

DRAWN REPORT

about the meetings held in Madrid
(15-16 September 2003)
(17-18 March, 2004)
dealing with the frontal collision of buses

1. On the 84th meeting of GRSG the Spanish delegate raised the problem of the frontal collision of buses and pointed out the severity of this type of accident (high mortality and injury rate) He asked for certain regulatory work on this field. Hungary supported this action. Spain offered to organise expert meetings about this subject to present an informal document to GRSG. GRSG welcomed and supported this action and informed WP.29. about it.
2. The meetings were held at INSIA in Madrid with the following participants:

Prof. F. Aparicio*	(INSIA, Spain, GRSG delegate)
Prof. F. Pérez	(INSIA, Spain)
Dr. A. Garcia*	(INSIA, Spain)
Mr. W. Niewöhner	(DEKRA, Germany)
Dr. M. Matolcsy*	(GTE, Hungary, GRSG delegate)
Dr. A. Martin*	(INSIA, Spain)
Ms. T. Vicente*	(INSIA, Spain)
Mr. A. McKenzie	(SMMT, UK)
Mr. V. Satochin	(TÜV-UVMV Czech Republic, GRSP delegate)
Mr. M. Burch	(Dept. of Transport, UK, GRSG delegate)
Mr. J. Kownacki	(MTI, Poland, GRSG delegate)
Mr. O. Aif-Salem	(INSIA, Spain)

*The persons marked by * attended both meetings.*

The following experts participating in the work, sending papers, comments, getting all the working document, but could not attend the meetings:

Prof. K. Langwieder	(GNV, Germany)
Mr. P. de Coo	(TNO, Netherlands)
Mr. B. Kowanda	(TÜV-UVMV, Czech Republic, GRSG delegate)
Mr. L. Bády	(TÜV-KTI, Hungary, GRSP delegate)
Mr. S. Vince-Pap	(AUTÓKUT, Hungary)

Four other persons asked for information, they have got all the working documents of the meetings.

3. During the two meetings the following subjects have been discussed:
 - statistical data about bus frontal collisions (partners, objects, fatalities and injuries, bus categories, etc.)
 - types and specifications of bus frontal collisions
 - ECE regulations for other vehicle categories in case of frontal collisions. Who are protected in these regulations? (Driver, crew, passengers, partners, etc.) What are the subjects of these regulations?

- what kind of ECE regulations and EU directives should be considered for buses in frontal collisions? (New regulation or extension of existing regulations)
- what kind of tests could be considered as approval test, is the industry (including research institutes and technical services) ready to use and apply these tests?

On the first meeting there were seven presentations and some publications were collected about these subjects. ((The details are given in the Inform. Doc. No.5. of 85th GRSG, October 2003) Before the second meetings working papers have been prepared and circulated. On the second meeting these working documents (WD) were presented and discussed:

- WD.1. Accident statistics (On the basis of the earlier presented and collected different statistical data prepared by Hungary)
- WD.2. Accident statistics (Based on the newest Spanish statistical data, prepared by Spain)
- WD.3. Typical bus frontal collisions (Prepared by Hungary)
- WD.4. In-depth accident analysis (Prepared by Spain)
- WD.4./Ext.1. Compatibility of vehicles (Prepared by Spain)
- WD.5. The role of full-scale frontal impact test of buses (Prepared by Hungary)
- WD.6. Persons and systems to be protected (Prepared by Hungary)
- WD.7. Parameters effecting the driver's safety (Prepared by Spain)
- WD.8. Considerable constructional and structural features of buses (Prepared by Hungary)
- WD.9. Draft proposal for possible and needful regulatory work in relation to bus frontal collisions. (Prepared by Spain and Hungary)

The authors of the WD-s were asked and encouraged to send the documents to Geneva (Secretariat of WP.29) as informal documents for the next GRSG meeting. It is important and worth-while for GRSG and GRSP to know these information, to let them available for everybody.

