Task force on frontal impact and restraint systems

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Strategic goals and top priorities for the IWG EqOP

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Strategic goals – from ToR

- Equitable and overall enhanced protection of a diverse population
  - *Regulations must be inclusive*
- Robust, inclusive and effective regulatory solutions
  - *Avoid bias in protection*
  - *Offer protection strategies which reduce the injury risk below a certain threshold for as many as possible*

Top priorities – endorsed by GRSP

- Rear-end impact (soft tissue neck injuries)
- **Frontal impact (restraint systems)**
- Extension of assessment towards currently not considered injury types with high frequency and risk of PMI (brain, soft tissue neck, lower extremities)

TF VCT (3)
TF Frontal / Restraint Systems (4)
TF New Injury Types (5)

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How could we improve? Possible next steps?

1. **Avoid submarining for all**
   1. Include criterion for submarining into type approval crash tests (e.g. iliac wing force measurement) with appropriate tools
   2. Investigate the usage of HBMs to evaluate the risk of submarining for body shapes where no ATD is available (in addition to geometric belt attachment criterion?)
   3. Improve geometric requirements? Add criterion which should avoid submarining, ensure good belt fit for different body shapes
2. **Evaluation of abdominal injury risks**
   1. What causes the risks and how can it be replicated in type approval test incl an appropriate measurement tool e.g ASIS & ATPS
   2. Check if the THOR 05F is capable to predict the observed abdominal injury risks in field and evaluate injury risk curves
3. Investigate application of DAMAGE for assessment of AIS4+ Diffuse Axonal Injuries for application in Dummy (HIII or THOR) tests
   1. What causes the risks and how can it be replicated in type approval test
   2. Revisit head and brain injury criteria in IWG/TF5
4. Investigate to enhance evaluation of lower extremity injuries
5. Investigate evaluation of neck injuries in frontal crashes
6. Consider that occupants of different sizes, weights and shapes can be passengers or drivers and use different seat adjustments
   1. Include testing on rear row?
   2. Make it possible for technical service to randomly select seat position and adjustment?
7. Consider that the majority of crashes leading to personal injuries happen at speeds below that currently tested
   1. How could this be evaluated? How are the injuries happening?
8. Work on ideas for a procedure to check protection over a range of scenarios (including lower speeds) and occupant shapes instead of having just a very specific requirement which is repeated all over; requirement shall be broader than the 2 crash tests (use holistic approach from emissions or AEB as role model)

Discussion of Priorities and Next Steps

Who can support the next steps?

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Avoid submarining for all

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– Include criterion for submarining into type approval crash tests (e.g. iliac wing force measurement) with appropriate tools

- Submarining is rare, but if it happens, it causes severe injuries
- More likely to happen in females than males (based on simulation studies)
- Criterion included in front row in Euro NCAP
- Several recent studies on rear row:
  - Jagtap, S., Jermakian, J., and Edwards, M., "Analysis and Comparison of Metrics to Assess Submarining Behavior with the Hybrid III 5th Percentile Dummy in the Rear Seat," *SAE Int. J. Adv. & Curr. Prac. in Mobility* 7(5):2135-2152, 2025, https://doi.org/10.4271/2025-01-8711.
  - Guettler, A. J., Bianco, S. T., Kemper, A. R., Albert, D. L., & Hardy, W. N. (2022). Submarining Protection for 50th-Percentile Male Anthropomorphic Test Devices in the Rear Seat during Frontal Crash Sled Tests. SAE International Journal of Transportation Safety, 10(2), 439–462. https://www.jstor.org/stable/27215868
- Related to belt paths, seat positions? → Education?
- Re-evaluation of geometric requirements for effective belt attachment points? Reasons?

Evaluation of abdominal injury risks

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- What causes the risks and how can it be replicated in type approval test incl an appropriate measurement tool e.g ASIS & ATPS?
- Check if the THOR 05F is capable to predict the observed abdominal injury risks in field and evaluate injury risk curves

Are abdominal injuries still an issue?

- Yes, in crashes >40 km/h, risk between 4-6%
- Risk for PMI decreased for males with latest vehicle fleet, but not for females; risk of PMI10 lower than for other body regions
- Risk higher on rear row and passenger side?
- Thorax and abdominal injuries are most relevant for fatal crashes of females on the passenger side in Japan

Who could contribute to field data analysis on abdominal injuries/submarining?

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- Austria (CEDATU cases)
- Sweden (STRADA)
- JAMA & JARI (HBM simulations to understand injury mechanisms)
- Germany (GIDAS data)

How many abdominal injuries in which severity in different countries on which seat position? How often does submarining occur?

Testing speeds

- Consider that the majority of crashes leading to personal injuries happen at speeds below that currently tested
  - How could this be evaluated? How are the injuries happening?

