Annex:
Detailed discussion of the VDA position on the proposal for draft amendments to UN-ECE R94
Informal Group “List of Issues”

1. Accident analysis – changing vehicle fleet
2. Accident analysis – thorax injury in frontal impacts
3. Harmonisation of frontal impact procedures
4. Test severity required for a regulation test
5. Test severity of PDB test
6. Measurement of EES of PDB test
7. Assessment of occupant restraint system with the PDB test

Additional points:
8. Testing with the current PDB design
9. Cost/Benefit
10. Design of future vehicles
Issue 1:
“Is an accident analysis needed to update information on changing vehicle fleet?”
Vehicle safety and the existing Regulation 94

Introduction of Regulation 94

Combined European accident statistics show a clear decrease in car occupant fatalities correlating with the introduction of the current test procedure. There is no evidence that this trend will change.
Vehicle safety and the existing Regulation 94

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Introduction of Regulation 94

GIDAS Data:
Belted passenger vehicle occupants in frontal collisions
Maximum AIS vs. Vehicle build year

Table showing vehicle build years and AIS levels from 1970-1980 to 2001-2005.
Vehicle safety and the existing Regulation 94

GIDAS Data:
Belted passenger vehicle occupants in front-to-front car-to-car collisions
Maximum AIS vs. Build year of opponent vehicle

Compatibility has improved too!

Introduction of Regulation 94
Vehicle safety and the existing Regulation 94

Car occupant fatalities and accident type

The PDB test procedure only addresses car-to-car collisions.

The existing Regulation 94 test procedure is a compromise between car-to-car collisions and other collision types. This provides a much broader assessment of a vehicle’s safety. National accident statistics show that car-to-car collisions are a relatively minor cause of occupant fatalities.
Vehicle safety and the existing Regulation 94

Crash testing with the ECE-R94 barrier has lead to a good balance between compartment stiffness and deceleration pulse in vehicle front end design.

### Real Accident

**Audi**: Driver MAIS 2, Rear seated child MAIS 1

**Ford**: Driver MAIS 3, Passenger MAIS 2

<table>
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<tr>
<th>Vehicle</th>
<th>Impact Speed (km/h)</th>
<th>Δv (km/h)</th>
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### Crash test Car-Truck

- **Audi A3**: 65 km/h vs. Scania
- **Audi A3**: stable compartment, low occupant loading
Issue 3:

“Assess potential for harmonisation of frontal impact procedure”
# Global harmonisation

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Tests with the ECE-R94-Barrier

- [Image: VDA Logo](image)
Issue 5:
“Validate that the PDB test guarantees a minimum EES test severity for all vehicles”

Issue 7:
“Validate that the PDB provides the required test requirements for interior restraints”
Self-protection and energy absorption in the PDB

**ECE-R94 Barrier:**
Total energy available: \(150\,\text{kJ}\)
Energy available with 560 mm overlap (excluding “bumper” element): \(56\,\text{kJ}\)
At 56 km/h test speed equal to kinetic energy of car with mass: \(460\,\text{kg}\)

**PDB:**
Total energy available: \(411\,\text{kJ}\)
Energy available with 700 mm overlap (excluding rear layer): \(212\,\text{kJ}\)
At 60 km/h test speed equal to kinetic energy of car with mass: \(1530\,\text{kg}\)
Misuse of the PDB: Volkswagen simulations

PDB v7
60 km/h

Standard vehicle model

Rigid left longitudinal and shotgun

Time of max. intrusion
Misuse of the PDB: Volkswagen simulations

Despite radically different vehicle structures, the deceleration pulses are practically identical!
Misuse of the PDB: Volkswagen simulations

- **ECE-R94 Barrier**
  - 56 km/h

- **Standard vehicle model**

- **Rigid left longitudinal and shotgun**

**Time of max. intrusion**
Misuse of the PDB: Volkswagen simulations

The current regulation test detects differences in structural stiffness, which are reflected in the deceleration pulse.

