European Commission frontal impact accident analysis study: Provisional results
David Richards on behalf of TRL, BASt, and LAB
Tuesday 27th April 2010
Objectives

- To perform an analysis of European accident data to ascertain the taxonomy of frontal impacts and quantify casualty target populations for potential changes to frontal impact legislation.

- To perform detailed case analysis:
  - To review the reasons for fatal injury in Regulation 94 compliant cars.
  - To analyse the performance of vehicles involved in impacts similar to Regulation 94 test to help understand how well this test represents real world accidents.

- To perform an analysis of car to other vehicle impacts to help understand the nature of the compatibility problem, in particular the distribution of the mass ratio of different weight cars involved in vehicle-to-vehicle crashes.
## Tasks

<table>
<thead>
<tr>
<th></th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Task 1: Determination of frontal impact taxonomy using European and national databases</td>
</tr>
<tr>
<td>2</td>
<td>Task 2: Determination of detailed frontal impact taxonomy using detailed accident databases</td>
</tr>
<tr>
<td>3</td>
<td>Task 3: Detailed case analysis to review fatalities and determine performance of current regulation 94 test</td>
</tr>
<tr>
<td>4</td>
<td>Task 4: Compatibility</td>
</tr>
</tbody>
</table>
Data sources – European / national / in-depth

- Eurostat
- CARE
- GB national data (STATS19)
- German national data
- French national data (ONISR)
- Co-operative Crash Injury Study (CCIS)
- German In-Depth Accident Study (GIDAS)
- LAB in-depth database
- Heavy Vehicle Crash Injury Study (HVCIS)
Task 1 - Determination of frontal impact taxonomy using European and national databases

- Task 1 identified:
  - Changes over time in the number of road casualties in Europe
  - Changes over time in the number of car and LGV occupant casualties in frontal impacts in France, Germany, and Great Britain
  - The size of high-level target populations (including cars and LGVs, by object hit, urban/rural/motorway, age and gender, seating position
  - Adjusted target populations, based on a Regulation 94 compliant fleet
Road casualties in EU

- EU (27 countries)
- EU (15 countries)
- UK + France + Germany
- France
- Germany (including ex-GDR from 1991)
- United Kingdom
Road casualties in GB, France and Germany

Car (M1) and LGV (N1) occupant fatalities 1998-2008 (CARE and national data)
Identification of target populations

Great Britain, 2008, cars

<table>
<thead>
<tr>
<th>Rollover</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>297 (23.7%)</td>
<td>1706 (16.0%)</td>
</tr>
<tr>
<td>Serious</td>
<td>731 (58.5%)</td>
<td>6995 (65.7%)</td>
</tr>
</tbody>
</table>

Impact side: first point of impact, regardless of rollover

Rollover: regardless of first point of impact

<table>
<thead>
<tr>
<th>All cars</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1250</td>
<td>10643</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Front</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>438 (35.0%)</td>
<td>2738 (25.7%)</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Side</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>130 (5.9%)</td>
<td>1239 (8.8%)</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rear</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>186 (8.4%)</td>
<td>1157 (8.2%)</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other/unknown</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>24 (1.9%)</td>
<td>210 (2.0%)</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

France, 2008, cars

<table>
<thead>
<tr>
<th>Rollover</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>132 (6.0%)</td>
<td>741 (5.2%)</td>
</tr>
</tbody>
</table>

Impact side: first point of impact, regardless of rollover

Rollover: regardless of first point of impact

<table>
<thead>
<tr>
<th>All cars</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>2205</td>
<td>14127</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Front</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1398 (63.4%)</td>
<td>9968 (70.6%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Side</th>
<th>Fatal</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>491 (22.3%)</td>
<td>1763 (12.5%)</td>
</tr>
<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<td>1157 (8.2%)</td>
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<tr>
<td>Serious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Identification of target populations

<table>
<thead>
<tr>
<th>GB</th>
<th>Target population</th>
<th>GB</th>
<th>Target population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted</td>
<td></td>
<td>Adjusted</td>
</tr>
<tr>
<td>Fatal</td>
<td>718</td>
<td></td>
<td>Fatal</td>
</tr>
<tr>
<td>Serious</td>
<td>6328</td>
<td></td>
<td>Serious</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>France</th>
<th>Target population</th>
<th>France</th>
<th>Target population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted</td>
<td></td>
<td>Adjusted</td>
</tr>
<tr>
<td>Fatal</td>
<td>1119</td>
<td></td>
<td>Fatal</td>
</tr>
<tr>
<td>Serious</td>
<td>8885</td>
<td></td>
<td>Serious</td>
</tr>
</tbody>
</table>

- Limitations
  - No adjustment made for non R94 compliant partner vehicle
    - There is evidence that R94 vs R94 impacts may lead to greater injury in the R94 vehicle than an R94 vs older car impact
    - Therefore, the adjusted population may underestimate the number of fatal and serious casualties in an R94 compliant fleet
    - However, there are other factors which this adjustment cannot take into account which may decrease the number of accidents
Tasks

1. Task 1: Determination of frontal impact taxonomy using European and national databases

2. Task 2: Determination of detailed frontal impact taxonomy using detailed accident databases

3. Task 3: Detailed case analysis to review fatalities and determine performance of current regulation 94 test

4. Task 4: Compatibility
Task 2 – Determination of detailed frontal impact taxonomy using detailed accident databases

Approach

- Continue development of frontal impact taxonomy and identification of target populations
  - Belt use, impact configuration (e.g. overlap) and severity, vehicle intrusion
  - Determine injuries and injury mechanisms of casualties and relationship to impact type, e.g. Are injuries different for different impact partners?

