Accident Analysis
Prepared by TRL, CEESAR, ACEA

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• Despite a three-fold increase in traffic, road safety in Europe has improved significantly in the last 30 years
• Maintaining this trend is equally important to society, authorities and the automobile industry
• In order to identify and implement appropriate vehicle safety systems for future application, in-depth accident research needs to be conducted to enable informed decision making

• To that end, a detailed analysis of road accident statistics was carried out by the Transport Research Laboratory (TRL) and Centre Européen d’Etudes de Sécurité et d’Analyse des Risques (CEESAR)
This document presents the results of the TRL/CEESAR accident analysis, and was prepared jointly by TRL, CEESAR and the European Automobile Manufacturers’ Association (ACEA).

From ACEA’s side, the Task Force Accidentology (bringing together safety experts from the 15 major EU automobile manufacturers) provided input.

In some rare cases, this analysis only provides data by TRL (United Kingdom) or CEESAR (France) for the simple reason that data for the other country was not available.

In those cases, this study presents the available data.
• This accident analysis follows the methodology described below

• Detailed evaluation of eight measures:

1. VIS: Improved front end design for direct and indirect driver VISion
2. ISA: Intelligent Speed Adaptation
3. FSO: Frontal impact Small Overlap crash test
4. SFS: Side impact Far Side occupant crash test
5. F94: Front impact crash test (removal of exemptions from regulation 94)
6. S95: Side impact crash test (removal of exemptions from R95)
7. HED: Adult HEaD to windsreen area
8. REV: REVersing detection
METHODOLOGY

• Phase 1 of the analysis defines the casualty target populations for each measure in terms of the killed, serious, and slightly-injured casualties

• Phase 2 of the accident analysis presents the effectiveness estimates referring to the eight measures which have been assessed

• Using this methodology, the results presented in this accident analysis provide clear guidance about the strengths, weaknesses and effectiveness of the assessed safety measures in terms of how much they can further improve road safety
Adult head to windscreen (HED) for M1 vehicles
• **Summary**
  - Target populations, with reference to all KSI: AEB and ISA
    - All fatally and seriously injured Pedestrians and cyclists in M1 frontal collisions:
  - Target population, with reference to all KSI: PPA
    - KSI Pedestrians & Cyclists w. AIS2+ Head Injury and contact to Windscreen area
  - Potential benefits expected: AEB, ISA & PPA

→ AEB addresses a larger Target Population than the PPA

• **Comments on the PPA evaluation**
  - Applied injury risk functions (Autoliv, 2015*) might lead to an overestimation of the PPA effectiveness
  - Injuries to VRU, that cannot be addressed with PPA, are still included in the target population:
    - AIS2+ head injuries caused by ground impact
    - AIS2+ Injuries of body regions other than head region (e.g. AIS2+ leg injury)

Within this analysis, the effectiveness of measures addressing injuries to the head caused by contact at the Windscreen area from M1 vehicles is analyzed. The windscreen can be differentiated between frame (scuttle, A-pillar, header) and central window area. Due to other technical requirements for the central windscreen area, no effectiveness of passive measures can be assumed for this analysis. Therefore, the analysis focuses on measures addressing the frame areas. As base for the analysis, the state-of-the-art countermeasure “pedestrian protection airbag” (PPA) is evaluated (see figure below).

Source: http://www.moditech.com/de/pedestrian-protection-airbag
• Target Populations for AEB and for PPA

The analysis does not consider slightly injured pedestrians and cyclists as the PPA does not address slight injuries. Despite this fact, other measures, like the AEB, can potentially reduce this share as well.

TP AEB = KSI PED & CYC in frontal collisions with M1 vehicles

TP PPA = KSI PED & CYC w. AIS2+ Head Injury and contact to WS in frontal collisions with M1 vehicles

Reference: total number of fatalities and seriously injured in all road accidents

TP - Target Population
KSI - Killed and severely injured
PED - Pedestrian
CYC - Cyclists
AEB - Autonomous Emergency Braking
ISA - Intelligent Speed Assist
PPA - Pedestrian Protection Airbag
WS - Windscreen area
**Key results**

**Reference:** total number of fatalities and seriously injured in all road accidents.
• **Research questions**

  o **Research Question 1: Target populations**
    Find the number of fatally and severely injured pedestrians and cyclists, that collided with the front of an M1 vehicle, suffered AIS2+ head injuries and had a head contact with the windscreen.

  o **Research Question 2: Potential benefits expected**
    Estimate potential benefits of the PPA considering the impacts (potential benefits) of other measures (ISA and AEB pedestrian).
• Overview of applied databases

VOIESUR (F)
2011
Accident study projected to National data

STATs19 (UK), RAIDS (UK)
2012-2015
In-depth data projected to National data

GIDAS (D)
2000-2016
In-depth data

- 3,851 Fatalities
- 25,022 Serious injured
- 53,116 Slight injured
- 8,873 Fatalities
- 112,769 Serious injured
- 842,367 Slight injured
- 761 Fatalities
- 10,011 Serious injured
- 29,410 Slight injured
• **Target populations: process**

**KSI VRU in collision with M1** → **Frontal impact** → **VRU with an AIS2+ head injury** → **Only VRU with head contact to the windscreen area** → **Target population (TP) for PPA**

**Target population (TP) for AEB and ISA**

Remark: As slightly injured VRUs cannot be addressed by PPA, they are excluded from the analysis though they could be addressed by AEB/ISA

Definition: VRU includes all pedestrians and bicyclists
**Potential benefits expected: process AEB - GIDAS (D)**

- The evaluation of the AEB is based on a GIDAS subsample of all KSI injured cyclists and pedestrians that collided with the front of an M1 vehicle. The databases (GIDAS and subsample) were compared based on the distribution of VRU type, as well as injury severity and collision speed.
- For all of the cases available as simulation files, the effectiveness of the AEB system is evaluated based on case-by-case simulations.
- System/Analysis specifications:
  - **Sensor:** Opening Angle: 60°, Range: 80m, Position: At windshield, Acquisition time: 150ms
  - **Algorithm:** The AEB is triggered, if the object is detected and in the field of view for at least 150ms AND the TTC goes below 1.0s.
  - **Brake parameters:** Brake delay: 200ms, brake gradient w. max. deceleration: 24.5m/s³ with 1g; **Remark:** max. deceleration is limited by the friction coefficient of every single accident
  - **Injury risk functions**: 
    - Age of VRU < 60: \[ P(\text{MAIS2+}) = \frac{1}{1+e^{(3.016 - 0.079 \nu_k)}} \], Age of VRU ≥ 60: \[ P(\text{MAIS2+}) = \frac{1}{1+e^{(2.223 - 0.113 \nu_k)}} \]
  
• Potential benefits expected: process AEB - VOIESUR (F) and STATS19 (UK)
  
  o The effectiveness of the AEB system is evaluated based on the simulative results from GIDAS, as it is not possible to conduct simulations based on the data available.
  