- **Rigid Structure Average**: 17.3 g
- **Standard Structure Average**: 15.2 g

ECE-R94 Barrier 56 km/h
Conclusions:

- The PDB test procedure does not punish aggressively stiff structures:
  - The barrier deforms to compensate for a lack of deformation travel in the vehicle front end
  - Compartment intrusions may be reduced
- The compartment accelerations that occur in a PDB test are based on the barrier stiffness, rather than the real stiffness of the vehicle front-end
- The ECE-R94 barrier punishes aggressively stiff structures because the barrier bottoms out and the vehicle must deform
- The compartment accelerations that occur with the ECE-R94 barrier reflect the design of the vehicle front-end and are more severe for the stiffened structure
Misuse of the PDB: Daimler simulations

**E-Class** (basic weight: 2018 kg)

- Some body structures have been reinforced
- This parts were stiffened in mean by +117 %
- Additional weight: 66 kg

**Vehicle deceleration pulse**

(Filter with CFC 60)

- 60 km/h, 50% offset, PDB
- Basic reinforced
- Slightly more moderate pulse shape

- 56 km/h, 40% offset, ECE-R94 barrier
- Increased pulse at bottoming out of stiffened longitudinal

- 56 km/h, 100 %, rigid wall
- Increased pulse.
- Quite different behaviour of restraints expected.
Misuse of the PDB: Daimler simulations

**SMART** (basic weight: 980 kg)

- Some body structures have been reinforced.
- This parts were stiffened in mean by +75 %.
- Additional weight: 66 kg

**Vehicle deceleration pulse**

(Filtered with CFC 60)

- **60 km/h, 50% offset, PDB**
  - basic: Slightly increased pulse.
  - reinforced: Increased pulse at bottoming out

- **56 km/h, 40% offset, ECE-R94 barrier**
  - Bottoming out
  - Increased pulse at bottoming out

- **56 km/h, 100 %, rigid wall**
  - Significantly increased pulse.
  - Quite different behaviour of restraints expected.
  - Significantly increased level of injuries expected.
Conclusions:

- The vehicle stiffness could be increased without significant change of crash severity assessed by the PDB test procedure.
- Even an opposite effect could be detected in the E-Class.
- The same reinforced vehicle exhibits an increased crash severity in the current ECE-R94 test and rigid wall test.
- Especially in the rigid wall test such a reinforced vehicle exhibits an insufficient safety level.
Misuse of the PDB – Audi simulations

Effects of front-end stiffness in vehicle to barrier tests:

Deformation in passenger compartment
In the current ECE-R94 barrier a stiffer front-end causes more deformation in the passenger compartment in comparison to the PDB-barrier

Crash Pulse
PDB: Engine block leads to small effect
ECE-R94: Bigger engine block causes higher crash pulse

Summary and drawbacks of PDB test:
- Deceleration pulse und deformation are not influenced by the front-end package
  ⇒ Opponent must absorb remaining energy
- PDB test procedure does not force vehicle front ends to be stiffer, but also fails to penalise designs where deformation length is removed from the crumple zone
- Designs optimised for the PDB test procedure will lead to lower safety in car-to-car and car-to-rigid object collisions
Issue 8:
Insufficient testing has been performed to validate the proposed barrier specification
What exactly is the Progressive Deformable Barrier?

The PDB is put forward as an accepted and well established barrier, but the new specifications described in the draft amendments are largely unknown and untested in Europe.
Why is the PDB the way it is?

The proposed amendments include several significant deviations from the existing test procedure:

- **Barrier stiffness profile**: Current barrier ➔ PDB
- **Test speed**: 56 km/h ➔ 60 km/h
- **Overlap**: 40% ➔ 50%
- **Barrier ground clearance**: 200 mm ➔ 150 mm

The goals of the two procedures are, however, identical: to reproduce the behaviour of a particular real world collision:

- **Car-to-Car**
- **100 km/h closing speed**
- **50% offset**
- **0° impact angle**

The current ECE-R94 barrier has been validated for these conditions but the PDB has not
Issue 9: Cost/Benefit
What benefit can be derived from the proposed amendments?

### 2- SELF PROTECTION: Dummies FC1

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⇒ No difference for Family cars

### 2- SELF PROTECTION: Dummies SMC1

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⇒ Light difference for super mini car (new generation)

### 2- SELF PROTECTION: Dummies FC2

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⇒ No difference for Family car

### 2- SELF PROTECTION: Dummies SMC 2

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⇒ Moderate difference for super mini car (old generation)
What benefit can be derived from the proposed amendments?

French test program shows that the existing barrier delivers the same results as the PDB when tests are performed with modern vehicles.

A “moderate” benefit is only seen when testing with an outdated small vehicle design.

These results indicate that the PDB test procedure offers no benefit for a modern fleet.
Issue 10:
If the PDB is introduced, how should and how could the cars of the future be designed?
How does this compare to the current situation and will it lead to a reduction in injuries and fatalities?
Conclusion:
The VDA does not oppose the improvement of regulatory requirements, but does not believe that the current proposals to amend ECE-R94 would improve safety in frontal impacts.