

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

TITLE OF THE REGULATION

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

TITLE OF THE REGULATION

Full frontal collision



$V \approx 35 \text{ km/h}$

$$E_{\text{kin}} = E_{\text{input}} = 756 \text{ kJ}$$

No drastic deformations in the DC



TITLE OF THE REGULATION

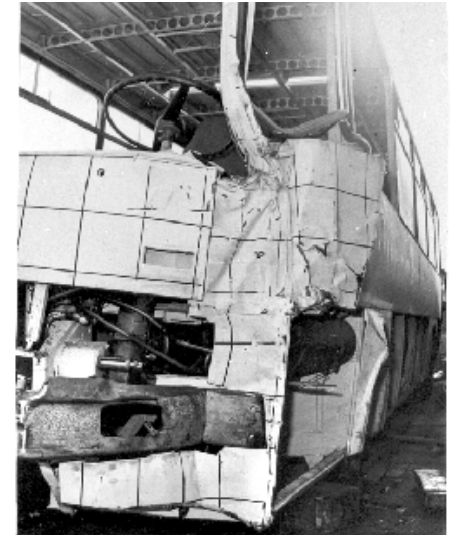


Partial frontal collision

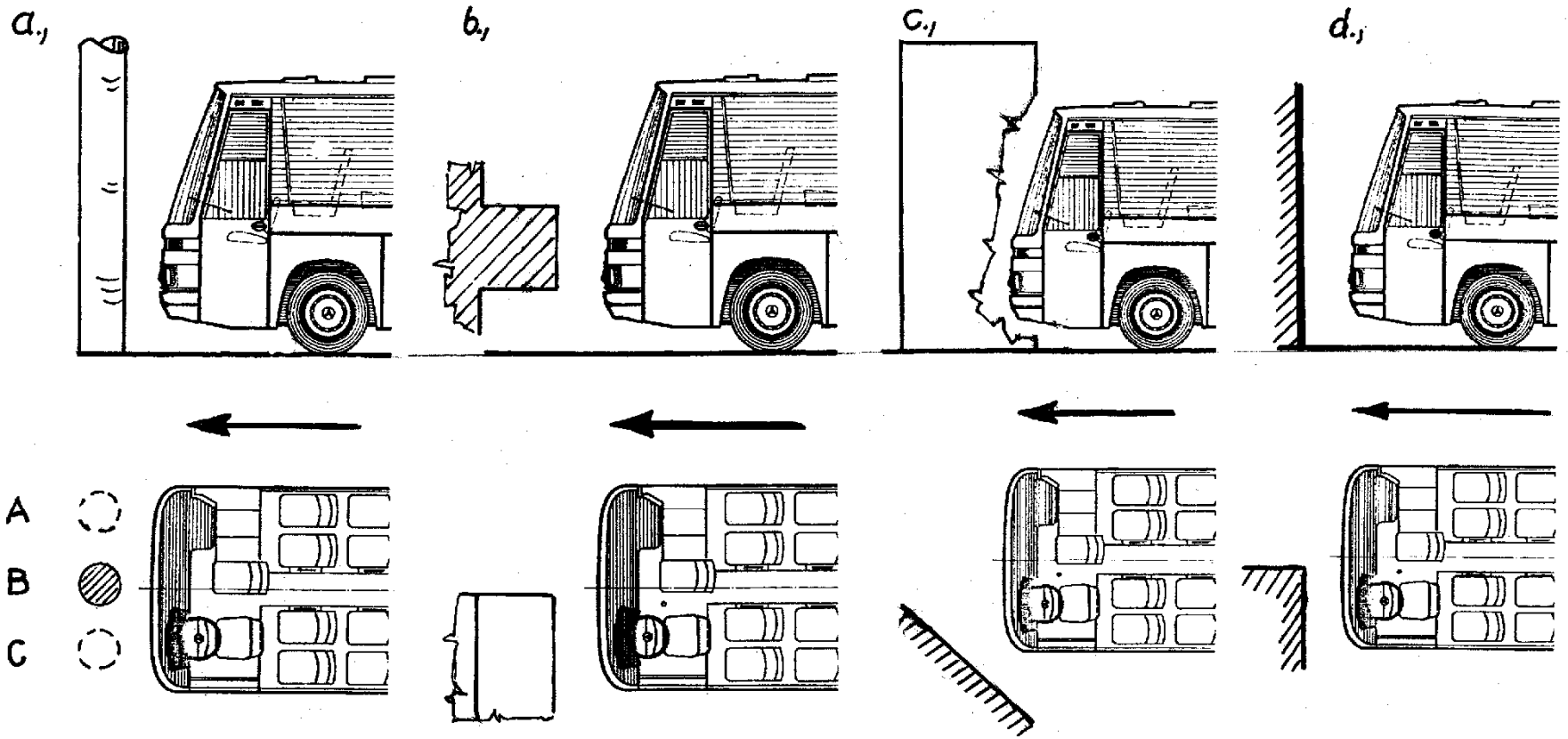
Frontal impact test under angle on DC side ($\alpha = 45^\circ$)

