DRIVER AND CREW PROTECTION IN FRONTAL COLLISION OF BUSES

(Proposals to the new draft Regulation)

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SUBJECT TO BE DISCUSSED

1. Title of the Regulation
2. Scope
3. Definitions
4. Superstructure, surrounding of the residual space
5. Requirements
6. Worst case concept, group of vehicles
7. Residual space (RS)
8. Dynamic impact test
9. Impact energy, energy input
10. What to be tested? Test-pieces
A more precise title is proposed in the inform.doc.

More interesting question to be answered, before regulating this subject:

in which accident situations can we, shall we protect the driver (crew)

• in high speed, full-width frontal collisions
• in partial frontal collisions with lower energy input.

Let’s study two frontal collision tests
Full frontal collision

\[ V \approx 35 \text{ km/h} \quad E_{\text{kin}} = E_{\text{input}} = 756 \text{ kJ} \]

No drastic deformations in the DC
Partial frontal collision

Frontal impact test under angle on DC side ($\alpha = 45^\circ$)

$V \approx 35$ km/h \hspace{1em} $E_{\text{kin}} = 756$ kJ \hspace{1em} $E_{\text{input}} = 210$-220 kJ

Drastic intrusions into the DC
Typical partial frontal impacts on DC side
Collision with pole-like object
TITLE OF THE REGULATION

Running into a truck platform
Offset collision with large, wall-like object
The right answer on the earlier question:

The driver (crew) shall be and can be protected in partial frontal impact with a realistic energy input.
The scope of the new Regulation shall cover Category M3 with all the three Classes: Class I, Class II, Class III.

Many accident statistics were collected and presented to GRSG.

GRSG – 86 – 11 **Hungarian data**, only frontal collisions included

- Class I: 12%
- Class II: 23%
- Class III: 18%
- Other or unknown: 47%

**German data**, all bus accidents

- Class I: 61%
- Coach: 18%
- Other: 31%

as a general figure, the frontal collisions are 50-60% of the total
**SCOPE**

**GRSG – 86 – 11** Spanish data, all bus accidents
- on urban roads: 68,5 %
- on rural roads: 18,5 %
- on highways: 10,8 %
- other: 2,2 %

**GRSG – 90 -30** Spanish data, frontal collisions among all accidents
- city bus: 25 %
- intercity: 42 %

The rate of partial collisions among all
- city bus: 88 %
- intercity: 53 %
This data do not support the exclusion of Class I. from the scope
DEFINITIONS

After discussing the basic issues GRSG should come back to the definitions

A draft was presented in GRSG – 95 - 13
SUPERSTRUCTURE, SURROUNDING OF THE RESIDUAL SPACE

SUPERSTRUCTURE: load-bearing and energy absorbing structure, listed among the definitions in the draft

SURROUNDING OF THE RESIDUAL SPACE: elements, parts, components with may intrude into RS, not listed among the definitions yet

Both of them have to be specified by the manufacturer

The way of this specification, description shall be given in an Annex to the Regulation (See Reg.66/Rev.1)
SUPERSTRUCTURE, SURROUNDING OF THE RESIDUAL SPACE

**The test-piece:** shall be correlated with the superstructure and the surrounding determines the approval determines the extension of approval

If the test-piece contains more structural elements than the superstructure (in the description) **the test-piece shall be considered as superstructure** (additional elements in load-bearing and energy absorption)
The requirements shall be extended:

a) **Independent test is needed for CC**, if any

   As it is shown, the full-width impact in the proposed range of energy is meaningless

b) **After the test at least one way shall be usable for the driver** to leave the DC.

   It means that if there are doors on the DC, one of them shall be openable after the test

A draft was presented to GRSG about these additional requirements. *(GRSG -95 -13)*
The approval is determined by three things:

- a) the residual space and its position (linked to the driver seat)
- b) the surrounding (elements which can intrude into RS)
- c) superstructure (load-bearing and energy absorbing frame)

**Group of vehicles** (in this respect): those vehicles in which these three things are the same.

All members of the „group of vehicles” may be approved by one approval process.
WORST CASE CONCEPT, GROUP OF VEHICLES

Extension of an approval

Threefold criteria of the worst case shall be examined:

a) RS criteria: the RS position is better or worse
b) Surrounding criteria: its position, arrangement is better or worse
c) Superstructure criteria: it has the same strength or weaker

3 positive answers → no need for new test
3 negative answers → new approval is needed
mixed situation → TS may ask for additional tests, calculations, evidences.

A draft was presented about this subject in GRSG – 95 -13
RESIDUAL SPACE

Spanish concept (2004)

Displacement of 300 mm
Manikin used in Reg.29. or Hybrid III dummy

Proposed survival space
- Simple, cheap
- Conservative, safer for the driver
- Easy to use it
RESIDUAL SPACE

Smaller or bigger driver? Which is closer to the front wall (surrounding)?

\[ A_5 < A_{95} \]
DYNAMIC IMPACT TEST

- Partial impact test on DC side
- Independent two tests on both sides if CC exists
- On the discretion of the Technical Service (consulting with the manufacturer) the more dangerous of the two options – related to the direction of the impact – shall be chosen: $\alpha=0^\circ$ or $\alpha=45^\circ$
- The impact shall act above the rigid underframe level, above the floor level of the DC, on the „softer” part of the front wall
DYNAMIC IMPACT TEST

Arrangement of the pendulum impact tests
What is the meaning of the energy input described in Reg.29? → 45 kJ
5t small bus hits the DC of a large bus (16 t) with 20 km/h

- half of the impact energy is absorbed by the small bus $\rightarrow E_{\text{input}} = 40\text{kJ}$
- absolute rigid small bus $\rightarrow E_{\text{input}} = 80\text{kJ}$
- large bus hits a rigid wall, with $E_{\text{input}} = 40\text{kJ}$, the speed of the bus $\approx 8\text{ km/h}$
IMPACT ENERGY, ENERGY INPUT

Some other energy information:

In ECE Reg.29 pendulum impact test 45 kJ

Kinetic energy when a 16 t bus impacts a wall with a speed of 35 km/h 756 kJ

45° impact on DC side with 35 km/h, the energy input into the structure 210 – 220 kJ

Kinetic energy in the USA test shown on the 94th GRSG session (speed 48 km/h) 1400 kJ
The proposed energy input (impact energy) \( 75 – 80 \, \text{kJ} \)

The belonging conditions:

- Partial impact with \( \alpha = 0^\circ \) or \( \alpha = 45^\circ \)
- Independent two tests, if CC exists
- Impact above the floor level of the DC (or CC)
- Rigid anchorages without plastic deformation in the test
WHAT TO BE TESTED?

The test-piece could be:

• complete (or incomplete) vehicle
• front part of the bodywork
• superstructure with the surrounding of the survival space

Three criteria to be considered

• suspension excluded if complete vehicle is tested
• anchorages must be rigid, no permanent deformation is allowed
• the test-piece essentially determines:

  the modification of the type
  the extension of the approval
  the check of CoP
CONCLUSIONS

1. Reg.29 is an old regulation with a lot of deficiencies, problems, it is not a good starting point for buses

2. 10 basic, important questions were shown. After discussing and deciding these question, a good, clear, up to date regulation could be drafted

3. Quick solution or a good regulation?

4. The draft in the present form will result an expensive approval test without improving the safety, expensive and not clear processes for modification of a type, or extension of an approval.