ANSWERS ABOUT ISSUES ON R94 AMENDMENT

French Experts
May 2009
Agenda

- Accident analysis
- Harmonization of Frontal impact
- Test severity of R94 amendment
- Assessment of occupant restraint system with PDB test
- Testing with the current PDB design
- Passive Safety Benefit
- Design of future vehicle
Issue 1:
ACCIDENT ANALYSIS

Is an accident analysis needed to update information on changing vehicle fleet?
PROBLEM IDENTIFICATION

BAAC 2005-2008, car occupants, belted, front seats, frontal impact against car (n=2871) Severity rate according to mean mass class, conception >1999 or model year >2003

Self protection - Severity rate in %

-949 950-1149 1150-1349 1350-1549 1550-1749 1750-++++

Mean mass class

➤ SEVERITY RATE IS MASS DEPENDENT FOR R94 CAR DESIGN
self protection level differences were also observed in crash tests
Different front end force and compartment force design lead to incompatible energy distribution in car to car configuration.

Problem still exists for “R94 fleet” generation.

Problem was confirmed by different worldwide organizations, different working groups and countries.
Issue 2:
Harmonisation of frontal impact procedure
Different car size and weight in the world

⇒ Current obstacle is not adapted for harmonization
Different fleet, size vehicle and mass around the world

Obstacle has problems with bottoming out and weak stiffness can not be adapted for worldwide harmonization

PDB shows that it is convenient and adapted for light cars to heavy vehicles
Issue 5:
Validate that PDB Test guarantees a minimum EES test severity for all vehicles
(VC-Compat test)

⇒ The Smart, known for its high stiffness factor doesn’t put so much energy in the barrier.
Large pick up known for its high front end stiffness doesn’t put so much energy in the barrier.

EES: 51 km/h

98 kJ
TEST SEVERITY

Current ECE R94

PDB Test @ 60 km/h

SMART (950 kg)
EES: 43 km/h

SMART
EES: 53 km/h

SILVERADO (2500 kg)
EES: 50 km/h

SILVERADO
EES: 51 km/h

➢ Self protection of the light car elevated (+ 20%)

➢ Self protection of the heavy vehicle is quite constant
Self protection level of a stiff light car is increased according to the combination of speed and deformable element stiffness.

Self protection level of the stiff heavy car is not affected.

By design, PDB is able to guarantee a minimum self protection level (associated to reasonable and common design rules used by car makers).
Issue 7: Validate that PDB provides the required test requirements for interior restraints

Issue 4: Assessment of occupant restraint system with PDB Test
SUPER MINI CAR 2 LHD - B-Pillar left

Displacement (m)

Acceleration (g)

EEVC 56kph
PDB 60kph
FW 56kph

2- SELF PROTECTION: VEHICLE SEVERITY
SUPER MINI CAR 1 LHD - B-Pillar left

Acceleration (g)

Displacement (m)

EEVC 56kph
PDB 60kph
FW 56kph
FAMILY CAR 2 LHD - B-Pillar left

Displacement (m)

Acceleration (g)

EEVC 56kph
EEVC 60kph
PDB 60kph
FW 56kph
2- SELF PROTECTION: VEHICLE SEVERITY

Mean acceleration

Acceleration (g)

<table>
<thead>
<tr>
<th>Speed</th>
<th>SMC</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEVC 56kph</td>
<td>16.00</td>
<td>14.00</td>
</tr>
<tr>
<td>PDB 60kph</td>
<td>22.00</td>
<td>20.00</td>
</tr>
</tbody>
</table>
2- SELF PROTECTION: VEHICLE SEVERITY

PDB test combines acceleration and intrusion

![Graph showing mean acceleration vs. compartment intrusion for different test severity levels.](image-url)
Mean acceleration = $\frac{V_0}{t}$

$t = \frac{\pi}{w}$

$w = f\left(\frac{K}{M}\right)$

$K \rightarrow w \rightarrow t \downarrow$

⇒ According to physics, higher stiffness leads to higher acceleration
Combination of higher test speed and higher obstacle stiffness lead to higher acceleration severity for occupants.

PDB test combines in one test the two causes responsible for road injuries in the real world.

Confirmed by laws of physics and tests performed.
Issue 6:
BENEFITS
WHAT R94 AMENDEMENT COULD DO?

BAAC 2005-2008, car occupants, belted, front seats, head on collisions, car to car (N=1875), according to mean mass classes, conception > 1999 or model year > 2003 for both cars

- Self protection - Severity rate in %
- Partner protection - Severity rate in %

Legend:
- < -949
- 950-1149
- 1150-1349
- 1350-1549
- 1550-1749
- 1750-++++
BENEFIT OF THE HARMONISATION OF FRONTAL PROTECTION ACCORDING TO THE VALUE OF THE TARGET SEVERITY RATE (SR).
Reduction of the number of fatal and severely injured car passenger. SETRA 2005 2006 2007 2008.
In 2007, benefits should have reached 7% of fatalities and severely injured that represent 1700 persons by year.
Issue 7:
Design of future vehicles / Misuse of the PDB
Examples

51 km/h

⇒ Weak compartment is detected

Silverado PDB+ 50%
Global force vs Displacement

Silverado PDB+ 50%
INTRUSIONS (mm)

- DASHBOARD
- A PILLAR WAIST
- PEDAL AXLE
- FOOTWELL
- A PILLAR SILL

⇒ Weak compartment is detected
Possibility to detect weak compartment even if car is design with stiff front end
Stiff front end is also detected
Examples

- Chevrolet Silverado  2293 Kg
- Ford Escape  1791 Kg
- Ford F250  3291 kg
- Saturn Outlook  1916 Kg

Different front designs were investigated
Front unit reinforcements lead to higher intrusions in the compartment.
MISUSE OF PDB: LARGE CAR

\( \Rightarrow \) Front unit reinforcement leads to higher intrusions in the compartment

+16 kg
CONCLUSION OF ISSUE 7

- Tests performed did not confirm the possibility to over deform the barrier, confirmed by simulations

- Possibility to detect weak compartment even if vehicle is designed with stiff front end

- Misuse of the PDB is not yet shown
Issue 8:
Insufficient testing has been performed to validate the proposed barrier specification
About 300 car to car accidents analysed
About 120 car to car tests performed
More than 80 tests have been performed since 2003
Since 2003, tests performed are comparable
INSUFICIENT TESTING: MAIN BARRIER CHANGES
Concept of the PDB is not new, it has existed since 1996 (derived from the German ADAC barrier)

80 R94 amendment tests comparable and available performed by countries, laboratories, car makers and international working groups

Eclectic cars / vehicles representing the “World fleet”
GENERAL CONCLUSIONS

- There is still a car to car problem with current R94
- R94 amendment doesn’t affect self protection level
- Misuse of the R94 amendment never observed
- Numerous tests are available and comparable for 6 years, performed with different vehicles from different continents
- R94 amendment has a high potential for future frontal test harmonization