Note: Analysis uses Regulation 94 compliant vehicles only
**Issues**

- **GB**
  - Representativeness of CCIS
    - Higher proportion of car-HGV/bus impacts
    - Lower proportion of car-narrow object impacts
    - Larger proportion of elderly occupants
    - Smaller proportion of occupants aged 12-25

- **Germany**
  - GIDAS data sample size

- **France**
  - LAB data sample size
Representativeness of CCIS

Object hit

STATS19
- Fatal
  - Car or LGV: 30%
  - Bus or HGV: 15%
  - Narrow object: 13%
  - Wide object: 11%
- Serious
  - Car or LGV: 25%
  - Bus or HGV: 5%
  - Narrow object: 16%
  - Wide object: 24%

CCIS
- Fatal
  - Car or LGV: 31%
  - Bus or HGV: 9%
  - Narrow object: 8%
  - Wide object: 22%
- Serious
  - Car or LGV: 20%
  - Bus or HGV: 5%
  - Narrow object: 9%
  - Wide object: 42%

Occupant casualties

STATS19
- Fatal
  - Car or LGV: 1%
  - Bus or HGV: 21%
  - Narrow object: 5%
  - Wide object: 17%
- Serious
  - Car or LGV: 21%
  - Bus or HGV: 18%
  - Narrow object: 23%
  - Wide object: 38%

CCIS
- Fatal
  - Car or LGV: 0%
  - Bus or HGV: 9%
  - Narrow object: 5%
  - Wide object: 32%
- Serious
  - Car or LGV: 15%
  - Bus or HGV: 23%
  - Narrow object: 29%
  - Wide object: 28%
Impact partner, rollover, belt use

Great Britain – CCIS scaled to STATS19 2008

Fatal
n = 704

Serious
n = 6230

MAIS 3+
n = 1801

MAIS 2
n = 3195

Fatal
n = 1096

Serious
n = 1694

MAIS 3+
n = 3017

MAIS 2
n = 12892

Frontal impacts

Regulation 94 compliant vehicles

All car occupants

Germany – 2008 national casualties represented by GIDAS

Fatal n=1096

Serious n=1694

MAIS 3+ n=3017

MAIS 2 n=12892

France – 2008 national casualties R94

Fatal n=213

Serious n=1694

Fatal n=1096

Serious n=1694

MAIS 3+ n=3017

MAIS 2 n=12892

Impact partner, rollover, belt use

Fatal
n = 704

Serious
n = 6230

MAIS 3+
n = 1801

MAIS 2
n = 3195

Fatal
n = 1096

Serious
n = 1694

MAIS 3+
n = 3017

MAIS 2
n = 12892

Frontal impacts

Regulation 94 compliant vehicles

All car occupants

Germany – 2008 national casualties represented by GIDAS

Fatal n=1096

Serious n=1694

MAIS 3+ n=3017

MAIS 2 n=12892

France – 2008 national casualties R94

Fatal n=213

Serious n=1694
Identification of target populations – in depth data scaled to adjusted national data - GB

**Front impact**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**Belted, no rollover**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>52%</td>
<td>68%</td>
<td>61%</td>
<td>74%</td>
<td></td>
</tr>
</tbody>
</table>

**Front seat occupants**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>51%</td>
<td>61%</td>
<td>55%</td>
<td>67%</td>
<td></td>
</tr>
</tbody>
</table>

**Rear seat passengers**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>7%</td>
<td>6%</td>
<td>7%</td>
<td></td>
</tr>
</tbody>
</table>

**Car/LGV**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>41%</td>
<td>37%</td>
<td>45%</td>
<td></td>
</tr>
</tbody>
</table>

**Drivers**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>23%</td>
<td>31%</td>
<td>28%</td>
<td>34%</td>
<td></td>
</tr>
</tbody>
</table>

**Front seat passengers**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>7%</td>
<td>10%</td>
<td>9%</td>
<td>11%</td>
<td></td>
</tr>
</tbody>
</table>

**HGV/BUS**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>3%</td>
<td>4%</td>
<td>4%</td>
<td></td>
</tr>
</tbody>
</table>

**Wide objects**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>11%</td>
<td>7%</td>
<td>12%</td>
<td></td>
</tr>
</tbody>
</table>

**Narrow objects**

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Serious</th>
<th>MAIS 3+</th>
<th>MAIS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td></td>
</tr>
</tbody>
</table>
Identification of target populations – in depth data scaled to adjusted national data - Germany

<table>
<thead>
<tr>
<th></th>
<th>Front impact</th>
<th>Belted, no rollover</th>
<th>Car/LGV</th>
<th>HGV/bus</th>
<th>Wide objects</th>
<th>Narrow objects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fatal</td>
<td>MAIS 3+</td>
<td>MAIS 2</td>
<td>Fatal</td>
<td>MAIS 3+</td>
<td>MAIS 2</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>11%</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>64%</td>
<td>78%</td>
<td>78%</td>
<td>18%</td>
<td>16%</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>22%</td>
<td>33%</td>
<td>49%</td>
<td>13%</td>
<td>16%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Belted, no rollover

- Fatal: 100%
- MAIS 3+: 100%
- MAIS 2: 100%

Car/LGV

- Fatal: 22%
- MAIS 3+: 33%
- MAIS 2: 49%

HGV/bus

- Fatal: 11%
- MAIS 3+: 13%
- MAIS 2: 9%

Wide objects

- Fatal: 18%
- MAIS 3+: 16%
- MAIS 2: 11%

Narrow objects

- Fatal: 13%
- MAIS 3+: 16%
- MAIS 2: 10%
Overlap

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts

GB – CCIS - drivers

Germany – GIDAS – front row occupants
Longitudinal loading

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts

GB – CCIS - drivers

Low overlap
Offset impacts
Full width

Longitudinal Loading
Fatal (n=21) MAIS 3+ survived (n=71) MAIS 2 survived (n=135) All Injured (n=893)
Speed