  o In order to address the different collision speed distributions, the average speed reduction within the GIDAS simulations was calculated in collision speed classes of 10kph each and transferred to the weighted STATS19 and VOIESUR data.
• **Potential benefits expected: process ISA (only for F & UK)**
  
  o VOIESUR (F): Effectiveness has been assessed for accidents in which at least one M1 was over the speed limit. The speed limit is defined according to the vertical sign and/or the legal road speed limit, the weather condition and the driver experience. Based on a case by case analysis (about 500 cases reviewed) a methodology was developed taking the energy reduction of the ISA for each case into account. During the evaluation of ISA probabilities of injury severities depending on the energy reduction are applied. (Source: CEESAR)

  o STATS19 (UK): ISA is predicted to have a mitigation effect, where the collision could not have been avoided but the severity of the collision and therefore the severity of the casualties is reduced. (Source: TRL)
• **Potential benefits expected: process PPA**

  o **GIDAS (D):** For every VRU with AIS2+ head injuries, the head impact location was analyzed and identified case-by-case. For VRU with impact within the windscreen area, the area (divided into: Scuttle, Windshield, A-Pillars) was zoned as shown schematically below. If a head impacted the transition zone, the contact was assigned to the structure aside (i.e. Scuttle or A-Pillars).

  o **STATS19 (UK) & VOIESUR (F):** For every VRU with AIS2+ head injuries, the head impact location (windscreen area divided into: Scuttle, Windshield, A-Pillars) was analyzed and identified case-by-case.

![Head impact zones in GIDAS case-by-case analysis](image)
Limitations to the methodology used for PPA evaluation:

- Derivation of injury risk functions (based on Autoliv 2015*)
  - The most challenging impact points were chosen and tested with only one car model
  - For the “Low windshield” impact point, it seems that the reference is related to historical designs of this area
    → These assumptions might lead to an overestimation of the effectiveness of PPA
    → For a more representative and realistic study, more and other impact points should be included

Limitations of the used PPA Target population:

- Due to availability issues in all datasets certain aspects could not be addressed in the analysis:
  - There are VRU with at least one injury with higher AIS level as the head injury
  - Some VRUs suffer their highest AIS head injury from ground impact
- Based on GIDAS analysis: approx. 16% of the VRU in the PPA TP suffer their highest AIS head injury from secondary/ground impact

Frontal small overlap for M1 vehicles
FSO – FRONTAL SMALL OVERLAP
(PASSENGER CARS)

• **Description**
  - Front collision with a direct damage located entirely outside of vehicle frame rails
    - Data analysis criteria: Ro and Lo from the CDC coding

• **Key results** (VOIESUR and STATS data)
  - **RQ1.** Small Target populations
    - 2.6 to 3.7% of all fatalities
    - 2.5 to 2.9% of all severely injured
    - 1.9 to 8.1% of all slightly injured
  - **RQ2.** Remaining Target population
    - 1.3 to 2.2% of all fatalities
    - 1.3 to 2.1% of all severely injured
    - 1.2 to 6.6% of all slightly injured
    - LDW/LKA and AEB are very effective measures to reduce small overlap accidents

• **Conclusions**
  - LDW/LKA and AEB have been proven to be effective to address small overlap loadcases
  - Euro NCAP considered in the roadmap 2025 Active Safety Measures as solution for Small Overlap Accidents.
• **Research questions**

  o Research Question 1: Target populations
    Find the proportion and gravity of small overlap car accidents for M1 vehicles sold in 2004 or later

  o Research Question 2: Potential benefits expected
    Estimate the potential benefit of passive safety measures considering the impact of active safety measures (ESC/AEB/LKA)
• Overview of applied databases

**VOIESUR (F)**
- 2011
- National data
- 3,851 Fatalities
- 25,022 Serious injured
- 53,116 Slight injured

**STAT19 (UK)**
- 2012-2015
- National data
- 8,873 Fatalities
- 112,769 Serious injured
- 842,367 Slight injured

**GIDAS (G)**
- 1999-2015
- In-depth data
- 748 Fatalities
- 9,416 Serious injured
- 28,724 Slight injured
Target populations: process

- Accidents involving (based on VOIESUR, STATS19 scaled with RAIDS and GIDAS data)
  - M1 vehicle sold 2004 or later in frontal impact and FSO crashes

- Fatalities, seriously and slightly injured occupants during FSO accidents in vehicle sold 2004 or later, reported to total M1 vehicles and to total number of fatalities, seriously and slightly injured road users
FSO – FRONTAL SMALL OVERLAP (PASSENGER CARS)

- Target populations

Reference: total number of fatalities, seriously and slightly injured, in all road accidents
• Potential benefits expected: process
  o French VOIESUR database (2011 National data) and UK STATS19 database (2012-2015 National Data)
  o TRL Methodology for Effectiveness Estimates, starting from FSO Target Population (RQ1)
  o New target populations considering potential benefits of existing measures: ESC
    Fatality reduction by 38% and injury reduction by 21% for loss of control crashes (Hoye 2011)
  o New set of target populations according to potential benefits of other proposed measures: LDW/LKA, AEB, ISA
    ▪ LDW/LKA: reduction by 53% for head-on and single-vehicle crashes on road with speed limit between 70 and 120 km/h and dry/wet surface not covered by ice or snow (Sternlund et al. 2017)
    ▪ AEB: reduction by 38% for rear-end crashes car to car (Fildes et al. 2015)
    ▪ ISA: Case by case effectiveness estimate
Potential benefits expected: results

- **VOIESUR (F):** New target populations considering potential benefits of existing measures (ESC)

Reference: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: results
  
  - VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+LDW)

**FSO - Target population with benefits of other proposed measures (ESC+LDW)**

- Fatally injured: 2.6% (RQ1-FO TP), 1.4% (target population (ESC+LDW) related)
- Severely injured: 2.5% (RQ1-FO TP), 1.5% (target population (ESC+LDW) related)
- Slightly injured: 1.9% (RQ1-FO TP), 1.3% (target population (ESC+LDW) related)

Reference: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: results
  o VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+AEB)

Reference: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: results
  o VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA)

**FSO - Target population with benefits of other proposed measures (ESC+ISA)**

- Fatally injured: 2.2%
- Severely injured: 2.4%
- Slightly injured: 1.7%

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA+LDW)

**FSO - Target population with benefits of other proposed measures (ESC+ISA+LDW)**

<table>
<thead>
<tr>
<th>Injury Level</th>
<th>RQ1-FSO TP (%)</th>
<th>Target Population (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatally injured</td>
<td>2.6%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Severely injured</td>
<td>2.5%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Slightly injured</td>
<td>1.9%</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA+AEB)

Reference: total number of fatalities, seriously and slightly injured road users
FSO – FRONTAL SMALL OVERLAP
(PASSENGER CARS)

- Potential benefits expected: results
  - VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+LDW+AEB)

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- **VOISEUR (F):** New set of target populations according to potential benefits of other proposed measures (ESC+LDW+AEB+ISA)

### FSO - Target population with benefits of other proposed measures (ESC+LDW+AEB+ISA)

- **Fatally injured:** 2.6%
- **Severely injured:** 2.5%
- **Slightly injured:** 1.9%

Reference: total number of fatalities, seriously and slightly injured road users
**Potential benefits expected: results**

- **VOIESUR (F) and STATS (UK):** New target populations considering potential benefits of **existing measures** (ESC)

**Reference:** total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F) and STATS (UK): New target populations considering potential benefits of other proposed measures (*).

