Equitable Occupant Protection, draft report to the 74th session of GRSP

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Overview EqOP 2023

- Equity issues further explored.
  - Worktable used for mapping equity issues and research gaps – shall be complemented with a report.
- Virtual testing procedures in regulations reviewed.
- Benefits and challenges of virtual crash testing for occupant protection explored.
- Research gaps identified.
- Task forces defined to address equity issues.

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Conclusions Workshop 1 1/2

- The injury risk increases with an incorrect height adjustment of the head restraint or an excessive distance between the head and the head restraint. A forgiving design of the back rest and head restraint should be targeted.

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Conclusions Workshop 1 2/2

- One priority of the IWG regarding rear impact protection should be to eliminate poor design of back rests and head restraints:
  - Extended geometric requirements for the head restraint (e.g., as proposed by CLEPA) could reduce the possibility of head restraints to be optimised for a specific ATD.
  - Testing of worst-case scenario. (Presentation by NL)

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Conclusions Workshop 2 (Equity issues) 1/2

- Field studies show that injury risk depends on
  - crash severity
  - vehicle crashworthiness (e.g., rating result, vehicle size, mass, age of the vehicle (market introduction))
    - Occupant protection of passenger vehicles has improved over the years. Certain issues of equity remain.
  - seat position (driver vs. passenger / front vs. rear)
  - age of occupant
  - BMI / body weight of occupant
  - gender of occupant
  - stature of occupant
- Interaction of parameters often different for females and males
  - Difference between males and females more often reported for younger groups, age distribution for fatally injured occupants
  - Interaction of BMI and gender (different body shapes, fat distributions, belt fits)
  - Crash severity (females more likely to be in smaller and struck car)
  - Females more likely to be passenger (front and rear)
- Relevance is different for different injury and crash types (not one group at highest risk in general) and statistical models applied

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Conclusions Workshop 2 (Equity issues) 2/2

Identified equity issues based on review of field data:

- Head injuries – different conclusions in different studies; further review also with simulation studies will be required (many interacting factors).
- Soft tissue neck injuries in rear-end impact.
- Extremity injuries in frontal crashes.
- Thoracic injuries in frontal and side crashes.
- Abdominal injuries in frontal crashes - different conclusions in different studies; further review also with simulation studies required.

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Conclusions Workshop 2 (Research gaps) 1/2

- Interaction of gender with other parameters:
  - Age
  - Anthropometry
    - Height
    - Weight
    - BMI
    - The Waist-to-Hip Ratio (WHR)
    - Shoulder Height Sitting (SHS)

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Conclusions Workshop 2 (Research gaps) 2/2

- Pregnant females.
- Understand the injury mechanisms causing equity issues for leg injuries, in particular lower leg & ankle.
- Missing tools for injuries and sizes which have not been in focus before (e.g., not clear if ankle injury can be assessed with THOR, no criterion now)
- Missing injury criteria for ankle.

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Conclusions Workshop 2 (Agreed task forces)

1. TF on Virtual Crash Testing
2. TF on rear impact seat assessment with focus on soft tissue neck injuries / whiplash associated disorders (Remark: presentations by NL and CLEPA at the next GRSP.)
3. TF on restraint system requirements.
    a. Geometric requirements for seatbelt
    b. Dynamic requirements / system performance
4. TF on extension of assessments towards currently not considered injury types with high frequency and risk of PMI.
    a. Lower extremity injuries in frontal and side impacts
    b. Upper extremity injuries in frontal and side impacts
    c. Brain injuries in frontal and side impacts
    d. Soft tissue neck injuries in frontal and side impacts
5. TF Drafting Team for the Report on equity issues: continue to work on the worktable and draft written report.

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Conclusions Workshop 3 (Virtual crash testing, VCT)

- Virtual testing already possible in several regulations
- Opportunities, barriers and ideas, to overcome them to implement virtual testing for occupant safety assessments have been discussed
- Next steps to work on have been identified

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Conclusions Workshop 3 (Potential benefits of VCT)

- Cover more scenarios, also those which cannot be physically tested (autonomous driving, diversity, position, posture)
- Potentially speed up testing (after initial investment)
- More robust evaluations
- Reduce the amount of physical tests
- New opportunities regarding assessments
  - Substitute design requirements with performance requirements (e.g. for seatbelt)

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Conclusions Workshop 3 (Potential barriers of VCT)

- Not everyone have the same resources
- Knowledge gaps in FE outside of industry (e.g., at Technical Services)
- Needed standards / references are missing (e.g. positioning of currently not considered statures)
- Software needs to be controlled (e.g. updates; is it needed to be able to run the same model up to 10 years?)
- Storage of results for CoP tests
- Intellectual Property Rights of simulation models
- Variability / scatter of outputs and in validation tests (depending also on complexity of design / load cases)
- Missing validation tools / standardised process