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts

GB – CCIS - drivers

Germany – GIDAS – front row occupants

Cumulative Distribution of EES [km/h] - Frontal Collisions to CAR/LGV:

- Fatal (n=20)
- MAIS 3+ survived (n=61)
- MAIS 2 survived (n=111)
- All Injured (n=779)
## Impact configuration – car-car/LGV impacts

<table>
<thead>
<tr>
<th>Population</th>
<th>GB: Fatal (drivers)</th>
<th>GB: MAIS 3+ (drivers)</th>
<th>GB: MAIS 2 (drivers)</th>
<th>Germany: MAIS 2 (Drivers + FSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle direction of force: 12 o’clock</td>
<td>67% (21%)</td>
<td>69% (28%)</td>
<td>66% (33%)</td>
<td>51% (24%)</td>
</tr>
<tr>
<td>Low overlap (0 rails)</td>
<td>10% (3.2%)</td>
<td>10% (4%)</td>
<td>10% (5%)</td>
<td></td>
</tr>
<tr>
<td>Medium overlap (1 rail)</td>
<td>57% (18%)</td>
<td>52% (21%)</td>
<td>50% (25%)</td>
<td></td>
</tr>
<tr>
<td>High overlap (2 rails)</td>
<td>34% (11%)</td>
<td>38% (16%)</td>
<td>39% (20%)</td>
<td></td>
</tr>
<tr>
<td>High overlap (&gt;90%)</td>
<td>28% (12%)</td>
<td>36% (15%)</td>
<td>35% (18%)</td>
<td>29% (14%)</td>
</tr>
</tbody>
</table>

Severity: EES <= 50 kph

<table>
<thead>
<tr>
<th></th>
<th>GB: Fatal (drivers)</th>
<th>GB: MAIS 3+ (drivers)</th>
<th>GB: MAIS 2 (drivers)</th>
<th>Germany: MAIS 2 (Drivers + FSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39% (12%)</td>
<td>83% (34%)</td>
<td>90% (45%)</td>
<td>95% (46%)</td>
<td></td>
</tr>
</tbody>
</table>

Severity: EES <= 56 kph

<table>
<thead>
<tr>
<th></th>
<th>GB: Fatal (drivers)</th>
<th>GB: MAIS 3+ (drivers)</th>
<th>GB: MAIS 2 (drivers)</th>
<th>Germany: MAIS 2 (Drivers + FSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46% (15%)</td>
<td>90% (37%)</td>
<td>95% (58%)</td>
<td>96% (46%)</td>
<td></td>
</tr>
</tbody>
</table>

Similar to current test

<table>
<thead>
<tr>
<th></th>
<th>GB: Fatal (drivers)</th>
<th>GB: MAIS 3+ (drivers)</th>
<th>GB: MAIS 2 (drivers)</th>
<th>Germany: MAIS 2 (Drivers + FSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20% (6%)</td>
<td>34% (14%)</td>
<td>33% (17%)</td>
<td>27% (13%)</td>
<td></td>
</tr>
</tbody>
</table>
Intrusion

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts

GB – CCIS - drivers

<table>
<thead>
<tr>
<th>Level of intrusion</th>
<th>Percentage of injury groups (car-car impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little/No Intrusion</td>
<td></td>
</tr>
<tr>
<td>Intrusion</td>
<td></td>
</tr>
</tbody>
</table>

Germany – GIDAS – front row occupants

<table>
<thead>
<tr>
<th>Level of intrusion</th>
<th>Percentage of injury group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little / no intrusion</td>
<td></td>
</tr>
<tr>
<td>Intrusion</td>
<td></td>
</tr>
</tbody>
</table>

Fatal (n=21)  MAIS 3+ survived (n=71)  MAIS 2 survived (n=135)  All injured (n=893)

Fatal (n = 2)  MAIS 3+ (n = 15)  MAIS 2 (n = 69)  All injured (n = 535)
Injury distribution

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts

GB – CCIS - drivers

MAIS 2 Survivors (n=135)

MAIS 3+ survivors (n=71)

Fatal (n=21)
Injury distribution

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts

Germany – GIDAS – front row occupants

MAIS 2 occupants – AIS 2 injuries
MAIS 3+ occupants – AIS 2+ injuries
Injury distribution and mechanisms

- In GB, the most frequent injuries are to the thorax, legs, and arms, for all injury severities
- In Germany, for MAIS 2 occupants, the most frequent injuries are to the thorax, followed by the head and arms

- For MAIS 2 drivers in GB, injuries are most frequently related to the restraint system, or contact with non-intruding structures
- For fatal drivers in GB, injuries are most frequently related to contact with intruding structures
**Age and gender**

**GB – CCIS - drivers**

- Fatal (n=21)
- MAIS 3+ survived (n=71)
- MAIS 2 survived (n=135)
- All Injured (n=893)

---

**Germany – GIDAS – front row occupants**

- Fatal (n=2)
- MAIS 3+ survived (n=15)
- MAIS 2 survived (n=69)
- All injured (n=528)

---

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-car/LGV impacts
## Occupant injuries – car-car/LGV impacts