FsO – Frontal Small Overlap (Passenger Cars)

(*) Voiesur data include also ESC

Reference: total number of fatalities, seriously and slightly injured road users.
• **Potential benefits expected: results**
  
  o VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining FSO target populations for **fatalities**

  o **Reference**: total number of fatalities, seriously and slightly injured road users
- Potential benefits expected: results
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining FSO target populations for seriously injured

  - Reference: total number of fatalities, seriously and slightly injured road users
FSO – FRONTAL SMALL OVERLAP
(PASSENGER CARS)

- Potential benefits expected: results
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining FSO target populations for *slightly injured*

- **Reference:** total number of fatalities, seriously and slightly injured road users
• Conclusions and comments
  o Differences between French and UK databases seem relevant but don’t influence a lot the assessment
  o **RQ1.** The FSO TP in M1 vehicles is a small sample respect to all casualties (2% in French data and 7% in UK data)
    ▪ 2.6 to 3.7% of all fatalities
    ▪ 2.5 to 2.9% of all severely injured
    ▪ 1.9 to 8.1% of all slightly injured
  o **RQ2.** Target Population remaining
    ▪ 1.3 to 2.2% of all fatalities
    ▪ 1.3 to 2.3% of all severely injured
    ▪ 1.2 to 6.9% of all slightly injured
    ▪ Existing measures (ESC) may reduce the target population with low benefits
    ▪ Benefits related to other proposed measures (AEB, LDW, ISA) contribute significantly to reduce the target population
    ▪ LDW is a very effective measure to reduce small overlap accidents
• Conclusions and comments

  o Possible solution
    ▪ Possible solution is a new passive safety test, but test and criteria have to be defined
    ▪ In addition in Euro NCAP roadmap 2025 published two days ago, Euro NCAP clearly suggest to push on Active Safety Measures, like Automated Emergency Steering (not just braking) as the solution for Small Overlap Accident.
Intelligent speed adaption (ISA) for M₁/N₁ vehicles
• **Description**
  
  - The speed of the vehicle gets limited at all times and on all networks. The vehicle is informed of the posted speed limit except there is a dynamic speed limitation due to driver (young licensor), weather (rain or fog), etc.
  
  The system status is mandatory set to on. The Driver can override the system by pushing harder on the accelerator.
**Key results**

- **Target Populations (VOIESUR (F), STATS19/OTS (UK) and GIDAS (GER))**
  - 16.4 to 20.8% of all road user fatalities
  - 7.0 to 10.5% of all seriously injured road users
  - 5.4 to 7.4% of all slightly injured road users

- **Potential benefits expected of other measures ESC + LDW/LKA + AEB**
  - 6.0 to 8.0% of all road user fatalities
  - 1.6 to 2.7% of all seriously injured road users
  - 0.9 to 1.6% of all slightly injured road users
  - Main benefits coming from ESC then LDW/LKA and then AEB

- **Potential benefits expected for ESC + ISA**
  - 5.2 to 8.7% of all road user fatalities
  - 1.6 to 3.6% of all seriously injured road users
  - 1.3 to 2.4% of all slightly injured road users

- **Potential benefits expected for ESC + SLI** (Speed Limit Information system), ref. Wilkie and Tate (2003), Carston and Tate (2005)
  - ~3.5% of all road user fatalities
  - ~1.3% of all seriously injured road users
  - ~0.9% of all slightly injured road users
Research questions

- Research Question 1: Target populations
  Find the proportion and gravity of accident involving M1/N1 vehicles with speed limit infringement.

- Research Question 2: Potential benefits expected
  Estimate potential benefits of the measure ISA for M1/N1 vehicles considering the impacts of other measures (ESC, LDW/LKA and AEB).
• Overview of applied databases

**VOIESUR (F)**
- 2011 National data
- 3,851 Fatalities
- 25,022 Severely injured
- 53,116 Slightly injured

**STATS19 & OTS (UK)**
- 2011-2015 National & In-depth data
- 8,873 Fatalities
- 112,769 Serious injured
- 842,367 Slight injured

**GIDAS (G)**
- 1999-2015 In-depth data
- 748 Fatalities
- 9,416 Serious injured
- 28,724 Slight injured
• **Target populations: process**
  
  o STATS19 and GIDAS study checks
    
    - if a M1/N1 vehicle was involved in the accident
    - if the M1/N1 vehicle was going faster as the speed limit
    - if going faster as the speed limit was a contributory factor to the cause of the accident

  o For the STATS19 data it is assessed that speed infringement is underreported. Therefore a pre-target population of casualties was upscaled by the factor 4.5, what is roughly derived from a OTS study, to come to the final target populations.
• **Target populations: process**

  o VOIESUR study checks
  
    - if a M1/N1 vehicle was involved in the accident
    - if the M1/N1 vehicle was going faster as the speed limit
    - does **not** check if going faster as the speed limit was a contributory factor to the cause of the accident
    - Speed infringement accidents with M1/N1 and M2/N2 or M3/N3 vehicles involved show up in both target populations – e.g. in TP for M1/N1 and M2/N2.

This explains the overestimation of the target populations of the VOIESUR study.
• **Target populations: results**

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected

- STATS19 / OTS (UK): Target and remaining populations considering potential benefits of existing/proposed measures ESC + LDW + AEB + AEB-Pedestrian and studied measure ISA.

Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected**
  
  o **VOISURE (F):** Target and remaining populations considering potential benefits of existing/proposed measures ESC + LDW + AEB + AEB-Pedestrian and studied measure ISA.