More than 70% of the crashes leading to AIS2+ injuries happen at EES<40 km/h

Injury risk starts to raise for females already at lower speeds than for males

(Östling et al., 2024)

Different seat positions

- Consider that occupants of different sizes, weights and shapes can be passengers or drivers and use different seat adjustments
  - Include testing on rear row?
    - How many occupants get injured on the rear row in accidents?
  - Make it possible for technical service to randomly select feasible seat position and adjustment?
    - Seat position selection needs to be properly described to avoid bias from different technical services (e.g. define some clear ranges)

- Injuries on rear row not as frequent as driver (every car has a driver), but as riding services are prominent numbers are increasing?

  Okada, N., Matsuyama, T., Takebe, K., Kitamura, T., Sado, J. and Ohta, B. (2020), Rear seating position is associated with a higher risk of mortality in motor vehicle crashes: analysis of Japanese Trauma Data Bank. Acute Med Surg, 7: e444. https://doi.org/10.1002/ams2.444

- If restraint system effectiveness is sensitive to small changes in the test conditions, how can we be sure they work in the real world?

Who could contribute to field data analysis on rear row?

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- Austria (CEDATU cases)
- Sweden (STRADA)
- CLEPA

  - How many occupants get injured on the rear row in accidents?

Robustness evaluation

- Work on ideas for a procedure to check protection over a range of scenarios (including lower speeds) and occupant shapes instead of having just a very specific requirement which is repeated all over; requirement shall be broader than the 2 crash tests (use holistic approach from emissions or AEB as role model)

Field data anaylsis showed, that it is not a single issue, but it seems that restraints systems are not working as they were designed to for certain body shapes under certain conditions
How can we make sure that they become more robust?
Link to Virtual Testing?
Increasing test number? (might be related to higher coststs, but not neccessarily higher real-world efficiency) → not intended, but give some felxibility what can be tested and vehicle has to comply for a range of possible speeds, seat positions,… (avoid bias from technical services)
How much can be invested in passive safety?
Idea: Document explaining technologies (as for emissions) showing that manufacturer has looked into relevant load cases

What do we mean with robustness?

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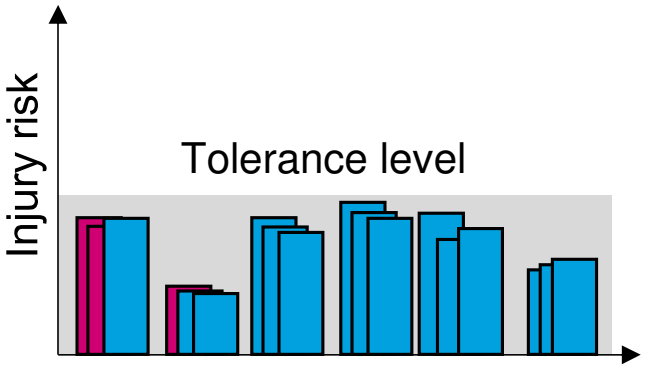
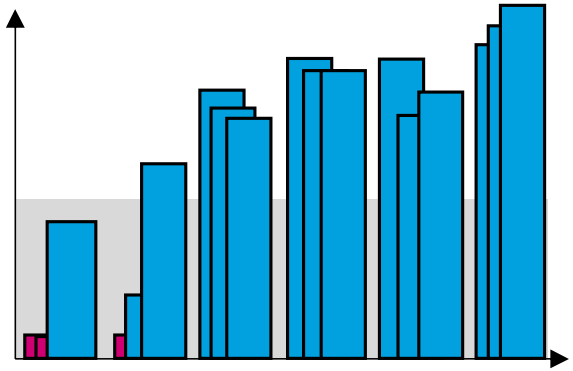
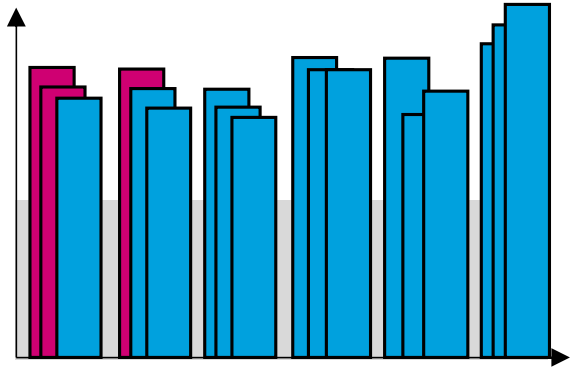
Robust system



Sub-optimised system



Bad system



Current regulations can identify a clearly bad system.
How can we make sure we have a robust system?

Prioritisation

Low, medium, high

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	Submarining	Abdominal Injuries	Crash Speeds	Seat Position Front Row	Rear Row	Robustness
Field data relevance						
- Fatalities						
- AIS 3+ injuries						
- AIS 2+ injuries						
- PMI						
- Exposure						
Feasibility						
Time frame						
Next steps						

Next steps

- Meeting time (issue with time zones…)
- Accident Analysis in Abdominal Injuries
- Accident Analysis on Rear Row
- Collect ideas for „robustness evaluation“
- Prepare yourself by completing prioritisation table before next meeting

Next Meeting:

- 28.1.2026 12:00 CET

Conclusions

- Try to find a way to avoid suboptimisation without increasing the number of offical tests and without risking a bias from different technical services