<table>
<thead>
<tr>
<th>Population</th>
<th>GB: Fatal drivers</th>
<th>GB: MAIS 3+ drivers</th>
<th>GB: MAIS 2 drivers</th>
<th>Germany: MAIS 2 Drivers + FSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender: Female</td>
<td>33% (11%)</td>
<td>34% (14%)</td>
<td>41% (21%)</td>
<td>55% (26%)</td>
</tr>
<tr>
<td>Age: elderly (66+)</td>
<td>48% (15%)</td>
<td>16% (7%)</td>
<td>17% (9%)</td>
<td>19% (9%)</td>
</tr>
<tr>
<td>Head AIS 2+</td>
<td>33% (11%)</td>
<td>8% (3%)</td>
<td>8% (4%)</td>
<td>27% (13%)</td>
</tr>
<tr>
<td>Thorax AIS 2+</td>
<td>80% (26%)</td>
<td>52% (21%)</td>
<td>32% (16%)</td>
<td>39% (19%)</td>
</tr>
<tr>
<td>Leg AIS 2+</td>
<td>61% (20%)</td>
<td>58% (24%)</td>
<td>33% (17%)</td>
<td>11% (5%)</td>
</tr>
<tr>
<td>Arm AIS 2+</td>
<td>61% (20%)</td>
<td>45% (18%)</td>
<td>32% (16%)</td>
<td>23% (11%)</td>
</tr>
<tr>
<td>Abdomen AIS 2+</td>
<td>58% (19%)</td>
<td>19% (8%)</td>
<td>7% (4%)</td>
<td>3% (1%)</td>
</tr>
<tr>
<td>Intrusion</td>
<td>76% (24%)</td>
<td>38% (16%)</td>
<td>15% (8%)</td>
<td>4% (2%)</td>
</tr>
</tbody>
</table>
Rear Seat Passengers

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-all

Seat belt use

Percentage belt use

<table>
<thead>
<tr>
<th>Seating position and gender</th>
<th>Male (Driver)</th>
<th>Female (Driver)</th>
<th>Male (FSP)</th>
<th>Female (FSP)</th>
<th>Male (RSP)</th>
<th>Female (RSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>38</td>
<td>145</td>
<td>35</td>
<td>82</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>MAIS 3+ survived</td>
<td>99</td>
<td>93</td>
<td>17</td>
<td>35</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>MAIS 2 survived</td>
<td>508</td>
<td>8</td>
<td>82</td>
<td>16</td>
<td>165</td>
<td>156</td>
</tr>
<tr>
<td>All injured</td>
<td>7</td>
<td>32</td>
<td>7</td>
<td>65</td>
<td>299</td>
<td>299</td>
</tr>
</tbody>
</table>

Percentage belt use

- 0% - 10%
- 10% - 20%
- 20% - 30%
- 30% - 40%
- 40% - 50%
- 50% - 60%
- 60% - 70%
- 70% - 80%
- 80% - 90%
- 90% - 100%

Male    Female
Driver  FSP    RSP
19100   17
14100   13
1400    7
17       7
1        1
32       16
11       8
35       17
82       35
165      16
156      16
299      16
299      16
19100    17
14100    13
1400     7
17       7
1        1
32       16
11       8
35       17
82       35
165      16
156      16
299      16
299      16
19100    17
14100    13
1400     7
17       7
1        1
32       16
11       8
35       17
82       35
165      16
156      16
299      16
299      16
Rear Seat Passengers

Frontal impacts
Regulation 94 compliant vehicles
No rollover, belted, no unbelted occupant behind
Car-all

Age and gender

Injury distribution

Body Region

Percentage of occupants with an injury to body region

MAIS2 (n=22)

MAIS3+ (n=16)
**N1 vehicle fatalities**

- **Seatbelt Use**
  - Not Used: 50%
  - Used: 20%
  - Unknown Use: 30%

- **Gender**
  - Female: 5%
  - Male: 95%
  - Unknown: 0%

- **Age Band**
  - 0-11: 10%
  - 12-25: 15%
  - 26-45: 25%
  - 46-65: 30%
  - 66+: 5%
  - Unknown: 0%

Frontal impact
No rollover
N1-all
Tasks

1. Task 1: Determination of frontal impact taxonomy using European and national databases
2. Task 2: Determination of detailed frontal impact taxonomy using detailed accident databases
3. Task 3: Detailed case analysis to review fatalities and determine performance of current regulation 94 test
4. Task 4: Compatibility
Task 3 – Detailed case analysis to review fatalities and determine performance of current regulation 94 test

Approach

- Detailed case analysis (GB data only):
  - Fatal injuries
    - Determine factors which caused fatal injuries
      - Accident, vehicle or occupant characteristics
  - Impacts with configuration similar to Regulation 94 test
    - Determine how well R94 test represents real-world accidents by review of the structural performance of the vehicle and injuries received by the occupants against that expected from test experience
      - Vehicle test performance (Euro NCAP)
      - Accident characteristics
      - Occupant characteristics
A Fiat Punto overtook a Suzuki and collided with a Peugeot 206 travelling in the opposite direction in a head-on collision.

### Fatal Occupants – Example

#### 2002 Fiat Punto
- **PDoF:** 12 o’clock
- **Overlap:** 73%
- **EES:** 32 kph
- **Mass ratio:** 1.08
- **O/S long direct**
- **N/S long indirect**

#### 2003 Peugeot 206
- **PDoF:** 12 o’clock
- **Overlap:** 85%
- **EES:** 33 kph
- **Mass ratio:** 0.92
- **O/S long direct**

**FSP compartment intrusion:** none

**Front seat passenger,** Female  
- **Age:** 76  
- **Height:** 1.55m  
- **Mass:** 56kg

**Injuries (AIS 2+):** head(3), multiple thorax injuries (highest:5)

**Primary factor:** elevated occupant age

**Secondary factor:** None

**Note:** seat belt related injury
Case Findings – Fatal occupants

There were 48 fatal occupants. The primary factors which caused the fatal injuries have been put into bins as follows:

