Informal document No. ①
(81st GRSG, 8-11 October 2001
agenda item 6.)

AHEG-10/Rev
May, 2001

REPORT OF THE INFORMAL EXPERT GROUP

about the Ad-Hoc Expert Group (AHEG) meeting dealing with the development of Regulation 66. (Brussels, 10-11 May, 2001)

1. The participants of the meeting:

Belgium	Ms Reyntjens, Pascale
	Mr Peelman, Michael
Czech Republic	Dr Hanke, Miroslav
France	Mr Diet, Serge
Germany	Mr Steinmetz, Gregor
Hungary	Dr Matolcsy, Mátyás
Netherlands	Mr Huibers, Jos
Poland	Mr Kownaczki, Jerzy
Spain	Mr Sanchez, Miguel
UK	Dr Sadeghi, Majid
	Mr Corfield, Ian
	Mr Burch, Malcolm

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

OICA	Mr Biver, Michael
France	Mr Minne, Francois
Finland	Mr Intosalmi, Juhani
Germany	Mr Becker, Michael
Italy	Mr Mendogni, Giulio
South-Africa	Prof. du Preez, Rudi
Spain	Prof. Aparicio, Francisco

The host of the meeting was FEBIAC (Federation of the Belgian Automotive Industry) and the chairman was Dr Matolcsy.

2. Documents

Before the meeting the following documents were circulated by e-mail (AHEG started to use a new numbering system of the documents):

AHEG-01	Annex [X_2] „View points to the structural description of the superstructure" (Hungarian proposal)
AHEG-02	Supplements and correction to the „Draft modification of Regulation 66" (Hungarian proposal)
AHEG-03	Information about dummies behaviour during rollover test (Hungarian presentation)
AHEG-04	Annex [X_4] „Rollover test with body sections" (Hungarian proposal)

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AHEG-05	Annex [X_7] „Quasi-static loading test of body sections" (Hungarian proposal)
AHEG-06	Modifications in the tilting test proposed for the determination of the centre of gravity in Regulation 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 regard to Regulation 66. (Spanish presentation)
AHEG-09	Rollover test of articulated buses (German proposal)

3. The agenda of the meeting

The experts agreed in the following agenda:

3.1. General exchange of information
3.2. Discussion of Annex [X_2] (AHEG-01)
3.3. Discussion of Annex [X_4] (AHEG-04)
3.4. Discussion of Annex [X_7] (AHEG-05)
3.5. The way of correction and supplement of the new draft of Reg.66 (AHEG-02)
3.6. Discussion of the effect of safety belts (AHEG-03 and AHEG-08)
3.7. Rollover test of articulated buses (AHEG-09)
3.8. Discussion of the geometrically limited superstructure deformation in the standard rollover test (AHEG-07)
3.9. Determination of the height of CG by tilting test and free suspension (AHEG-06)
3.10. Computer simulation of rollover test.
3.11. Future works and tasks.

4. General exchange of information

4.1. The chairman informed the expert group about the discussion in GRSG, related to the Regulation 66. Two request:
- GRSG is waiting for the proposal of the expert group about the effect of the belted passengers. GRSG thinks that this is a very important issue.
- GRSG accepted the Hungarian demand to study the problem of the geometrically limited deformation of the superstructure in the rollover test and asked AHEG to study this problem and try to find a solution.

4.2. AHEG agreed that the drafts proposed and sent to GRSG are agreed in their content and structure, but they may need certain editorial and linguistic corrections. The group hopes that GRSG and the Secretariat can help in this field.

4.3. AHEG agreed that the best way for presenting the modified Regulation 66. (and its Annexes) to GRSG would be the usual technics:
- using the original text as basis
- crossing out the text being deleted
- using italics for the new text,
- giving references to the text changing the place of which, etc.

These could help GRSG in better understanding. But this method can not be used in this case: new structure (similar to other regulations, e.g. R.36.) is used for the main text, new definitions are involved,

new Annexes are formulated, paragraphs from the main text were put into Annexes, certain old Annex was divided into three Annexes, etc. The best way to help GRSG in understanding: the experts participating in the GRSG meetings can explain the things, answer on the questions.

5. Annex [X_2]: View points to the structural description of the bodywork.

On the basis of the last discussion in Prague, a new version of Annex [X_2] - see AHEG-01 - has been circulated. Discussing the new version, some new definitions have been introduced: superstructure instead of „model of load bearing structure" and bay instead of ring, body-work, and some further modifications, corrections have been made. Together with these modifications Annex [X_2] has been accepted. The modified version of Annex [X_2] will be circulated in June and after the final agreement it will be sent to the Secretariat in Geneva.
The German expert offered a formulation about the „worst case" of the superstructure. It will be discussed on the next AHEG meeting.