4. Further interesting and valuable documents were circulated, discussed and considered on the meetings:
 - Results and conclusions of ECBOS project (EC 5th Framework, Enhanced Coach and Bus Occupant Safety) There are some recommendations for frontal impact of buses, e.g.: protection of the drivers and crew, avoidance of ejection through the windscreen, extension of Reg.80 to all kind of bus seats, etc.
 - Inform. Doc. No.3. of 75th GRSG, October 1998. Transmitted by Japan: Safety measures for the structure of trucks and buses. (Short, medium and long-term tasks in Japan to improve the safety of large buses, including the case of frontal impact, too.)
 - Inform. Doc. No.10 of 132nd WP.29, March 2004. Transmitted by Japan: Future rulemaking plan in Japan (Areas of the planned activities: crash worthiness, heavy-duty vehicles, occupant protection in full frontal crash, underrun protection, etc.)
 - Report of European Vehicle Passive Safety Network 2: Prospective Study on Bus and Coach Safety (January, 2004) The problems of frontal collision, like protection of driver and passengers, energy absorbing bumper system, appropriate safety belts, etc. got high "importance index".
5. The survey of the existing ECE regulations (and EU directives) related to the frontal collisions of all kind of vehicle categories show that there are altogether 13 ECE regulations

but only 2 of them cover bus subjects. The main goals of these 13 ECE regulations, dealing with frontal collisions are:

- driver protection
- occupant (passenger) protection
- structural integrity of buses
- partners protection, including passengers, too
- reducing aggressivity and increasing compatibility

These fields of safety are not regulated for buses, except the strength of certain seats and their anchorages (but not all kind of bus seats) and the safety belt anchorages.

6. Analysing real bus frontal impacts different accident types may be separated, which means different dangers for the bus occupants and other road users:

- collision with vulnerable partners (run over)
- full head on impact with big, rigid objects (heavy vehicles, walls, pole like objects) in which every bus occupant is endangered by the deceleration and especially those occupants who are sitting in the deformation zone. Special attention should be given to the collision with the rear part of plato of heavy trucks
- impact on the driver compartment, in which the driver has unacceptable casualty risk
- impact on the service door side of the front wall, in which the crew and passengers are endangered
- underrun type accidents, in which the bus driver, the main controlling systems of the bus (steering, braking, electric systems) could be endangered as well as the occupants of the underrunning car.

7. Different kind of approval tests methods may be considered for buses, which are known, widely used, well instrumented for testing other vehicle categories:

- pendulum impact test
- dynamic impact test by moving impactor
- static loading tests
- calculation methods

There is no need to specify new type of test for regulating the problems of buses, only the specification of these tests listed above will be required for bus requirements. It was the common opinion of the experts that there is no need for full scale frontal impact test of complete buses as approval test.

8. The experts expressed their common view about the necessity of a unified, internationally harmonized, technically usable accident statistics, data base. They call the attention of WP.29 on this lack, hoping that this high level international body could initiate some activity to collect this date base.

9. Conclusion of the meeting

The frontal collision of buses is a rather severe accident category endangering both the bus occupants and the other road user partners. Similarly to other vehicle categories the driver protection, passenger protection, underrun protection, structural integrity, partners protection, etc. should be regulated for buses, too.

The experts worked out a proposal to GRSG (and WP.29) which is in the Annex of this report.

PROPOSAL FOR POSSIBLE AND NEEDFUL REGULATORY WORK IN RELATION TO BUS FRONTAL COLLISIONS.

I. GENERAL COMMENTS

Studying the available accident statistics, analysing a lot of individual bus frontal collisions, determining essential collision categories, considering the persons and systems to be protected in this type of accidents, the following general approach may be fixed to the solution:

- It is impossible to solve the problems with one safety regulation: there are different goals with different dangerous accident situations (standard accidents) that means different requirements and test methods.
- Some existing ECE regulations may be extended for buses or should be improved according to the new requirements.
- It is important to consider all kind of bus categories when thinking about future regulatory work.
- The Japanese and European work and activity on that field should be held together and harmonized in the future.
- Both GRSG and GRSP should be involved in this future work having a good and strong cooperation mainly in the general approach of the problems.
- GRSG should ask the support of WP29 to this work, because it is a rather complex one: it covers a very important, extended field of safety, more regulations are involved and touched, two WG-s should work in this - work and time consuming - process, etc.
- This will be a new type of action in WP29 and its WG-s, a multi-body cooperation, giving example for other future cooperation (e.g. between GRSG and GRFF in the subject of lateral stability of buses rollover avoidance with electronically controlled stability systems)

II. SUMMARY TABLE

The table below summarizes the possible and needed activities on the field of safety in bus frontal collisions. The proposed priorities and the responsible WG-s are also listed in the table, as well as the needed effort, work is also estimated.

