AHEG-11/Rev.3.)
- 3.8 Analysis of the safety belt effect (AHEG-03, AHEG-08, AHEG-16, AHEG-21)
- 3.9 Harmonised and unified technical specification of vehicles
- 3.10. The problem of limited deformation (AHEG-20)
- 3.11. Annex [X<sub>8</sub>]: Computer simulation of rollover test (AHEG-17)
- 3.12. Definition and use of worst case (AHEG-22)
- 3.13 Future plan and tasks.

#### 4. General exchange of information

The chairman informed the group about the last GRSG and WP.29. session, concerning the Regulation 66:

- GRSG appreciated the work done by AHEG and the results achieved, and the oral presentation of the GRSG's chairman at WP.29 session expressed this opinion, too.
- Both GRSG and WP.29. underlined the importance of the safety belt issue. Based on the Spanish proposal, GRSG is open to accept an approach, which says that on every seat having seat belt, a certain ratio ( $0 < k < 1$ ) of the passenger mass should be considered.
- GRSG requested AHEG to produce a consolidated document (CD) about the new draft of Reg.66. together with its Annexes. UK undertook to produce the first version of this CD to the next GRSG meeting
- GRSG accepted that AHEG needs at least one more meeting in 2002.

#### 5. The consolidated document of the new draft of Reg.66.

UK experts informed the group how they think about CD. As an example they showed the document AHEG-18. After discussing this subject, AHEG agreed on the followings:

- AHEG will present the first version of CD to the next GRSG meeting as an informal GRSG document. So it is enough to send this document to the Secretariat on the first week of next April.
- The first version will contain all the documents which have been already presented to GRSG and also which are agreed on the present (Frankfurt) meeting. It will be circulated to AHEG members in February, they can comment it in March and after the needed modification it will be sent to Geneva. Every AHEG member will get this version, too.
- AHEG will emphasize to GRSG that this first version of CD may be changed by AHEG in the future, as the consequence of future discussions and new ideas. But always this CD will be modified, so GRSG will have only one document in hand.
- The CD will be managed by the UK experts, but any change or proposal to change shall go through the chairman or he shall be informed about it. UK undertook to produce constructed figures to the final version of CD.
- AHEG-13 contains all the modifications which were mentioned during earlier AHEG discussions. Some of them are already agreed text, the others are not

accepted yet. All delegates may comment this document until the end of January. Czech experts proposed to put into the definitions “cantrail” and “wastrail”. The modified version (AHEG-13/Rev.1) will be discussed on the next AHEG meeting.

- Para.6.2. in AHEG-13 says that in the case of an extension of approval, if further tests are required, the same approval test method shall be used as it was chosen by the manufacturer for the basic approval. Spanish expert (IDIADA) asked the question: what is the situation with the rollover test with full scale complete vehicle? AHEG decided to think about this question.

#### 6. Determination of CG’s height (Annex [X<sub>1</sub>])

This Annex has been already accepted by AHEG and presented to GRSG. On the last AHEG meeting Spain (INSIA) suggested to adopt a measuring method of CG’s height with free suspension. UK experts offered and presented a combined solution (see AHEG-19) which were discussed now. The group agreed on the followings:

- Considering all aspects of the rollover test the blocked suspension system is preferred, and all the equivalent approval tests shall be based on blocked suspension.
- In this Annex one-one simple measuring method shall be given for the three coordinates of the CG’s position and a statement (paragraph) that every equivalent measurement is acceptable on the responsibility of the Technical Service.
- The measuring method to determine CG’s height in this Annex will be a “tilting” method using load transducers under the wheels. This method shall be described for a three axle vehicle.
- Spain (IDIADA) requested to describe the accuracy of the measurements
- This modification of Annex [X<sub>1</sub>] will be made by the UK experts as AHEG-19/Rev.1. and this document will be incorporated into the CD.