6. Annex [X_4]: Rollover test with body sections

The draft of Annex [X_4] - see AHEG-04 - has been discussed and after certain correction and modification accepted. The corrected version of Annex [X_4] will be circulated in June and after the final agreement it will be sent to the Secretariat in Geneva.
There was a general discussion about the content of the report of an approval test. The Polish expert offered a general formulation for the next meeting of AHEG.

7. Annex [X_7]: Quasi -static test of body sections

After the first reading of the draft - when the structure of the Annex was discussed - the expert group concluded to the common opinion that instead of Annex 6 of the existing Regulation („verification of strength of superstructure by calculation") the new, modified Regulation shall have three independent Annexes describing three different approval test methods:

- Quasi-static test of body sections
- Quasi-static calculation based on the results of laboratory tests of components (plastic hinges)
- Computer simulation of rollover test on full scale vehicle.

There was no time enough to finish the discussion of Annex [X_7] This subject will be again on the agenda of the next AHEG meeting.

8. The method of correction and supplement of the new draft of Regulation 66.

AHEG presented the „Draft Modification of Regulation 66." and some of its Annexes to GRSG for studying and commenting it. But AHEG called the attention of GRSG to the necessity and possibility of further modifications (supplements and corrections) of this draft during the following work when producing the further Annexes to the Regulation. The result of the discussion about the safety belts and the geometrically limited deformation may also need certain modifications.
AHEG decided to collect all of this kind of modifications in one document and present it to GRSG only at the end of its work. This document shall be updated after the AHEG meetings.
To improve para.6. (Extension of approval) and para.7. (COP) the Czech expert brought a copy of the same paragraphs of Reg.93. as a good example.

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9. The affect of safety belts

9.1. Hungary produced a document (AHEG-03) which is based on the experiences of three real rollover tests using unbelted dummies in the buses. The main conclusion of this paper is that the mass of the dummy sitting directly next to the impacting side wall (window seat, „near" position) contributed to the total mass of the vehicle even if it does not have seat belt. The other dummies left their seats and were „flying" in the passenger compartment after the cantrail impact on the ground.

9.2. The Spanish expert also presented a paper (AHEG-08) studying the rollover test of three kind of buses:

- high decker coach with 55 seats, (Height = 3,5 m)
- midi bus with 19 seats (Height = 2,7 m)
- high decker coach (CENTURY, Height = 3,6 m)

Theoretical considerations, FEM analysis and body section rollover test were made. Conclusions:

- the mass of belted passengers are adjoined to the body-work: trough safety belts to the seats and throng seat anchorage to the body
- the energy increment to be absorbed is around 40% in case of midi bus and 30% in case of high decker coach if every passenger is belted (related to the unbelted situation)

9.3. The expert from CIC (Cranfield) had an oral presentation about the effect of seat belt on dummies motion in accident situation. No seat belt, lap belt and three points belt situations were examined. Conclusion: using seat belt the mass of the passenger contributes to the total mass of the vehicle, it increases the energy to be absorbed, but the measure of this contribution needs further examination. The contribution depends on the flexibility (rigidity) of the load-path: passenger, seat belt, seat belt enchorages, seat enchorages. The UK experts promised to circulate a brief written version of this presentation to the AHEG members.

9.4. The Polish expert distributed copies of four technical papers. Two of them seems to be very valuable and useful to this subject. The Hungarian expert offered a brief summary of these two papers for the next meeting in written form, stressing their conclusions about the effect of safety belts in rollover of buses and trucks.

9.5. The Czech expert offered a presentation about their experiences in this subject on the next AHEG meeting.

9.6. As certain conclusions of the discussion of this subject the followings may be mentioned:

- the masses of the belted passengers may be considered by a factor „k". The two theoretical extremes of „k" are: k=1 if a rigid passenger would be rigidly fixed to its seat, and k=0 if there is no seat belt, the passenger can move freely, can leave the seat. (This assumption is used in the existing Regulation)
- the passenger - as a mass - represents a certain kinetic energy during the rollover. Having a seat belt, this energy is absorbed by the following ways:
  - by the general deformation of the body-work, by the energy absorption of the plastic hinges
  - by the local deformation of the elements of the passenger compartment, having inside collisions with the belted, but moving passengers (seat cushion, inside panels, etc.)
  - by the passengers deformations
  - by the seat belts and the belt and seat anchorages.

10. Rollover test of articulated buses

The German expert distributed a proposal about the rollover test of articulated buses. (AHEG-09) The essence of this proposal is that the rollover test of articulated buses may be done by two ways:

- separately, as it stands now in the Regulation,

- as one unit, one vehicle, but in this case the rigid sections of the vehicle have to be fixed to each other in a way which does not allow relative movement between the rigid sections during the rollover process.