**Reference:** total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining ISA target populations for fatalities

Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining ISA target populations for seriously injured

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining ISA target populations for slightly injured

Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures, benefits of ISA and non-addressable population for fatalities

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F) and STAT19 (UK): Potential benefits of other measures, benefits of ISA and non-addressable population for seriously injured

Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures, benefits of ISA and non-addressable population for slightly injured

**Reference:** total number of fatalities, seriously and slightly injured road users
• Summary

○ Target Populations (VOIESUR (F), STATS19/OTS (UK) and GIDAS (GER))
  ▪ 16.4 to 20.8% of all road user fatalities
  ▪ 7.0 to 10.5% of all seriously injured road users
  ▪ 5.4 to 7.4% of all slightly injured road users

○ Potential benefits expected of other measures ESC + LDW/LKA + AEB
  ▪ 6.0 to 8.0% of all road user fatalities
  ▪ 1.6 to 2.7% of all seriously injured road users
  ▪ 0.9 to 1.6% of all slightly injured road users
  Main benefits coming from ESC then LDW/LKA and then AEB

○ Potential benefits expected for ESC + ISA
  ▪ 5.2 to 8.7% of all road user fatalities
  ▪ 1.6 to 3.6% of all seriously injured road users
  ▪ 1.3 to 2.4% of all slightly injured road users

○ Potential benefits expected for ESC + SLI (Speed Limit Information system), ref. Wilkie and Tate (2003), Carston and Tate (2005)
  ▪ ~3.5% of all road user fatalities
  ▪ ~1.3% of all seriously injured road users
  ▪ ~0.9% of all slightly injured road users
• **Conclusion**
  - Other measures (ESC + LDW/LKA + AEB) are predicted to have a greater overall casualty benefit than ISA.

• **Comments**
  - To estimate the effectiveness of ISA other parameters (short term licence holder, age of vehicles etc.) have to be considered, too. More details please see detailed presentation about ISA.
  - In addition to that the introduction of ISA needs an updated infrastructure to work in the intended way.
Intelligent speed adaption (ISA) for M2/N2 and M3/N3 vehicles
ISA - INTELLIGENT SPEED ADAPTION
(M2/N2 & M3/N3)

• Description
  o The speed of the vehicle gets limited at all times and on all networks.
    The vehicle is informed of the posted speed limit except there is a
dynamic speed limitation due to driver (young licenser), weather (rain
or fog), etc.
The system status is mandatory set to on. The Driver can override the
system by pushing harder on the accelerator.
Key results

- Target Populations for VOIESUR (F) and STATS19 (UK)
  - 0.7 to 3.9% of all road user fatalities
  - 0.12 to 0.4% of all seriously injured road users
  - 0.07 to 0.4% of all slightly injured road users

- Remaining Target Populations with potential benefits for studied measures (Speed Limiter + AEB + LDW)
  - 0.57 to 2.62% of all road user fatalities
  - 0.11 to 0.32% of all seriously injured road users
  - 0.07 to 0.25% of all slightly injured road users

- Potential benefits expected for ISA* in addition to Speed Limiter + AEB + LDW
  - 0.14 to 0.23% of all road user fatalities
  - 0.004 to 0.02% of all seriously injured road users
  - 0.01 to 0.05% of all slightly injured road users

- Comments
  - In addition to M1/N1 conclusions speed limits for M2/N2 & M3/N3 vehicles with regards to directive 92/6/EWG to be considered

* Assumption: The speed of the vehicle is always limited to the correct limit (not possible with todays infrastructure)
**Research questions**

- Research Question 1: Target populations
  Find the proportion and gravity of accident involving M2/N2 or M3/N3 vehicles with speed limit infringement.

- Research Question 2: Potential benefits expected
  Estimate potential benefits of the measure ISA for M2/N2 or M3/N3 vehicles considering the impacts of other measures (Speed Limiter + AEB + LDW).
• Overview of applied databases

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- 2011 National data
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- 25,022 Severely injured
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- 9,416 Serious injured
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• **Target populations: process**

  - STATS19 and GIDAS study checks
    - if a M2/N2 or M3/N3 vehicle was involved in the accident
    - if the M2/N2 or M3/N3 vehicle was going faster as the speed limit
    - if going faster as the speed limit was a contributory factor to the cause of the accident

  - For the STATS19 data it is assessed that speed infringement is underreported. Therefore a pre-target population of casualties was upscaled by the factor 4.5, what is roughly derived from a OTS study, to come to the final target populations.
• **Target populations: process**
  
  o **VOIESUR study checks**
    - if a M2/N2 or M3/N3 vehicle was involved in the accident
    - if the M2/N2 or M3/N3 vehicle was going faster as the speed limit
    - does **not** check if going faster as the speed limit was a contributory factor to the cause of the accident
    - Speed infringement accidents with M1/N1 and M2/N2 or M3/N3 vehicles involved show up in both target populations – e.g. in TP for M1/N1 and M2/N2.

This explains the overestimation of the target populations of the VOIESUR study.
ISA - INTELLIGENT SPEED ADAPTATION
(M₂/N₂ & M₃/N₃)

- Target populations: results

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected

- VOISURE (F): Target and remaining populations considering potential benefits of existing/proposed measures Speed Limiter + AEB + LDW and studied measure ISA.

Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining ISA target populations for fatalities

Reference: total number of fatalities, seriously and slightly injured road users
ISA - INTELLIGENT SPEED ADAPTATION (M2/N2 & M3/N3)

- Potential benefits expected: results
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining ISA target populations for seriously injured

Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining ISA target populations for slightly injured

**Reference**: total number of fatalities, seriously and slightly injured road users
Summary and Comments

- Target Populations for VOIESUR (F) and STATS19 (UK)
  - 0.7 to 3.9% of all road user fatalities
  - 0.12 to 0.4% of all seriously injured road users
  - 0.07 to 0.4% of all slightly injured road users

- Remaining Target Populations with potential benefits for studied measures (Speed Limiter + AEB + LDW)
  - 0.57 to 2.62% of all road user fatalities
  - 0.11 to 0.32% of all seriously injured road users
  - 0.07 to 0.25% of all slightly injured road users

- Potential benefits expected for ISA in addition to Speed Limiter + AEB + LDW
  - 0.14 to 0.23% of all road user fatalities
  - 0.004 to 0.02% of all seriously injured road users
  - 0.01 to 0.05% of all slightly injured road users

- Comments
  - In addition to M1/N1 conclusions speed limits for M2/N2 & M3/N3 vehicles with regards to directive 92/6/EWG to be considered
VIS – Front end design for N2/N3 vehicles
**VIS - FRONT END DESIGN** *(TRUCKS)*

- **Description**
  - Allow driver to perceive obstacle in the front and side of the vehicle

- **Key results**
  - Target populations
    - $\approx 3\text{-}4\%$ of all road user fatalities
    - $\approx 0.75\text{-}1\%$ of all seriously injured road users
    - $\approx 0.25\%$ of all slightly injured road users
  - Results show Detection and AEB measures are more effective than changes in CAB design (direct vision)
  - Potential benefits expected
    - Less than target populations which is already low

<table>
<thead>
<tr>
<th>Results from STATS19 (UK) as reduction of total number of fatalities, seriously and slightly injured, all road users</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severity</strong></td>
</tr>
<tr>
<td><strong>VIS Approach</strong></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