#### 7. Annex [X<sub>1</sub>]: Quasi-static loading test of body sections

The new document (AHEG-14) is based on the results of the discussion and proposed modifications at the last AHEG meeting. The following comments have been made now in the discussion:

- Spanish expert (INSIA) pointed out that this test method can not simulate the wastrail effect (when the wastrail hits the ground), therefore its equivalency is questionable.
- Czech expert emphasized that the coefficient 0,75 is too small in the energy equation, the realistic value is more than 0,8.
- He also suggested the harmonisations of the symbols used for the same concept but in different Annexes (e.g.  $E_T \rightarrow W_{ph}$ ) This is accepted by AHEG.

This Annex was approved by AHEG and it will be incorporated into the CD.

#### 8. Annex [X<sub>6</sub>]: Quasi-static calculation based on component tests.

The draft of this Annex (AHEG-15) was prepared by Belgian – Hungarian- Spanish (INSIA) contribution. Applying the loads two versions have been formulated: the Belgian- Hungarian and the Spanish version. In the discussion the following opinions were expressed:

- The Spanish loading system is based on the assumption that the superstructure has uniform deformation alongside the vehicle, or in other words the cantrail moves parallel to its original position during the deformation. The Spanish expert showed a

video about four full-scale rollover tests made with different HD coaches. The four plastic hinges (PH) deformation mechanism in all of the four tests seemed to prove this assumption

- The Belgium-Hungarian loading system allows the inclination of the cantrail, or in other words the cantrail can move anyhow during the deformation. This was supported by real full scale rollover tests shown by UK, Czech and Hungarian experts.
- Finally the Spanish expert proposed a combined compromise: the displacement of the cantrail is free, but the angle of the load is changing according to the deformation
- The Spanish expert (INSIA) pointed out again that this approval method also can not simulate the waistrail effect, therefore its equivalency is also questionable
- The expert of Nederland's discussed the value (1,2) of the dynamic factor. UK and Hungary said that they can accept any value in the range of 1,15-1,25

The Spanish expert offered to prepare the modified version of this document (AHEG-15/Rev.1.) and circulate it to the AHEG members, which will be discussed again on the next AHEG meeting.

#### 9. Pendulum test of body sections.

AHEG earlier discussed this subject and decided to delete this approval test from the regulation. This was a conditional decision, because the UK experts did not attend those two AHEG meeting. Now the UK experts also agreed to delete this Annex.

#### 10. Annex [X<sub>3</sub>]: View-points to the structural description of superstructure

This Annex has been already accepted on the last AHEG meeting and presented to GRSG (AHEG-11/Rev.1.) Meanwhile UK experts found some inaccuracies and ambiguous formulations and they proposed certain modifications in the text and also one additional figure was introduced (AHEG-11/Rev.3.) AHEG adopted the modifications and this Annex will be also incorporated into the first version of CD.

#### 11. The effect of the safety belts.

AHEG had earlier two documents (AHEG-03, AHEG-08) and discussed this subject. On this meeting further presentations were given and followed by a discussion:

##### 11.1. The Czech experts informed the group about their studies in this subject:

- Full-scale trolleybus rollover test with Hybrid 2 dummies having 2 pts safety belt
- Computer simulation of body section rollover with four dummies having 2 pts, 3 pts safety belt and no belt.

The brief summary of these studies:

- The dummies without seatbelt leave their seats and they are “flying” in the passenger compartment
- Both 2 pts an 3pts seat belt is restraining the dummy on the seat. The 3 pts belt limits the motion of the upper body of the dummy but the shoulder belt may cause neck injury (may wind on the neck)
- The belts fix the dummies to the seats, therefore the kinetic energy of the vehicle is increasing as well as the absorbed energy by PH-s

The Czech experts are continuing the research and they hope they can present new results on the next AHEG meeting (what is the ratio of the dummy's kinetic energy which is absorbed by the structural deformation)

#### 11.2. The UK expert presented:

- A full-scale rollover test with complete vehicle having dummies on board, without seatbelt. The “English rollover method” was used, one dummy was ejected through the window, another was “flying” in the passenger compartment and finally compressed by a seat back and the collapsing roof structure.
- Body section rollover test with four dummies and 2 pts safety belt. The dummies were restrained on their seats, and their kinetic energy was transferred to the structure trough a load path (belt - belt anchorage – seat - seat anchorage – floor structure)
- Computer simulations of body section rollover with dummies which gave good correlation with the body section rollover test. These simulations also proved the increasing of the kinetic energy as well as the absorbed energy related to the complete vehicle.