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

Drastic intrusions into the DC



TITLE OF THE REGULATION



Typical partial frontal impacts on DC side

TITLE OF THE REGULATION



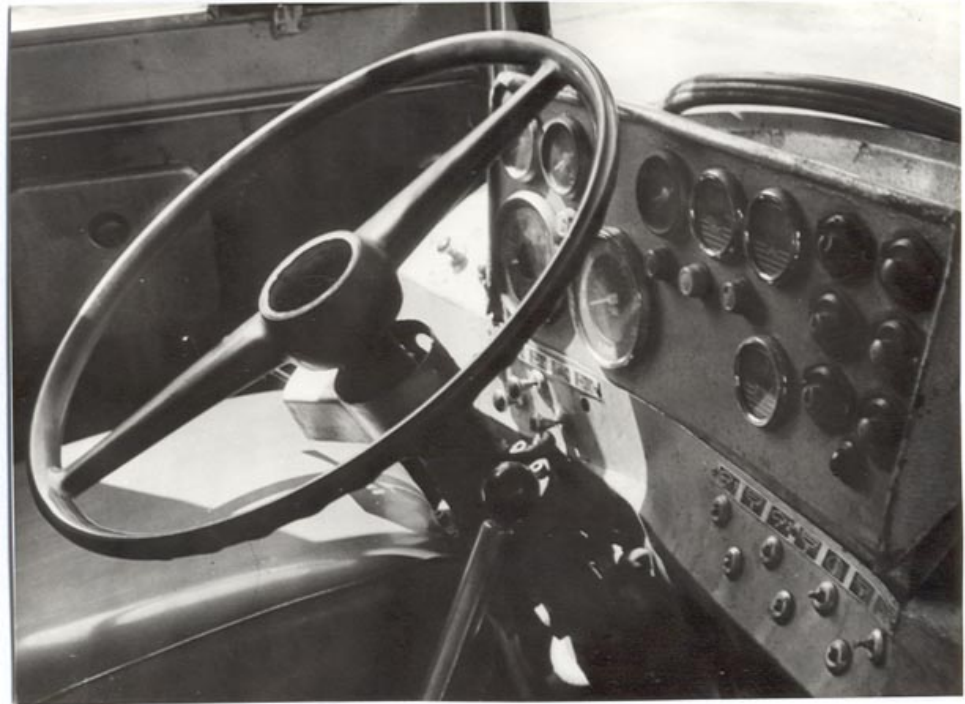
Collision with pole-like object

TITLE OF THE REGULATION



Running into a truck platform

TITLE OF THE REGULATION



Offset collision with large, wall-like object

TITLE OF THE REGULATION

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.

SCOPE

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 %

SCOPE

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)

REQUIREMENTS

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)