AHEG accepted this solution, therefor certain modifications, corrections have to be made both in the main text of Regulation and in Annex [X_3]

11. The problem of the geometrically limited deformation in the rollover test.

11.1. Hungary presented a paper (AHEG-07) in which the problem of the geometrically limited deformation was shown and explained:

- in the case of traditional buses, when the total height of the vehicle does not exceed 3,0 -3,1 m, this problem does not exist. In this case the standard rollover test separates the strong superstructures from the week one.
- in the case of high decker coaches the structural deformation may be limited by the „ditch geometry" related to the height of the vehicle, therefor the rollover test can produce positive result without the required strength of the superstructure. In this case the standard rollover test does not separate the strong superstructures from the week one anymore.
- the ditch depth (800 mm) in the standard rollover test does not represent a characteristic real rollover situation, it is the result of a long international discussion, a compromise in the discussed range of 600 - 1400 mm of depth. So the argument that the higher bus is safer in respect of the rollover situation is not acceptable.

11.2. After a brief discussion the experts decided to study this problem at home and coming back to its discussion on the next AHEG meeting.

12. Determination of CG's height with free axle suspensions.

Annex [X_1]: „Determination of CG's position" has been earlier accepted and sent to GRSG. Now the Spanish expert proposed a new variation for the determination of CG's height with free suspension (AHEG-06) In the discussion the UK experts offered a new variation: a tilting test combined with the measurement of vertical reaction forces on the wheels. This method could substitute both tilting methods: the accepted one with fixed suspension and the new Spanish proposal with the free suspension. They will prepare a draft for the next AHEG meeting. The Belgian expert proposed to correct the „track" value (b) in Annex [X_1] to (b + w) where „w" is the width of the tyres. This correction will be done together with the other corrections.

13. Computer simulation of the rollover test on full scale vehicle.

13.1. The French expert had an oral presentation about a rollover simulation method used by MECALOG EUROSIN in the practice. The presentation was focused on the main items of the future Annex of Reg.66. dealing with the computer simulation.

13.2. The presented simulation method gave information about:

- the modelling of the superstructure (location of plastic hinges on the rings, rigid parts like front-end rear walls and underframe structure, glued windows, strengthening effect of seats and hand luggage racks on the roof, etc.)
- the stress-strain curve of different materials (Johnson-Cook low for metals), plastic hinge (PH) characteristics,

- different kind of materials used in the body-work, their properties (steel, aluminium, plastic, glass, wood)
- different kind of joints between the elements of the superstructure (spot welding, line welding, gluing, screwing)
- the CG's position was measured and calculated, the inertia of the vehicle calculated,
- the simulation started with the bus standing on the horizontal tilting platform,
- some technical data from the simulation:
  - the angular velocity of the rotation of the bus when hitting the ground by the cantrail was $2x\ 10^{-3}$ rad/ms
  - the length of the main deformation process was 200 ms
  - the time interval (incremental step) was 1μs
  - the number of the elements was 250.000
  - the running time of the simulation was 2,5 day
- the total kinetic energy, when the cantrail hit the ground was 122 KJ, from which 108 KJ was absorbed by the plastic hinges (deformation work) and 14 KJ was dissipated by oscillation, ground, sound, etc.
- the residual space was checked in four cross sections of the bus
- the simulation was validated (checked) by a full scale rollover test. The simulation produced the same type of deformation, the same location of PH-s but bigger (+13%) deformation

13.3. There was a brief discussion about the simulation method, especially the location of PH-s, the general characteristics of PH-s, the unstable range of these characteristics, the fracture of PH-s. The experts agreed that this presentation was a good contribution to the future Annex [X_8]

14. Future steps and works

14.1. The chairman will prepare the report of this meeting and circulate it - together with the corrected text of Annex [X_2] and Annex [X_4] - to the participants of AHEG meeting giving them the possibility to check it. The final texts will be sent to the Secretariat in Geneva and to all of AHEG members.

14.2. The next AHEG meeting is planned in November (after the autom GRSG meeting) The final date and place will be organised by the chairman.

14.3. The preliminary agenda of the next meeting:

- finishing the discussion of Annex [X_7]: „Quasi-static loading test of body sections"
- Annex [X_6]: „Quasi-static calculation method based on laboratory tests of plastic hinges". The expert of Hungary - with the help of Spanish expert - will produce a draft. The Belgian expert also offered a contribution to this work.
- Annex [X_8]: „Computer simulation of rollover test". The Hungarian expert - with the help of the Czech experts - offered a draft.
- The effect of the safety belt on the rollover test (with a Czech presentation)
- The problem of the geometrically limited deformation
- New tilting test to determine the CG's height (UK proposal)
- Corrections and supplements of the new draft of Reg.66.

14.4. The experts have the common opinion that after the November meeting AHEG needs at least one more meeting next year to finish its work.

30.05. 2001

dr. Matolcsy Mátyás
chairman of AHEG