• **Severe crash / anomaly**
  - EES > 65 kph 11
  - 56 kph < EES <= 65 kph 5
  - Anomaly 1

• **Vulnerable occupant**
  - Elevated occupant age 13

• **Underride**
  - HGV front 4
  - HGV rear 3
  - LCV front 1
  - SUV front 1
  - Car front 1

• **Limited horizontal structural engagement**
  - With underride 2
  - Without underride 2

• **Other**
  - Post crash fire 2
  - Oblique impact 1
  - Unknown 1
# Case Findings – Fatal occupants

The primary and secondary factors which caused the fatal injuries were as follows:

## Severe crash / anomaly

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>EES &gt; 65 kph</td>
<td>11</td>
</tr>
<tr>
<td>Intrusion (steering wheel)</td>
<td>5</td>
</tr>
<tr>
<td>Compatibility (minibus)</td>
<td>2</td>
</tr>
<tr>
<td>No secondary factor</td>
<td>2</td>
</tr>
<tr>
<td>Elevated occupant age</td>
<td>1</td>
</tr>
<tr>
<td>Underride (LCV front)</td>
<td>1</td>
</tr>
<tr>
<td>56 kph &lt; EES &lt;= 65 kph</td>
<td>5</td>
</tr>
<tr>
<td>Intrusion (steering wheel)</td>
<td>3</td>
</tr>
<tr>
<td>Compatibility (car)</td>
<td>1</td>
</tr>
<tr>
<td>Intrusion (upper compartment)</td>
<td>1</td>
</tr>
<tr>
<td>Anomaly</td>
<td>1</td>
</tr>
<tr>
<td>Underride (HGV rear)</td>
<td>1</td>
</tr>
</tbody>
</table>

## Vulnerable occupant

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated occupant age</td>
<td>13</td>
</tr>
<tr>
<td>No secondary factor*</td>
<td>9</td>
</tr>
<tr>
<td>Anomaly</td>
<td>1</td>
</tr>
<tr>
<td>Obese occupant</td>
<td>1</td>
</tr>
<tr>
<td>Small stature</td>
<td>1</td>
</tr>
<tr>
<td>Severe crash (56 kph &lt; EES &lt;= 65 kph)</td>
<td>1</td>
</tr>
</tbody>
</table>

## Underride

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>HGV front</td>
<td>4</td>
</tr>
<tr>
<td>Elevated occupant age</td>
<td>1</td>
</tr>
<tr>
<td>External object</td>
<td>1</td>
</tr>
<tr>
<td>Intrusion (facia)</td>
<td>1</td>
</tr>
<tr>
<td>Intrusion (upper compartment)</td>
<td>1</td>
</tr>
<tr>
<td>HGV rear</td>
<td>3</td>
</tr>
<tr>
<td>External object</td>
<td>2</td>
</tr>
<tr>
<td>Guard did not prevent underride</td>
<td>1</td>
</tr>
<tr>
<td>LCV front</td>
<td>1</td>
</tr>
<tr>
<td>Intrusion (facia)</td>
<td>1</td>
</tr>
<tr>
<td>SUV front</td>
<td>1</td>
</tr>
<tr>
<td>Sitting too far forward</td>
<td>1</td>
</tr>
<tr>
<td>Car front</td>
<td>1</td>
</tr>
<tr>
<td>Intrusion (steering wheel)</td>
<td>1</td>
</tr>
</tbody>
</table>

## Limited horizontal structural engagement

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrusion (steering wheel)</td>
<td>1</td>
</tr>
<tr>
<td>Intrusion (upper compartment)</td>
<td>1</td>
</tr>
<tr>
<td>Underride (bus front)</td>
<td>1</td>
</tr>
<tr>
<td>Underride (HGV front)</td>
<td>1</td>
</tr>
</tbody>
</table>

## Other

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post crash fire</td>
<td>2</td>
</tr>
<tr>
<td>Severe crash (EES &gt; 65 kph)</td>
<td>1</td>
</tr>
<tr>
<td>Severe crash (56 kph &lt; EES &lt;= 65 kph)</td>
<td>1</td>
</tr>
<tr>
<td>Oblique impact</td>
<td>1</td>
</tr>
<tr>
<td>Elevated occupant age</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>No secondary factor</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: 6 of this group had seatbelt related injury
## Case Findings – Like reg. occupants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object hit</td>
<td>Car, LGV, or wide object</td>
</tr>
<tr>
<td>Longitudinal loading</td>
<td>Only one longitudinal directly loaded</td>
</tr>
<tr>
<td>Overlap</td>
<td>&gt;= 20% AND &lt;= 70%</td>
</tr>
<tr>
<td>Direction of force</td>
<td>11, 12 or 01 o’clock</td>
</tr>
<tr>
<td>Severity (EES)</td>
<td>45-56 kph</td>
</tr>
</tbody>
</table>

**EES distribution**

**Age and gender distribution**
Like Reg. Occupants – Example

The Mini Cooper loses drifts onto the opposite carriageway whilst negotiating a sweeping left hand bend and collides with the Peugeot Expert van traveling in the opposite direction.

**2002 BMW Mini**
- **PDof:** 12 o’clock
- **Overlap:** 67%
- **EES:** 47 kph
- **Mass ratio:** N/K

**Peugeot Expert Van**
- Note: Van not examined

**Intrusion:** none

**Driver, Female**
- **Age:** 19
- **Height:** 1.63m
- **Mass:** 51kg

**Injuries (AIS 2+):** knee laceration (2)

**Structural performance:** as expected. No intrusion.
**Injury outcome:** as expected.
**Reasons:** knee impact area judged to be aggressive in NCAP test
Like Reg. Occupants – Example

A Nissan lost control whilst negotiating a left hand bend and crossed onto the opposite carriageway, colliding with an oncoming Fiat Punto.