WORST CASE CONCEPT, GROUP OF VEHICLES

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

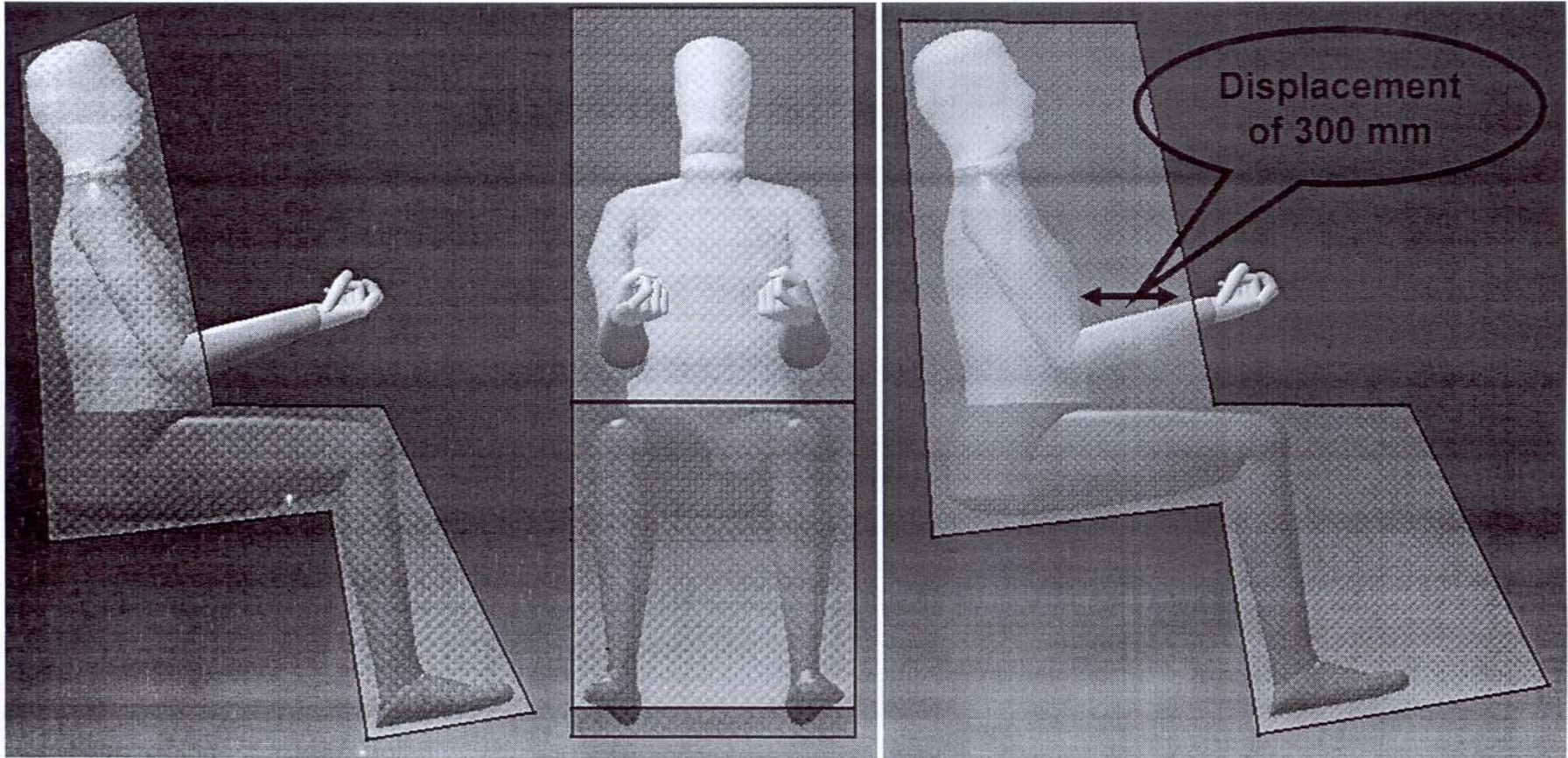
3 negative answers → new approval is needed

mixed situation → TS may ask for additional tests, calculations, evidences.

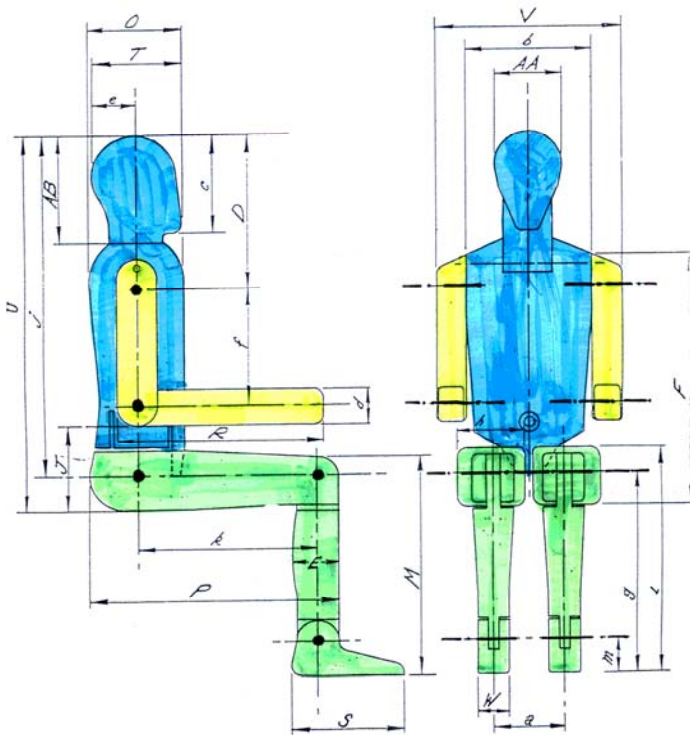
A draft was presented about this subject in [GRSG – 95 -13](#)