	Object of regulatory work	Related ECE regulation	Related EU directive	Responsible WG	Proposed priority	Estimation of needed work
1.	Strength of bus seats and their anchorages	R.80/01 R.17/04	91/676-03/20EC	GRSP	A	M
2.	General safety of buses (all kind)	R.17/Rev.1.	2001/85/EC	GRSG	B	M
3.	External projection	R.61/00		GRSG	B	S
4.	Safety belt anchorage	R.14/05 R.16/04	76/115-96/38EC 77/541-00/3EC	GRSP	B	S
5.	Structural integrity	R.107/Rev.1*	2001/85/EC	GRSG	A	M
6.	Underrun protection	R.93/00	92/114/EC	GRSG	B	M
7.	Limit of deceleration	-	-	GRSG	B	L
8.	Compatibility and aggressivity	-	-	GRSP	B	M

Symbols:

- A = first priority
- B = second step priority
- * = it could be an independent new regulation, too
- S = short work, less than 2 years, it does not need further study and analysis
- M = medium size work, 2-4 years, it needs certain study
- L = Long term work, more than 4 years, further study, analysis, international discussion is needed

The first six objects in the table have certain basis, background among the existing regulations, but the last two ones do not have this.

Some more details, proposals are mentioned below to the objects listed in the table

III. POSSIBLE MODIFICATION (EXTENSION, IMPROVEMENT) OF EXISTING REGULATIONS

1. Strength of bus seats and their anchorages R.80.
 - The scope should be extended to all bus categories, including city-buses, too (their seats and seat anchorage also need certain strength requirements and the passengers behind them also need certain protection, may be different from the tourist coaches)
 - All kind of seats (driver, passenger, crew) and seat arrangement (rearward and inward facing seats, folding seats) should be considered
 - Children seats and adequate restrain system should be involved
 - May be the wheel-chair restrain systems could be involved into this regulation
 - Strength requirements should be reconsidered according to the use of seat belts (the load on a seat, but not on all of them may be doubled: from the belted passenger seating on the seat and from the passenger seating behind the seat but using no seat-belt)
 - Extension and/or generalization of deceleration plus to all kind of buses (M₂, M₃) and seats
 - Analyse relation between R.80 and R.16.
 - Seat and vertical handhold combination to be considered
2. General safety of buses. R107/Rev.1
 - Safety features of walls in front of passenger seats
 - Safety features of partition (e.g. at stair cases) in front of passenger seats
 - Avoidance of ejection of bus occupants (driver, crew, passengers) through the windscreen
 - Strength requirements of handholds
 - Reducing aggressivity of inside structural parts against passengers (inside collision)
3. External projection of commercial vehicles R.61
 - Extension of the scope to buses
 - Consider the different size and position of bus front walls and their accessories like windscreen wiper, bed of head-lamp, etc.
 - Consider the shape of the lower part (skirt) of the front wall
 - Think about bull-bars and similar structural elements
 - Think about rear view mirrors having low position

4. Safety belt anchorages R.14.
Think about the use of safety belt on special seats (driver, crew, children, folding, rearward facing seats, etc.)
5. Structural integrity of the front part of the bus. R.107/Rev.1.
 - The requirements should serve several goals: to protect the occupants in the direct deformation zone (driver, crew if any, passengers in the first row of seat) and to protect the vital control systems (steering, braking, electric and electronic, etc.
 - Survival space should be defined
 - Energy absorbing capability of the structure
 - All categories of buses should be considered
 - It could be a new Annex of the contracted bus regulation (R.107/Rev.1.) This solution follows the earlier practice (like structural integrity in case of rollover, which is an Annex to R.107/Rev.1.)
 - The approval test method(s) based on the multipurpose requirements should be simple and flexible, the frontal collision test of complete buses is not recommended
6. Front underrun protection R.93.
 - To avoid small car (and van) underrun
 - To protect the main control systems (break, steering, electrical, etc.) of the bus
 - These subjects could be combined with the driver protection if the driver compartment has low location
 - All kind of bus category should be considered

IV. POSSIBLE NEW REGULATIONS

7. Limitation of deceleration. (Strength and energy absorbing capability of underfloor structures)
 - The seats and their anchorages are tested according to a described deceleration pulse for an impact speed of 30 km/h against a rigid barrier.
 - Now there is a lack of requirements for the underfloor structures providing not higher deceleration than it is used for seat approval (otherwise the seats are not strong enough, the passengers are not protected)
 - The deceleration is in strong relation with the strength and energy absorbing capability of the underfloor structure and these requirements should be harmonized with the requirements of structural integrity
 - All bus categories should be considered (where the seat requirements are used)
8. Increasing compatibility and reducing aggressivity of bus bumpers in relation to partner vehicles in frontal collisions
 - Mainly cars, vans, and other vulnerable road users should be considered as partners.
 - The main geometry (size, location) should be regulated, as well as the surface requirements
 - The strength requirements should be harmonized with the underrun protection.