**2001 Fiat Punto**
- PDoF: 12 o’clock
- Overlap: 35%
- EES: 51 kph
- Mass ratio: 1.35
- O/S long direct
- N/S long indirect

**2001 Nissan Almera**
- PDoF: 12 o’clock
- Overlap: 36%
- EES: 36 kph
- Mass ratio: 0.74
- O/S long direct
- N/S long indirect

Intrusion: steering wheel up 3cm, inboard 42cm, backwards 33cm, knee 35cm, footwell, 53cm, o/s facia 37cm

**Driver, Female**
- Age: 17
- Height: unknown
- Mass: unknown

Injuries (AIS 2+): multiple thorax injuries (highest:2), multiple limb fractures (highest:2)

**Structural performance**: worse than expected. Large intrusion (e.g. Footwell 53 cm)

**Injury outcome**: worse than expected

**Reasons**: large mass difference. Possible compatibility issue (poor structural interaction)
### Case Findings – Like reg. occupants

<table>
<thead>
<tr>
<th>Performance Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>As expected / better compartment performance</strong></td>
<td>16</td>
</tr>
<tr>
<td>• As expected / better injury outcome</td>
<td>6</td>
</tr>
<tr>
<td>• Slightly worse than expected injury outcome</td>
<td>4</td>
</tr>
<tr>
<td>• No intrusion</td>
<td>10</td>
</tr>
<tr>
<td>• Low intrusion</td>
<td>3</td>
</tr>
<tr>
<td>• As expected / better injury outcome</td>
<td>2</td>
</tr>
<tr>
<td>• Slightly worse than expected injury outcome</td>
<td>1</td>
</tr>
<tr>
<td>• Medium intrusion</td>
<td>2</td>
</tr>
<tr>
<td>• As expected / better injury outcome</td>
<td>2</td>
</tr>
<tr>
<td>• Large intrusion</td>
<td>1</td>
</tr>
<tr>
<td>• Slightly worse than expected injury outcome</td>
<td>1</td>
</tr>
<tr>
<td><strong>Slightly worse than expected compmtt performance</strong></td>
<td>1</td>
</tr>
<tr>
<td>• Medium intrusion</td>
<td>1</td>
</tr>
<tr>
<td>• Slightly worse than expected injury outcome</td>
<td>1</td>
</tr>
<tr>
<td><strong>Worse than expected compartment performance</strong></td>
<td>8</td>
</tr>
<tr>
<td>• Low intrusion</td>
<td>1</td>
</tr>
<tr>
<td>• As expected / better injury outcome</td>
<td>1</td>
</tr>
<tr>
<td>• Medium intrusion</td>
<td>2</td>
</tr>
<tr>
<td>• Worse than expected injury outcome</td>
<td>1</td>
</tr>
<tr>
<td>• Fatal</td>
<td>1</td>
</tr>
<tr>
<td>• Large intrusion</td>
<td>5</td>
</tr>
<tr>
<td>• As expected</td>
<td>2</td>
</tr>
<tr>
<td>• Worse than expected</td>
<td>1</td>
</tr>
<tr>
<td>• Fatal</td>
<td>2</td>
</tr>
</tbody>
</table>
Case Findings – Like reg. occupants

Structural performance:

• Worse than expected 8
  • Possible compatibility issue (poor structural interaction) 3
  • Possible compatibility issue (poor structural interaction / low overlap) 2
  • Poor structural interaction (low overlap) 1
  • Overridden by SUV, large mass difference 1
  • EES possibly an underestimate 1

Occupant injuries:

• Worse than expected 2
  • Large intrusion – compatibility issue (poor structural interaction / low overlap) 1
  • Medium intrusion – poor structural interaction (low overlap) 1

• Fatal 3
  • Large intrusion – overridden by SUV 1
  • Large intrusion – EES possibly an underestimate 1
  • Medium intrusion – possible compatibility issue, age of occupant 1
### Tasks

<table>
<thead>
<tr>
<th></th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Task 1: Determination of frontal impact taxonomy using European and national databases</td>
</tr>
<tr>
<td>2</td>
<td>Task 2: Determination of detailed frontal impact taxonomy using detailed accident databases</td>
</tr>
<tr>
<td>3</td>
<td>Task 3: Detailed case analysis to review fatals and determine performance of current regulation 94 test</td>
</tr>
<tr>
<td>4</td>
<td>Task 4: Compatibility</td>
</tr>
</tbody>
</table>

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**Page ▪ 40**
Task 4 - Compatibility

Approach

- Perform analysis to quantify compatibility in frontal impacts
  - Determine partner protection (aggressivity) ratio by vehicle mass and class (e.g. SUVs, small cars, etc)
  - Determine severity proportion by vehicle mass and class for car-to-car and car-to-object impacts
  - Produce cumulative frequency curves of mass ratio of vehicles involved in car-to-car impacts for all vehicles and by mass category (e.g. < 1000 kg, 1000 - 1200 kg, etc.)
**Aggressivity (partner protection)**

For vehicle mass, the aggressivity is calculated as:

\[ \text{Aggressivity} = \frac{\text{Driver fatalities in collision partner}}{\text{Number of crashes of subject vehicle}} \]

**France**

- French National data, years 2005-2008, car to car, front-front impacts, belted drivers in both vehicle.
- Aggressivity = Driver fatalities in collision partner / Number of crashes of subject vehicle (N=number of crashes)

**Germany**

- ALL ages vs ALL ages (N=25299)
- 2004+ vs ALL ages (N=3800)
- 2004+ vs 2004+ (N=753)