RESIDUAL SPACE

Spanish concept (2004)

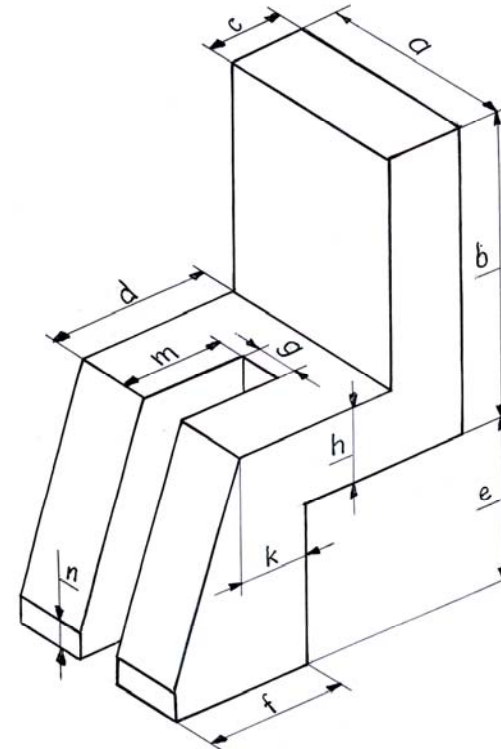


RESIDUAL SPACE



Manikin used in Reg.29.