- Effects cannot be summed up since the different measures address the same accidents
Side impact for far side occupant crash tests M1 vehicles
SFS – FAR SIDE
(PASSENGER CARS)

• **Description**
  o Protect occupants seated on the non-struck side of car in a side impact
  o Collision partner could be various: vehicle or fixed obstacle

• **Key results**
  o RQ1 (FR & GB): Target population
    ▪ 4.5 to 4.9% of all fatalities
    ▪ 1.7 to 2.3% of all severely injured
    ▪ 3.9 to 4% of all slightly injured
  o RQ2 Remaining target populations after consideration of other measures (ESC, ISA, AEB)
    ▪ 3.2 to 3.5% all fatalities
    ▪ 1.5 to 1.9% all severely injured
    ▪ 3.7 to 3.9% all slightly injured
    ▪ SBR and Pole test measures may have potential to reduce further the TP but were not addressed

• **Conclusion:**
  o All together, ESC, ISA and AEB stationary vehicle have some reduction potential on fatality target population. However, these measures have little effect on other casualties.
  o Effectiveness of potential counter measures are not proven. RQ2 was stopped at the level of refined TP
• **Other key results**
  
  o Objective: Euro NCAP far-side protocol
    - Analysis on occupant injury details
    - Analysis on the effect of a close occupant
  
  o Head and thorax are the most frequently injured body regions
    - Head injuries are caused mainly by contacts with car interior
    - Head injuries are decreased with close occupant
    - Further evolution of side curtain airbags will also provide benefits for far side occupants
• **Research questions**
  
  o Research Question 1 (GSR): Target populations
    Find the proportion and gravity of M₁ far side accident

  o Research Question 2 (GSR): Estimate the potential benefit of dedicated passive safety solutions considering the impact of active/passive safety existing measures (ESC) and proposed measures (ISA/AEB)

  o Other (Far-side occupant injuries): Points to be addressed in far-side occupant assessment for passive safety measures (Euro NCAP: FYI)
### Overview of applied databases

<table>
<thead>
<tr>
<th>Database</th>
<th>Year Period</th>
<th>Type of Data</th>
<th>Fatalities</th>
<th>Slight Injured</th>
<th>Serious Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOIESUR (F)</td>
<td>2011</td>
<td>National</td>
<td>3,851</td>
<td>25,022</td>
<td>53,116</td>
</tr>
<tr>
<td>STAT19 (UK)</td>
<td>2011-2015</td>
<td>National</td>
<td>8,873</td>
<td>112,769</td>
<td>842,367</td>
</tr>
<tr>
<td>GIDAS (G)</td>
<td>1999-2015</td>
<td>In-depth</td>
<td>748</td>
<td>9,416</td>
<td>28,724</td>
</tr>
</tbody>
</table>
- **Target populations (RQ1)**

  **FRANCE – VOIESUR 2011**
  - % M1 (all casualties)
    - 52% of fatalities
    - 35.3% Severely injured
    - 45.7% Slightly injured
  - % Far-side All seats (M1 2004+ casualties)
    - 9.4% of fatalities
    - 6.7% Severely injured
    - 8.5% Slightly injured
  - \( \times \)
  - % Far-side All seats (all casualties)
    - 4.9% of fatalities
    - 2.3% Severely injured
    - 3.9% Slightly injured

  **GERMANY – GIDAS 1999-2015**
  - % M1 (all casualties)
    - 52.9% of fatalities
    - 43.8% Severely injured
    - 55.6% Slightly injured
  - % Far-side All seats (M1 2004+ casualties)
    - 4.9% of fatalities
    - 1.5% Severely injured
    - 1.4% Slightly injured
  - \( \times \)
  - % Far-side All seats (all casualties)
    - 2.6% of fatalities
    - 0.7% Severely injured
    - 0.8% Slightly injured

  **GB – STATS19 2011-2015**
  - % M1 (all casualties)
    - 45.0% of fatalities
    - 35.2% Severely injured
    - 63.2% Slightly injured
  - % Far-side Front seats (M1 2004+ casualties)
    - 10.1% of fatalities
    - 4.8% Severely injured
    - 6.3% Slightly injured
  - \( \times \)
  - % Far-side Front seats (all casualties)
    - 4.5% of fatalities
    - 1.7% Severely injured
    - 4% Slightly injured

- Reference: total number of fatalities, seriously and slightly injured road users
• **Target populations (RQ1)**
**SFS – FAR SIDE**
*(PASSENGER CARS)*

- **Target populations (RQ2)**
  - New TP considering the potential benefit of ESC, ISA and AEB stationary vehicle

![SFS - Refined Target Population for FRANCE - VOIESUR 2011 (% of all road casualties)](chart)

- RQ2 TP: ESC+ISA+AEB stationary Savings
- RQ2 TP: ESC Savings
- RQ1 TP
- **Target populations (RQ2)**
  - New TP considering the potential benefit of ESC, ISA and AEB stationary vehicle

![Bar chart showing SFS - Refined Target Population for GB - STATS19 - 2011-2015 (% of all road casualties)]
• Potential benefit on total casualties and fatalities (RQ2-FR)
• Potential benefit on total casualties and fatalities (RQ2-GB)
**SFS – FAR SIDE**
(\textit{PASSENGER CARS})

- Points to be addressed in far-side occupant assessment for passive safety measures (Euro NCAP)
- Similar samples as GSR

<table>
<thead>
<tr>
<th></th>
<th>GERMANY GIDAS</th>
<th>BAAC French National Database</th>
<th>French in-depth database LAB (weighted data)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injured accidents No P or 2W</td>
<td>Injured+ accidents (under reporting) No P or 2W</td>
<td>Injured+ accidents No P or 2W</td>
</tr>
<tr>
<td>Impacts</td>
<td>Lateral</td>
<td>Lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Occupants</td>
<td>Belted Front seat passengers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ages</td>
<td>10+</td>
<td>10+</td>
<td>10+</td>
</tr>
<tr>
<td>Sample</td>
<td>1,719 (804/915)</td>
<td>14,775 (6,801/7,974)</td>
<td>432 (199/233)</td>
</tr>
<tr>
<td>MAIS 2+</td>
<td>99 (43/56)</td>
<td>172 (64/108)</td>
<td></td>
</tr>
<tr>
<td>MAIS 3+</td>
<td>34 (9/27)</td>
<td>89 (34/55)</td>
<td></td>
</tr>
<tr>
<td>F+S Injured</td>
<td>3,433 (1,391/2,042)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SFS – FAR SIDE
(PASSENGER CARS)

LATERAL IMPACT, FRONT SEAT BELTED ADULT OCCUPANTS: PROPORTION OF INVOLVED

- Far Side 45 to 47% of involved occupants
  - 22 to 27% Alone
  - 19 to 25% With close occupant