**GB**

- All ages vs all ages (n = 62,860)
- Oct 2003+ vs all ages (n=13,812)
- Oct 2003+ vs Oct 2003+ (n = 3,056)
Severity proportion (self protection)

\[ \text{Severity ratio} = \frac{\text{Driver fatalities} + \text{Seriously injured drivers}}{\text{Fatal} + \text{Serious} + \text{Slight drivers}} \]

\[ \text{Severity ratio} = \frac{\text{Driver fatalities} + \text{Seriously injured drivers}}{\text{Fatal} + \text{Serious} + \text{Slight} + \text{uninjured drivers}} \]

- Severity ratio generally seems to decrease with increasing mass
  - In Germany there is a clear trend for reducing severity ratio as mass increases
  - In France and GB, there is a slight trend towards lower severity ratios at higher masses
**Severity proportion (self protection)**

**Car – to-car**  
France – R94 vs R94 – injured only

**Car – to-object**  
France – R94 vs object – injured only

**France – R94 vs R94 – injured and non-injured**

**France – R94 vs object – injured and non-injured**
Severity proportion (self protection)

Germany – R94 vs R94

DotPlot of Empirical Severity Ratio (SR) - R94 vs R94 car using also uninjured drivers (blue) - using only injured drivers (green)

Curb Weight

Germany – R94 vs object

R94 Single car accidents - all impact modes using also uninjured drivers (blue) - using only injured drivers (green)
**Mass ratio**

France – R94 car-car

- Rate of severe or fatal injury increases as the mass ratio increases

\[
\text{Mass ratio} = \frac{\text{Mass of other vehicle}}{\text{Mass of vehicle containing driver}}
\]

GB – R94 car-car

<table>
<thead>
<tr>
<th>Mass ratio</th>
<th>Number of Cases</th>
<th>Percentage of Injured Occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50-0.75</td>
<td>17</td>
<td>100%</td>
</tr>
<tr>
<td>0.75-1.00</td>
<td>40</td>
<td>100%</td>
</tr>
<tr>
<td>1.00-1.25</td>
<td>41</td>
<td>100%</td>
</tr>
<tr>
<td>1.25-1.50</td>
<td>20</td>
<td>100%</td>
</tr>
<tr>
<td>1.50-1.75</td>
<td>9</td>
<td>100%</td>
</tr>
<tr>
<td>1.75-2.00</td>
<td>2</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Slightly injured
- Severely injured
- Fatal
Mass ratio

**GB – R94 car-car**

- mais 2 survived (n=25)
- mais 3+ survived (n=12)
- fatal (n=9)
- All Injured (n=152)

**France – R94 car-car**

- slightly injured n=249
- severely injured n=140
- fatal n=7
- all injured n=396

**Germany – R94 car-car**

Cumulative Distribution of Mass Ratio - Frontal Collisions R94 cars

- FATAL/MAIS3, n=2
- MAIS1, n=28
- MAIS2, n=8

Cumulative Percentage of Injured Occupants

- 0.26-0.50
- 0.51-0.75
- 0.76-1.00
- 1.01-1.25
- 1.26-1.50
- 1.51-1.75
- 1.76-2.00
- 2.01-2.25
- 2.51-2.75

Cumulative Percentage of Injured Drivers

- percentage of injured drivers

Mass Ratio

- 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
Mass ratio – France national data

Cars < 1000 kg
- Slightly injured: n=50
- Severely injured: n=26
- All injured: n=76

Cars 1000-1200 kg
- Slightly injured: n=86
- Severely injured: n=47
- All injured: n=137
- Fatal: n=4

Cars 1200-1400 kg
- Slightly injured: n=67
- Severely injured: n=40
- All injured: n=110
- Fatal: n=3

Cars 1400-1600 kg
- Slightly injured: n=36
- Severely injured: n=21
- All injured: n=57
Preliminary Conclusions

Frontal impact taxonomy

- **Data sample**
  - Only Regulation 94 compliant or equivalent vehicles considered
    - Exception car-to-car impacts where impact partner may be non R94 compliant

- **Impact configuration**
  - Impact partner
    - Car-to-car/LGV most frequent
      - GB: 42% fatal, 52% MAIS 3+, 58% MAIS 2; Germany: 29% fatal, 68% MAIS 3+, 54% MAIS 2; France 28% fatal
    - HGV / Bus significant proportion of fatal
      - GB 15%; Germany 16% ; France 19%
  - Unbelted and rollovers
    - Target population reduced substantially with removal of unbelted and rollovers
      - GB: 52% fatal, 74% MAIS 3+, 61% MAIS 2; Germany: 64% fatal, 78% MAIS 2; France 80% fatal
  - Overlap and longitudinal loading
    - Medium overlap most frequent followed by high and low, e.g car-to-car/LGV impacts for GB fatals
      - Medium (1 rail represented by current ODB test) - 57%
      - High (2 rails represented by full width test) – 34%
      - Low (no rails represented by small overlap test) – 10%
  - Collision angle
    - Majority of accidents are head-on, i.e. pdf 12 o’clock, although for Germany only 51% for MAIS 2
  - Severity
    - Current test severity addresses large proportion of impacts, e.g for car-to-car/LGV impacts
      - EES ≤ 50 km/h addresses GB: 39% fatal; 83% MAIS 3+; 90% MAIS 2; Germany: 95% of MAIS 2
      - EES ≤ 56 km/h addresses GB: 46% fatal ; 90% MAIS 3+; 95% MAIS 2; Germany 96% of MAIS 2
Preliminary Conclusions

Frontal impact taxonomy

- **Population injured**
  - Majority of drivers male, FSP female
  - Proportion of elderly (aged 66+) drivers and front seat passengers over-represented for fatalities
    - Car-to-car/LGV GB: 48% of fatal drivers; 75% of fatal FSP but note that elderly over-represented in CCIS sample