They also continue the research hoping new results to be presented on the next AHEG meeting.

11.3. The Spanish expert (INSIA) referring to their earlier study (AHEG-08) informed the group that they are also continuing the research, they try to determine the ratio of the dummy's kinetic energy transferred to the structure trough the belt system, and also to study the time delay effect on the energy balance.

#### 11.4. Hungary presented:

- Brief summery of three earlier published technical papers (and suggested by the Polish expert) concerning to the discussed problem (AHEG-16)
- A video about a full-scale rollover test with complete vehicle, having three dummies on board. The test was carried out according to the “Hungarian rollover method”. This test fully supported the results given earlier in AHEG-03.
- Mathematical formulation of the mass and kinetic energy increasing when using seat belt (AHEG-21) Having different geometrical parameters of the bus construction and assuming a certain efficiency of the seat belt (which ratio of the passenger mass is fixed rigidly to the seat) the energy increasing may be calculated.

11.5. After discussion AHEG accepted the principle: on every seat which is equipped with safety belt a fixed mass shall be placed for the approval tests of Reg.66. This mass shall be a certain ratio ( $0 < k < 1$ ) of the passenger mass (68 kg) The position of this mass, the value “k” and the way of fixing this mass will be determined on the next AHEG meeting. UK experts undertook the task to produce a document: what should be changed, amended in the new draft of Reg.66. (and its Annexes) when accepting this safety belt principle.

## 12. Harmonized and unified technical specification of a vehicle

The Belgian expert raised the demand: it would be necessary and useful to have a harmonized and unified technical specification related to the approved vehicle. There are at least three representations of technical data:

- The technical data and information required from the manufacturer when applying for approval

- The Communication Sheet for the contracting parties (see Annex 1. in the regulation)
- Technical data in the test reports identifying the vehicle.

The everyday practice is now contingent, the different Technical Services have different usage, even in one approval. In the discussion the German expert called the group attention that in Brussels a work is going on in this subject, the Annex of the Directive 70/156/EEC will contain the required technical data for a type approval. The Polish expert pointed out that ECE regulations are not directly related to a type approval. The discussion resulted the following AHEG opinion: This is an important issue, but not specific to Reg.66. (other regulations are also touched with this problem) AHEG calls the GRSG's attention to this problem and waits for its decision.

### 13. The problem of the limited structural deformation

Last time Hungary raised the problem (AHEG-07) and now UK experts presented their opinion (AHEG-20) They described the history of the formation of the existing rollover test bench. It was not a requirement to assure the same type of deformation for any kind of buses. They do not see the reason to modify the test bench geometry.

The Hungarian expert emphasized that the existing test bench geometry does not have any technical, scientific or standard base, there were different proposals for the depth of the ditch: UK and France (600 mm) Hungary (1000 mm) Sweden (1000-1400 mm) had different opinions and the final result of a two years discussion resulted 800 mm as a compromise. The videos showed by the Czech and Spanish experts proved that the limited structural deformation is a real, existing problem.

After this discussion AHEG did not see the necessity to change the geometry of the rollover test bench. Hungary reserved the right to turn once more to GRSG with this problem.