Legend

<table>
<thead>
<tr>
<th></th>
<th>Far Side</th>
<th>Near Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With close occupant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SFS – FAR SIDE
(PAASNGER CARS)

LATERAL IMPACT, FRONT SEAT BELTED ADULT OCCUPANTS: PROPORTION OF MAIS3+ OR F+SI

- Far Side 27 to 41 % of MAIS3+ or Seriously Injured occupants
  - 20 to 24 % Alone
  - 6 to 18 % With close occupant

Legend

<table>
<thead>
<tr>
<th></th>
<th>Far Side</th>
<th>Near Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With close occupant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Detailed analysis on MAIS3+ level in Far Side not presented in the following due to low sample sizes
• **Close occupant**
  - Far-side with close occupant (all belted)
    - 19 to 25% of involved people in lateral crashes
    - 6 to 18% of KSI* in lateral crashes
  - Far-side alone (all belted)
    - 22 to 27% of involved people in lateral crashes
    - 20 to 24% of KSI in lateral crashes

→ **Close occupant does not increase far-side KSI**

*Killed or Seriously Injured*
• Far-side occupant injuries

- Accident year 2003-2015
- Registration year 2000+
- No rollover
- Belted
- Age 10+
- Impact angle 2-4, 8-10 o’clock

GIDAS-MAIS2+ front seat belted adult occupants in Far side (n=68 injuries)

- Head represents 48% of injuries sustained by far-side occupants
- Thorax represents 27% of injuries sustained by far-side occupants
• Far-side occupant injury causation

GIDAS-MAIS2+ front seat belted adult occupants in Far side (n=68 injuries)

To head:
- Struck-side interior contact 41%
- Adjacent interior 31%
- Other occupant 13%
- Opposite seat 3%
- Body movement 6%
- Unknown contact 6%

To thorax:
- Belt and buckle 50%
- Unknown contact 28%
- Struck-side interior contact 11%
- Opposite seat 6%
- Body movement 5%
- Opposite occupant 0%

- 72% of head injuries are caused by contacts with car interior (struck or far side)
- 50% of thoracic injuries are caused by belt and buckle
SFS – FAR SIDE
(PASSENGER CARS)

• Far side occupant injuries and close occupant

→ Head injuries are decreased with close occupant
• Conclusions (1/2)
  o RQ1: Target Population (FR & GB)
    ▪ 4.6 to 4.9% of all fatalities
    ▪ 1.7 to 2.3% of all severely injured
    ▪ 3.9 to 4% of all slightly injured
  o RQ2: Refined Target Population (FR & GB)
    ▪ 3.2 to 3.7% all fatalities
    ▪ 1.6 to 1.9% all severely injured
    ▪ 3.7 to 3.9% all slightly injured
• Conclusions (2/2)

  o ACEA far-side study
    ▪ Far-side ~ 45% of all involved in lateral crashes
    ▪ Far-side: 27 to 41% of MAIS3+
    ▪ Far-side KSI with close occupant lower than far-side KSI alone
    ▪ Head and thorax most frequently injured
    ▪ Head injuries are caused mainly by contacts with car interior
      → Further evolution of side curtain airbags will provide benefits for far side occupants
    ▪ Head injuries less with close occupant

  o ESC, ISA and AEB effects have only been considered here. Additionally, SBR and Pole test may have some potential to reduce further the TP.
ECE R94 – Frontal impact crash test extension to all M1/N1 vehicles
**F94 - FRONT IMPACT**
*(M1/N1 NOW EXCLUDED)*

- **Description**
  - Extend ECE R94 – Frontal Impact Crash Test to M1 and N1 vehicles which are exempted (gross vehicle mass > 2,500 kg)

- **Key results**
  - Target Populations (VOIESUR (F) and STAT19 (UK))
    - 1.3 to 1.4% of all road user fatalities
    - 0.9 to 1.1% of all seriously injured road users
    - 1.4 to 1.6% of all slightly injured road users
  - Refined Target Populations with potential benefits from other measures
    - 0.7 to 0.8% of all road user fatalities
    - 0.6 to 0.7% of all seriously injured road users
    - 1.0 to 1.2% of all slightly injured road users
  - Main benefits coming from LDW/LKA, then AEB or ISA and then ESC

- **Conclusion**
  - No evaluation of efficiency available for R94 regulation
  - Expectation is a low potential of R94 and even less if we refer to the refined target population. The discussed vehicles have already a high level of self protection
  - Regulation 137 for M1-vehicles up to 3,5 tons.
  - Current accident data doesn’t show problems with regard to safety of electric vehicles
• **Research questions**
  
  o Research Question 1: Target populations  
    Find proportion and gravity of  
    frontal collisions involving exempt M1 and N1 vehicles.

  o Research Question 2: Potential benefits expected  
    Estimate potential benefits of  
    ECE R94 – Frontal Impact Crash Test for exempt M1 and N1 vehicles  
    considering the impacts of other measures (ESC, ISA, LDW/LKA and AEB).
**Overview of applied databases**

- **VOIESUR (F)**
  - Year: 2011
  - Data type: National data
  - Fatalities: 3,851
  - Serious injured: 25,022
  - Slight injured: 53,116

- **STAT19 (UK)**
  - Year: 2012-2015
  - Data type: National data
  - Fatalities: 8,873
  - Serious injured: 112,769
  - Slight injured: 842,367

- **GIDAS (G)**
  - Year: 1999-2015
  - Data type: In-depth data
  - Fatalities: 748
  - Serious injured: 9,416
  - Slight injured: 28,724
**F94- FRONT IMPACT**

(M1/N1 NOW EXCLUDED)

- **Target populations: process**
  - Accidents involving
    - Exempt M1 and N1 vehicle (gross vehicle mass > 2,500 kg)
      Frontal impact
  - Part of fatalities, seriously and slightly injured occupants during these accidents
    Relative to total number of fatalities, seriously and slightly injured road users
  - Note: for French and German data
    - Analyses are made for M1 and N1 vehicle sold 2004 and later and then adjust to whole fleet after:
      \[
      \%F94 \text{ (all casualties)} = \%F94 \text{ (M1/N1 2004+ casualties)} \times \% \text{ M1/N1 (all casualties)}
      \]
Target populations: results
Occupants of exempt M1 and N1 vehicles in frontal impact

- Reference: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: process
  o New target populations considering potential benefits of existing measures
    ▪ ESC: Fatality reduction by 38% and injury reduction by 21% for loss of control crashes (Hoye 2011)

  o New set of target populations according to potential benefits of other proposed measures
    ▪ LDW/LKA: reduction by 53% for head-on and single-vehicle crashes on road with speed limit between 70 and 120 km/h and dry/wet surface not covered by ice or snow (Sternlund et al. 2017)
    ▪ AEB: reduction by 38% for rear-end crashes car to car (Fildes et al. 2015)
    ▪ ISA: case by case analysis (see ISA presentation)

  o Potential benefits of ECE R94 – Frontal Impact Crash Test
    ▪ No evaluation of efficiency available for R94 regulation
    ▪ Risk of increasing mass leading to decrease partner protection
• Potential benefits expected: results
  o VOIESUR (F): New target populations considering potential benefits of existing measures (ESC)
  o Reference: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: results

- VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+LDW/LKA)

- Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  o **VOIESUR (F):** New set of target populations according to potential benefits of other proposed measures (ESC+AEB)

  ![Graph showing F94 - Target population with benefits of other proposed measures (ESC+AEB)](image)

  - % fatality: 1.1%
  - % seriously injured: 0.9%
  - % slightly injured: 1.4%

  o **Reference:** total number of fatalities, seriously and slightly injured road users
**F94- FRONT IMPACT**  
(M1/N1 NOw EXCLUDED)

- **Potential benefits expected: results**
  - VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA)

![Chart showing the target population with benefits of other proposed measures (ESC+ISA)]

- Reference: total number of fatalities, seriously and slightly injured road users
**F94- FRONT IMPACT**
(M1/N1 NOW EXCLUDED)

- **Potential benefits expected: results**
  - VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA+LDW/LKA)
  - Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  o VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA+AEB)

  ![Diagram showing % fatality, % seriously injured, and % slightly injured for F94 and other measures.]

  o **Reference**: total number of fatalities, seriously and slightly injured road users
F94 - FRONT IMPACT
(M1/N1 NOW EXCLUDED)

• Potential benefits expected: results
  o VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+LDW/LKA+AEB)

![F94 - Target population with benefits of other proposed measures (ESC+LDW/LKA+AEB)](image)

  o Reference: total number of fatalities, seriously and slightly injured road users
F94 - FRONT IMPACT
(M1/N1 NOW EXCLUDED)

- **Potential benefits expected: results**
  - **VOIESUR (F):** New set of target populations according to potential benefits of other proposed measures (ESC+LDW/LKA+AEB+ISA)
  - **Reference:** total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  o VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining F94 target populations for fatalities

  o **Reference**: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  o VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining F94 target populations for serious injuries

  ![Graphs showing potential benefits for VOIESUR (F) and STAT19 (UK)]

  o **Reference**: total number of fatalities, seriously and slightly injured road users
**F94- FRONT IMPACT**

**Potential benefits expected: results**

- VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining F94 target populations for slight injuries

- **Reference**: total number of fatalities, seriously and slightly injured road users
Summary and comments

- Target Populations (VOIESUR (F) and STAT19 (UK))
  - 1.3 to 1.4% of all road user fatalities
  - 0.9 to 1.1% of all seriously injured road users
  - 1.4 to 1.6% of all slightly injured road users

- Refined Target Populations with potential benefits from other measures
  - 0.7 to 0.8% of all road user fatalities
  - 0.6 to 0.7% of all seriously injured road users
  - 1.0 to 1.2% of all slightly injured road users

  Main benefits coming from LDW/LKA, then AEB or ISA and then ESC

- Potential benefits expected
  - No evaluation of efficiency available for R94 regulation
  - Potential benefits will be lower than target populations
ECE R95 – Side impact crash test extension to all M1/N1 vehicles
R95 - SIDE IMPACT

(M1/N1 NOW EXCLUDED)

• **Description**
  - Extend ECE R95 – Side Impact Crash Test to M1 and N1 vehicles having R-Point above 700 mm

• **Key results**
  - **Target Populations for VOIESUR (F) and STAT19 (UK)**
    - 0.3% (total 26 in STATS19) to 0.5% (total 6 in VOISEUR) of all road user fatalities
    - 0.2% to 0.9% of all seriously injured road users
    - 0.5% to 0.6% of all slightly injured road users
  - **Remaining TP with potential benefits from studies measures (ESC + AEB + ISA)**
    - 0.2% (total 22 in STATS19) to 0.42% (total 5 in VOISEUR) of all road user fatalities
    - 0.2% to 0.78% of all seriously injured road users
    - 0.47% to 0.53% of all slightly injured road users
  - **Conclusions**
    - No evaluation of efficiency available for R95 regulation
    - Expectation is a very low potential of R95 extension. The discussed vehicles have already a high level of self protection.
    - Regulation 135 (worst case intrusion: Pole) has no exemptions for M1 vehicles
    - Current accident data doesn’t show problems with regard to safety of electric vehicles
• **Research questions**
  
  o Research Question 1: Target populations  
    Find proportion and gravity of side impact collisions involving portion of M1 and N1 vehicles.

  o Research Question 2: Potential benefits expected  
    Estimate potential benefits of ECE R95 – Side Impact Crash Test for portion of M1 and N1 vehicles considering the impacts of other measures (ESC, AEB and ISA).
Overview of applied databases

**VOIESUR (F)**
- 2011
- National data
- 3,851 Fatalities
- 25,022 Slight injured
- 53,116 Serious injured

**STAT19 (UK)**
- 2012-2015
- National data
- 8,873 Fatalities
- 112,769 Serious injured
- 842,367 Slight injured

**GIDAS (G)**
- 1999-2015
- In-depth data
- 748 Fatalities
- 9,416 Serious injured
- 28,724 Slight injured
**Target populations: process**

- Accidents involving
  - Portion of M1 and N1 vehicle (having Vehicle Height VH > 1500 mm) in side impact

- Part of fatalities, seriously and slightly injured occupants during these accidents relative to total number of fatalities, seriously and slightly injured road users

- Note: for French and German data
  - Analyses are made for M1 and N1 vehicle sold 2004 and later and then adjust to whole fleet after:
    
    \[
    \%F_{95} \text{ (all casualties)} = \%F_{95} \text{ (M1/N1 2004+ casualties)} \times \% \text{ M1/N1 (all casualties)}
    \]
• **Target populations: results**
  Occupants of exempt M1 and N1 vehicles in side impact

---

**Reference**: total number of fatalities, seriously and slightly injured road users
Potential benefits expected: process

- New target populations considering potential benefits of existing measures
  - ESC: Fatality reduction by 38% and injury reduction by 21% for loss of control crashes (Hoye 2011)

- New set of target populations according to potential benefits of other proposed measures
  - AEB: reduction by 38% for rear-end crashes car to car (Fildes et al. 2015)
  - ISA: case by case analysis (see ISA presentation)

- Potential benefits of ECE R95 – Side Impact Crash Test
  - No evaluation of efficiency available for R95
  - Final results have a very small numbers (5 fatal cases for VOISEUR data)
  - Potential benefits for all features (ESC, AEB and ISA) have small numbers
**Potential benefits expected: results**

- VOIESUR (F): New target populations considering potential benefits of existing measures (ESC)

- Reference: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: results
  - VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+AEB)

  ![R95 - Target population with benefits of existing measures (ESC+AEB)](image)