or Hybrid III dummy

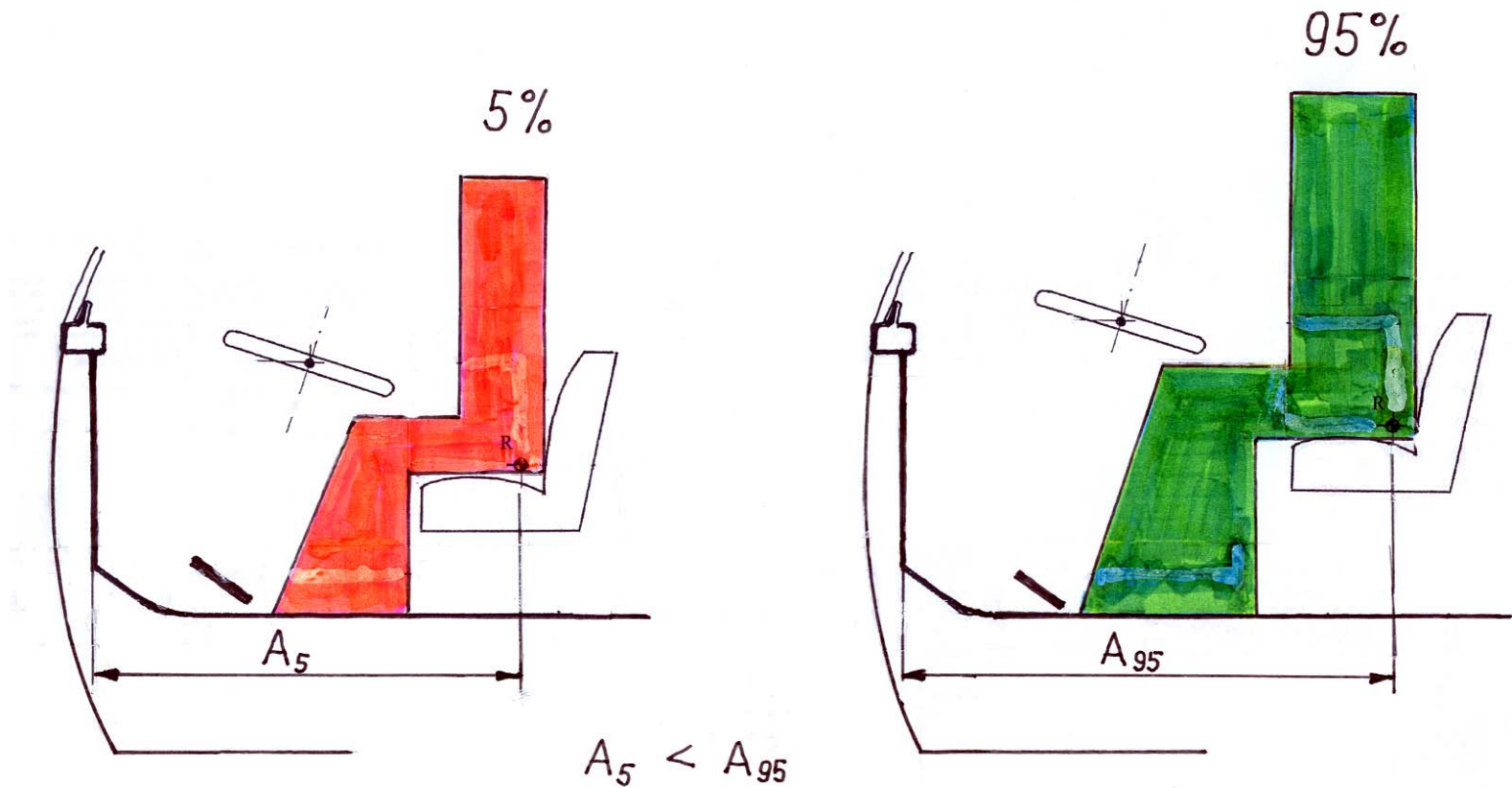


Proposed survival space

- Simple, cheap
- Conservative, safer for the driver
- Easy to use it

RESIDUAL SPACE

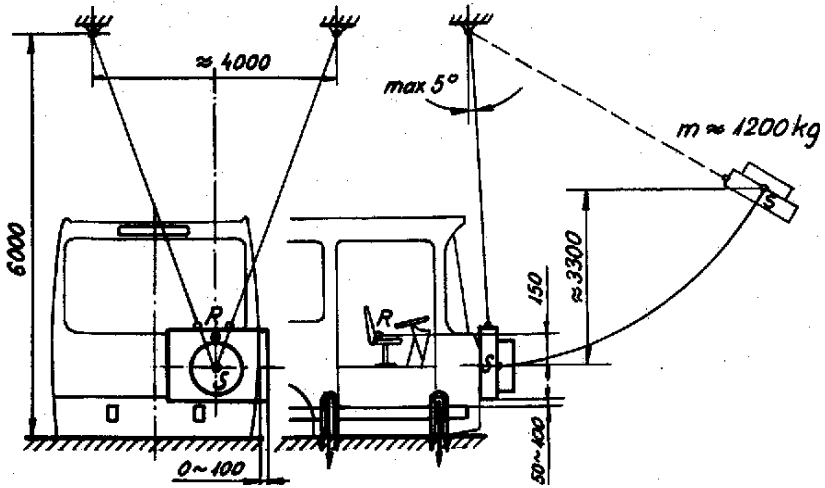
Smaller or bigger driver? Which is closer to the front wall (surrounding)?