### 14. Annex [X<sub>8</sub>]: Computer simulation of rollover test

14.1. With the contribution of Czech, French and Hungarian experts a draft was produced and circulated (AHEG-17)

14.2. In the very active and interesting discussion the following major arguments, opinions were expressed:

- UK and Hungary emphasized that the simulation is a very useful tool in the development, but it is not used in the approval yet. In the development only one interest (manufacturer) dominates, but in the approval process two interests (manufacturer and authority) may have conflicts. The simulation may be a tool of the manipulation, it could be an animation. Germany pointed out that any kind of approval method by calculation can be subject of manipulation. The Czech experts said that the quasi-static calculation method offers even more possibilities for manipulation.
- The rollover test is a non-linear, dynamic, time dependent process with plastic deformations and large scale distortions and displacements. The simulation of this very sophisticated process can not be checked and controlled by an average engineering knowledge. It is very easy to make significant mistakes in this simulations, mainly if it is desirable for somebody.
- The opinions differed, whether the location of plastic hinges in the superstructure shall be determined by FEM (e.g. PAMCRASH) or by the manufacturer based on engineering practice an knowledge and design criteria. The Czech, German and Holland experts had the former opinion preferring the computer simulation based

on FEM, while UK and Hungarian experts supported the latter version. UK expert (CIC) emphasized that there is no computer calculation which can substitute the engineering knowledge and practice. The superstructure, the mechanical model of the frame shall be determined by the manufacturer, this is his task and responsibility

- It was discussed whether the rollover process – which should be simulated – shall be described in the regulation or not. Now there is a description as the Appendix of this Annex. Mostly the experts agreed to have it, the question is how detailed should it be. The German expert stated that from this point of view, the appendix, if necessary, should be redrafted.
  - The draft requires the accreditation of the algorithm and computer program which is used for the simulation. But nothing is said, how to do that (on national or international level, which kind of criteria should be used, etc.)
  - UK experts informed the group that a three years EU research project is going on, working on the field of “virtual tests” including the simulations, too. But the results of this work are not available yet.
- 14.3. AHEG is waiting for further comments, proposals to this subject and draft and the discussion will be continued on the next AHEG session. The majority has the opinion that the simulation as an approval method may be used only if it is a well defined, transparent, controllable method with approved algorithm and computer program. The Czech expert emphasized that the same strictness shall be prescribed also for the procedure using quasi-static computer calculation (see in AHEG-15)

#### 15. Definition and use of “worst case”.

The German experts presented a proposal about the “worst case” approach (AHEG-22) saying that in case of a bus family only one version – which represents the worst case – shall be tested and having positive test results the whole family shall be approved. In the discussion it became clear that the new draft of Reg.66. contains and realises the worst case concept: it is the manufacturer task and responsibility to determine the superstructure (the load bearing frame and body elements), the reference energy (masses and CG’s height) and the residual space (independently from a certain seat arrangement) The approval is valid (and may be extended without further tests) for all the family members which have:

- the same superstructure
- equal or smaller reference energy
- equal or smaller residual space.

The Technical Service checks these threefold criteria when the manufacturer applies for the extension of an approval. AHEG agreed that the “worst case concept” is an essential issue in Reg.66 and expressed the demand to harmonise this principle in the four parts of the new draft (Definitions, Application for approval, Requirements and Extension of Approval) where it is applied. UK and Hungarian experts undertook this task.

#### 16. Future plan and task of AHEG

AHEG earlier agreed to have at least one more meeting in next year. This was supported by GRSG, too. This meeting will be held in May, after the GRSG meeting, and the group has a preliminary invitation from IDIADA, Barcelona. The final arrangement will be managed by the chairman. Probably the following subjects will be on the agenda of the meeting:

- development of the consolidated document

- computer simulation of rollover test
- safety belt effect
- worst case approach
- quasi-static calculation method based on laboratory tests

Probably the first three subjects may not be finished on the next meeting. AHEG members expressed their view that if it is necessary they could participate on one more meeting in the second half of the year.