  - Reference: total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: results**
  
  - VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA)

  ![Diagram showing target populations with benefits of existing measures (ESC+ISA)](image)

  - **Reference**: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: results
  
  o VOIESUR (F): New set of target populations according to potential benefits of other proposed measures (ESC+ISA+AEB)

  o Reference: total number of fatalities, seriously and slightly injured road users
**R95- SIDE IMPACT**

(M1/N1 NOW EXCLUDED)

- **Potential benefits expected: results**
  - VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining R95 target populations for fatalities

  - Reference: total number of fatalities, seriously and slightly injured road users
• Potential benefits expected: results
  o VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining R95 target populations for serious injuries

  - Reference: total number of fatalities, seriously and slightly injured road users
**Potential benefits expected: results**

- VOIESUR (F) and STAT19 (UK): Potential benefits of other measures and remaining R95 target populations for slight injuries

**Reference:** total number of fatalities, seriously and slightly injured road users
### Result summary and comments

#### Target Populations for VOIESUR (F) and STAT19 (UK)
- 0.3% (total 26 in STATS19) to 0.5% (total 6 in VOISEUR) of all road user fatalities
- 0.2% to 0.9% of all seriously injured road users
- 0.5% to 0.6% of all slightly injured road users

#### Remaining TP with potential benefits from studies measures (ESC + AEB + ISA)
- 0.2% (total 22 in STATS19) to 0.42% (total 5 in VOISEUR) of all road user fatalities
- 0.2% to 0.78% of all seriously injured road users
- 0.47% to 0.53% of all slightly injured road users

#### Potential benefits expected
- No evaluation of efficiency available for R95 regulation
- Expectation is a very low potential of R95. The discussed vehicles have already a high level of self protection.
- Regulation 135 has no exemptions for M1 vehicles
Reverse detection for N2/N3/O vehicles
• **Description**
  o Allow truck drivers to perceive Vulnerable Road Users in the rear of the vehicle during reverse maneuvers

• **Key results**
  o Target populations
    ≈ 0.10% of all road user fatalities
    ≈ 0.04% of all seriously injured road users
    ≈ 0.02% of all slightly injured road users
  o Potential benefits expected
    ▪ No evaluation of the potential benefits available (too few samples)

⇒ There is a very low benefit expected of the measures as the target population is already very low.
• Research questions
  o Research Question 1: Target populations
    Find the proportion and gravity of N2/N3/O reverse accident against VRU

  o Research Question 2: Potential benefits expected
    Estimate the potential benefit of reverse detection for N2/N3/O
• Overview of applied databases

BAAC (F) 2010-2014 National data
18,260 Fatalities
139,825 Serious injured
245,405 Slight injured

STAT19 (UK) 2012-2015 National data
8,873 Fatalities
112,769 Serious injured
842,367 Slight injured

GIDAS (G) 1999-2015 In-depth data
748 Fatalities
9,416 Serious injured
28,724 Slight injured

Overview:
- **GIDAS (G)**: 1999-2015
  - In-depth data
  - 28,724 cases
  - 748 Fatalities
  - 9,416 Serious injured
  - 28,724 Slight injured
- **STAT19 (UK)**: 2012-2015
  - National data
  - 842,367 cases
  - 8,873 Fatalities
  - 112,769 Serious injured
  - 842,367 Slight injured
- **BAAC (F)**: 2010-2014
  - National data
  - 18,260 Fatalities
  - 139,825 Serious injured
  - 245,405 Slight injured

Details:
- **GIDAS (G)**
  - GIDAS (G)
  - 1999-2015
  - In-depth data
  - 28,724 cases
  - 748 Fatalities
  - 9,416 Serious injured
  - 28,724 Slight injured

**Notes:**
- The database names and data periods are specified.
- The number of cases, fatalities, serious injured, and slight injured are listed for each database.
• Target populations: process
  o Accidents involving
    ▪ N2/N3/O3/O4 vehicle
      During reversing maneuver
    ▪ And pedestrian or cyclist (VRU)

  o Part of fatalities, seriously and slightly injured VRU during these accidents
    Relative to total number of fatalities, seriously and slightly injured road users

  o Note: databases used only include collisions occurred on public/open roads
    (like official National and European statistics)
• **Target populations: results**
  Pedestrians and cyclists hit by a reversing N2/N3/O3/O4 vehicle

**Reference:** total number of fatalities, seriously and slightly injured road users
• **Potential benefits expected: process**
  - No existing measure or other proposed measure take into account
  - Case by case analysis done only with the French VOIESUR database (2011 National data)
    - 5 accidents with a reversing N2/N3/O3/O4 vehicle against a pedestrian (6 pedestrians)
    - No accident which involves a reversing N2/N3/O3/O4 vehicle against a bicycle
  - Possible solutions studied
    - Camera monitoring: image of the rear area displayed to the driver
    - Reverse detection: detection and warning of VRU’s behind the vehicle
    - Reverse detection with Auto Emergency Brake: detection, warning and auto brake to avoid or mitigate collisions of VRU’s behind the vehicle
## Potential benefits expected: results

<table>
<thead>
<tr>
<th>Accident N°</th>
<th>Reversing Vehicle</th>
<th>Vulnerable Road User</th>
<th>Measure and Confidence concerning possible mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vehicle type</td>
<td>Injury</td>
<td>Movement</td>
</tr>
<tr>
<td>1</td>
<td>Garbage truck</td>
<td>Fatally injured</td>
<td>Along same direction</td>
</tr>
<tr>
<td></td>
<td>(between 3.5 and 7.5T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Truck</td>
<td>Fatally injured</td>
<td>Along opposite direction</td>
</tr>
<tr>
<td></td>
<td>(over 7.5T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sweeping truck</td>
<td>Fatally injured</td>
<td>Crossing</td>
</tr>
<tr>
<td></td>
<td>(over 7.5T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Truck</td>
<td>Fatally injured</td>
<td>Along same direction</td>
</tr>
<tr>
<td></td>
<td>(over 7.5T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Truck</td>
<td>Slightly injured</td>
<td>Crossing</td>
</tr>
<tr>
<td></td>
<td>(over 7.5T)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Garbage truck: Sound signal and rear-view camera
- Truck: No
- Sweeping truck: Sound signal and rear-view camera
- Truck: No
- Truck: No, warning light
• **Summary and comments**
  
  o Target populations
    
    ≈ 0.10% of all road user fatalities
    
    ≈ 0.04% of all seriously injured road users
    
    ≈ 0.02% of all slightly injured road users
  
  o Potential benefits expected
    
    ▪ Less than target populations
    
    ▪ **Confidence concerning possible mitigation for analyzed cases:**
      
      Low for camera monitoring
      
      Medium for reverse detection
      
      High for Auto Emergency Brake
  
  o Comment: databases used only include collisions occurred on public/open roads (like official National and European statistics)