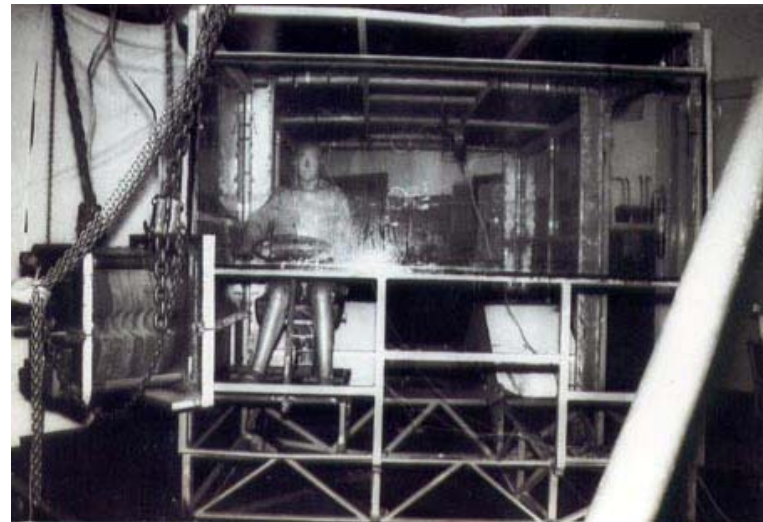
DYNAMIC IMPACT TEST

- 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



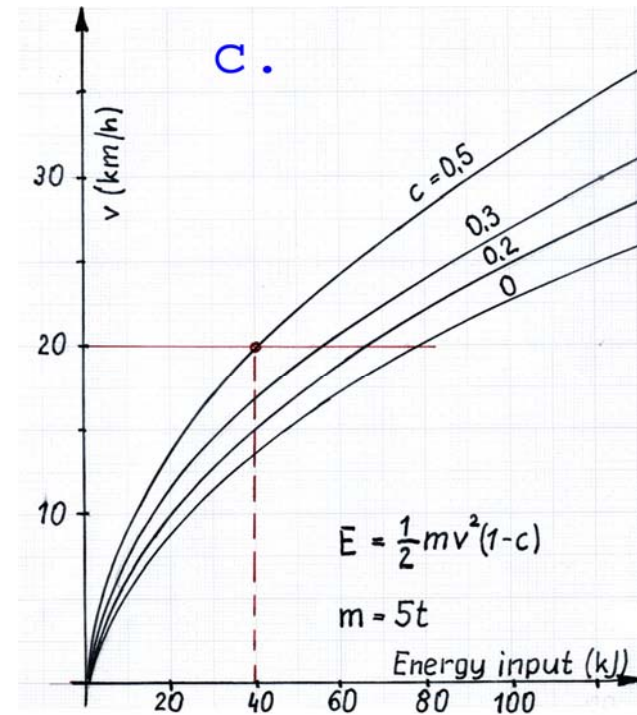
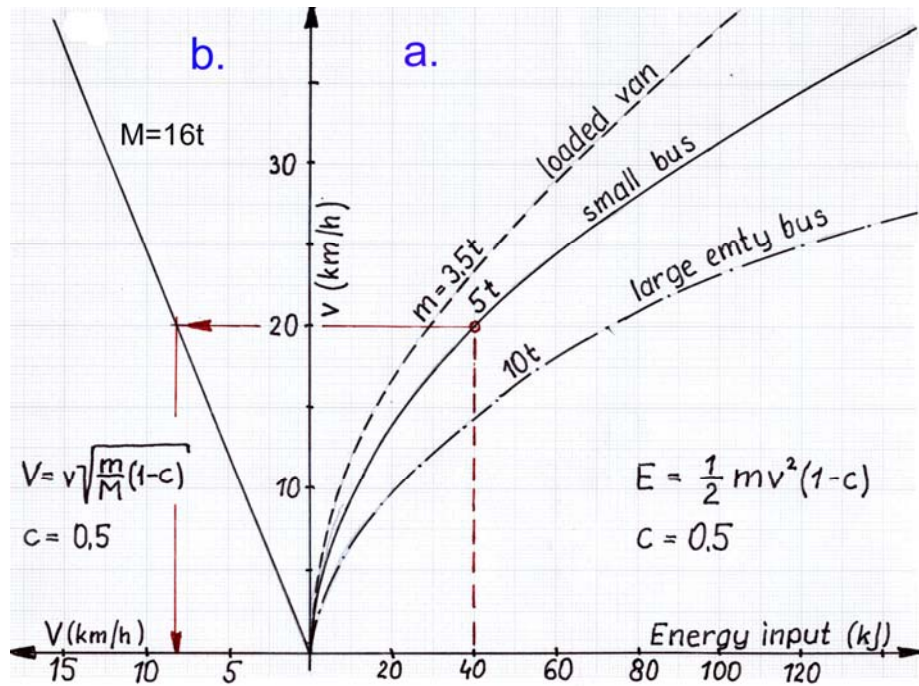
Arrangement of the pendulum impact tests



IMPACT ENERGY, ENERGY INPUT

What is the meaning of the energy input described in Reg.29? → 45 kJ

IMPACT ENERGY, ENERGY INPUT



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 $\rightarrow E_{input} = 40\text{kJ}$
- absolute rigid small bus $\rightarrow E_{input} = 80\text{kJ}$
- large bus hits a rigid wall, with $E_{input} = 40\text{kJ}$, the speed of the bus ≈ 8 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 94 th GRSG session (speed 48 km/h)	1400 kJ

IMPACT ENERGY, ENERGY INPUT

The proposed energy input (impact energy) 75 – 80 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.