Budapest, 15 February 2002

Dr Matolcsy Mátyás  
Chairman of AHEG



## LIST OF AHEG DOCUMENTS

### **1. Earlier AHEG documents**

|                |  |
|----------------|--|
| AHEG –01       | Annex [X <sub>2</sub> ]:”View-points to the structural description of the superstructure.”   |
| AHEG –02       | Supplements and corrections to the draft modification of Reg.66.”  |
| AHEG –03       | Information about dummies during rollover tests (Hungarian experiences)  |
| AHEG –04       | Annex [X <sub>4</sub> ]: “Rollover test with body sections”  |
| AHEG –05       | Annex [X <sub>7</sub> ]: “Quasi-static loading test of body sections (combined with calculation)   |
| AHEG –06       | Modifications in the tilting test proposed for the determination of the CG in Reg.66. (Spanish proposal)   |
| AHEG –07       | Grave problem with the standard rollover test (Hungarian presentation)   |
| AHEG –08       | Study about the incidence of the use of safety belts with regards to Reg.66 (Spanish paper)  |
| AHEG –09       | Rollover test of articulated buses (German proposal)   |
| AHEG –10/Rev.  | Report of Brussels meeting the informal expert group   |
| AHEG –11/Rev.  | Annex [X <sub>2</sub> ]: “View-points to the structural description of the superstructure. (It was sent to GRSG, official doc: TRANS/WP.29/GRSG/2001/18) |
| AHEG –11/Rev.3 | Annex [X <sub>2</sub> ]: “View-points to the structural description of the superstructure (After some modification, proposed by UK)                      |
| AHEG –12/Rev   | Rollover test with body sections   |

### **2. AHEG documents used at the Frankfurt meeting**

|          |   |
|----------|---|
| AHEG –13 | Supplements an corrections to the “draft modification of Reg.66.”   |
| AHEG –14 | Annex [X <sub>7</sub> ]: “Quasi-static loading test of body sections”   |
| AHEG –15 | Annex [X <sub>6</sub> ]: “Quasi-static calculation based on laboratory test of components”                          |
| AHEG –16 | The effect of belted passengers on the rollover process of buses (Conclusions of published papers, made by Hungary) |
| AHEG-17  | Annex [X <sub>8</sub> ]: “Computer simulation of rollover test on full scale vehicle                                |
| AHEG-18  | UN-ECE Reg.66 Consolidated proposal (UK)  |

|                |  |
|----------------|--|
| AHEG-19        | Alternative method for the calculation of the CG of a vehicle (UK) |
| AHEG-20        | Rationale for current ditch height and profile (UK)                |
| AHEG-21        | Study of energy increasing (Hungarian)                             |
| AHEG-22        | Worst case (Germany)   |
| AHEG-15/Rev.1. | Spain modification (it will be presented)                          |
| AHEG-23        | List of proposed Annexes for Reg.66.                               |

## **2. GRSG documents presented by AHEG**

### **Official GRSG papers:**

|                          |  |
|--------------------------|--|
| TRANS/WP.29/GRSG/2001/6  | Proposal for draft amendments to Reg.66. (The main text of the Regulation)   |
| TRANS/WP.29/GRSG/2001/5  | Annex 7: Determination of the CG of the vehicle  |
| TRANS/WP.29/GRSG/2001/18 | Annex 4: Viewpoints to the structural description of the superstructure<br>Annex 6: Rollover test with body sections |
| TRANS/WP.29/GRSG/2001/14 | Annex 5: Rollover of full scale vehicle as the basic approval test method  |

### **Informal GRSG documents:**

|            |  |
|------------|--|
| 3/80/2001  | Report of the informal expert group Prague meeting                                   |
| 5/80/2001  | Unusual statistics about rollover accidents of buses                                 |
| 9/80/2001  | Grave problem with the standard rollover test  |
| 21/80/2001 | Modification in the tilting test proposed for the determination of the CG in Reg.66. |
| 1/81/2001  | Report of the informal expert group Brussels meeting                                 |
| 9/81/2001  | Study about the incidence of the use of safety belts with regards to Reg.66.         |