- **Injuries**
  - **Body distribution**
    - In GB, the most frequent body regions injured at AIS 2+ are the thorax, legs, and arms, for all injury severities with the thorax the most frequent for fatal and the legs for other severities
      - For fatalities there are significantly more head injuries than for other injury severities
    - In Germany, for MAIS 2 occupants, the most frequent body region injured is the thorax, followed by the head and arms
  - **Mechanisms**
    - For GB fatal drivers, injuries are most frequently related to contact with intruding structures
      - A large proportion of fatalities had intrusion of 10 cm or greater, e.g. for car-to-car/LGV GB: 75% of fatal
    - For GB MAIS 2 drivers, injuries are most frequently related to the restraint system, or contact with non-intruding structures
Preliminary Conclusions

Frontal impact taxonomy

- Rear seat (GB analysis only)
  - Seat-belt use
    - Much lower than drivers and front seat passengers
  - Population injured
    - Majority of casualties are children or young adults of both gender
  - Injuries
    - Abdomen injuries appear to be more common for rear seat passengers in CCIS sample

- N1 vehicle fatalities (GB analysis only)
  - Much lower seat belt use than fatally injured front seat occupants of cars
  - Vast majority of fatalities are male (over 95%)
  - Fewer elderly fatalities (aged 66+) than in cars
Preliminary Conclusions

Detailed case analysis

- **Fatals**
  - Analysis found that primary factors were:
    - Severe crash / anomaly 17
    - Vulnerable occupant 13
    - Underride (mostly HGV) 10
    - Limited horizontal engagement 4
    - Other 4
  - Note: sample has bias to vulnerable occupants and HGV impacts

- **Regulation 94 type impacts**
  - In approximately 25% of cases examined the vehicle’s compartment integrity was worse than expected
  - In approximately 12% of cases examined the occupant’s injury was worse than expected
  - In all these cases the compartment performance was also worse than expected
Preliminary Conclusions

Compatibility

- Aggressivity metric
  - ‘Aggressivity’ of heavier/larger vehicles generally greater than lighter/smaller vehicles for all countries, although trend much more distinct for France and Germany than GB
  - For GB aggressivity of ‘LCVs’ and ‘MPVs and 4x4s’ surprisingly low compared to other classes of vehicles for ‘R94 vs R94’ age vehicle collisions
  - Agressivity for ‘R94 vs R94’ collisions lower than for ‘R94 vs all vehicles’ and ‘all vehicles vs all vehicles’ for France and GB, but for Germany this is not the case for all masses/sizes of vehicle

- Severity proportion
  - For Germany strong trend of higher severity proportion for lighter cars in ‘car-to-car’ collisions compared to no trend for ‘car-to-object’ collisions
  - For France weak trend of higher severity proportion for lighter cars in ‘car-to-car’ collisions compared to no trend for ‘car-to-object’ collisions only when severity proportion defined in one manner, i.e. ‘uninjured’ included in denominator

- Notes:
  - Severity proportion is a blunt metric which will be subject to confounding factors
  - Significant differences between French and German national data such as the level of reporting of accidents with slight injuries is much less in France
Preliminary Conclusions

Compatibility

- Mass ratio
  - A mass ratio of 1.6 covers approximately 85% of fatalities and over 90% of serious injuries.
  - For lighter cars a much higher mass ratio is needed to cover the same percentage of fatalities and serious injuries as for heavier cars. The main contributory factor to this is likely to be exposure (i.e. light cars generally impact heavier cars) although there could be other confounding factors (e.g. more older people drive lighter cars).
  Hence, provided the other confounding factors have little influence, this indicates that the mass ratio should be higher for lighter cars than for heavier cars is needed if the test is to be representative of the ‘real world’ situation.
Preliminary conclusions

Regulatory change implications

- Addition of Full Width test
  - Full width (2 rails) most frequent configuration following offset (1 rail), 34% of car-to-car/LGV fatals for GB

- Compatibility
  - Aggressivity metric illustrates degree of compatibility problem with larger/heavier vehicles up to 3 to 4 times more aggressive than smaller/lighter vehicles
  - Severity proportion metric shows compatibility problem clearly for Germany but result is not so clear for France
  - Mass ratio of 1.6 covers about 85% of fatal injuries and over 90% of serious injuries. For lighter cars a much higher mass ratio is needed to cover the same percentage of fatalities and serious injuries as for heavier cars. Assuming that mass ratio is the main contributory factor to the accident outcome, this indicates that a test in which the mass ratio is higher for lighter cars than for heavier cars is needed if the test is to be representative of the ‘real world’ situation.

- Population injured / injury region / dummy related
  - Majority of drivers male, FSP female
  - Proportion of elderly (aged 66+) drivers and front seat passengers over-represented for fatalities
  - Thorax body region is most frequently injured for fatal and MAIS 2+ injuries

- Extension of scope (N1)
  - For fatals (GB); low belt wearing rate compared to M1; different population (mainly male, less elderly)
  - Aggressivity for 2004+ aged vehicles less than large cars and comparable to small medium cars

- Rear seated occupants
  - Approx 10% of casualties; low belt usage rate compared to front seat occupants; different population (children and young adults); different injuries (more abdomen)– note limited sample size
Do You Have Any Questions?
Thank you

David Richards, TRL (drichards@trl.co.uk +44 1344 770438)
Mervyn Edwards, TRL (medwards@trl.co.uk +44 1344 770723)
Cyril Chauvel, LAB (cyril.chauvel@lab-france.com +33 176873526)
Claus Pastor, BASt (Pastor@bast.de +49 2204 43 – 657)

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