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Virtual testing used in type approval 1/4

- UN R13 Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking
  - Appendix 1-3 specifies how simulations need to be validated and reported

- E/ECE/TRANS/505/Rev.3 "worst-case", selection
  - Schedule 8: General conditions for virtual testing methods

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Virtual testing used in type approval 2/4

- UN R58 –Rear underrun protective devices (RUFDs)
- UN R11 – Door latches and door rentention components
- UN R46 – Devices for indirect vision and their installation
- UN R21 – Interior fittings
- UN R26 – External projections

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Virtual testing used in type approval 3/4

- UN R48 – Installation of lighting and light-signalling devices on vehicles
- UN R125 – Forward field of vision
- UN R73 – Lateral protection of goods vehicles
- UN R61 – Commercial vehicles with regard to their external projections forward of the cab´s rear panel

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Virtual testing used in type approval 4/4

- UN R55 – Mechanical coupling components of combinations of vehicles
- UN R102 – Close-coupling device (CCD), fitting of an approved type of CCD
- UN R107 M och M3 vehicles
- UN R66 – Strength of the superstructur of large passenger vehicles
- UN R93 – Front underrun protective devices (FUPDs) and their installation; front underrun protection (FUP)

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Conclusions Workshop 3 (Next steps)

1. Define wording (/ glossary) related to virtual crash testing
2. Sketch a general process
3. Definition of load cases (in collaboration with other TFs)
4. Define requirements for occupant simulation models (ATDs & HBM)
5. Define requirements for vehicle model validation (standards)
6. Define processes to combine occupant and vehicle model to a simulation load case/scenario
7. Requirements for FE Software
    a. Process for traceability of model changes and linked results
    b. Process for running models at technical service
8. Requirements for outputs and documentation

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Working plan for future work in EqOP

Task Force Descriptions

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Task Forces – the following tasks will be important in several task forces

- Reviewing research
- Close collaboration between industry and research for filling knowledge gaps
- Review of concerned regulatory requirements
- Explore opportunities to improve robustness of concerned regulations
- Prioritization based on relevance of the injury type

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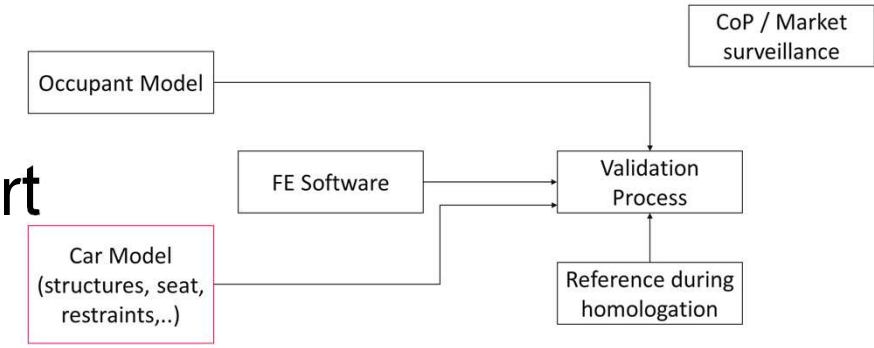
Task Force 1: Virtual testing

- Explore benefits of virtual crash testing to overcome equity issues.
- Define procedures how virtual crash testing can be implemented to assess occupant protection (type approval vs. self certifying countries)
- Define requirements for all building blocks of the procedure
- Strong collaboration with other expert groups and initiatives



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Task Force 2: Rear impact assessment

- Explore and discuss how to adress the need for a forgiving design of the seat – focus on head restraints and back rest.
  - Eliminiate poor design of back rest and head restraints.
- Explore the SETs – Seat Evaluation Tools that have been developed in VIRTUAL.
- Identify any shortcomings of existing regulations and related standards.
  - Can current test protocols be misapplied to optimize crash performance for the specific test conditions and test dummies in a narrow way that is detrimental to the protection of a diverse population?
- Discuss and understand the possibilities and challenges with virtual crash testing.
  - Knowledge gaps?
  - How can we develop a robust regulation?

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Task Force 3: Restraint system requirements

- Geometric requirements for seatbelt
  - Define how to assess improved belt fit for a diverse population in all seats
- Dynamic testing requirements / restraint system performance
  - Define how to assess adaptive protection
- Investigate the possibilities and challenges with virtual crash testing regarding evaluation of restraint system performance in regulations

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Task Force 4: Extension to new injury types

- TF on extension of assessments towards currently not considered injury types with high frequency and risk of PMI *(where equity issues have been identified)*

  4a) Lower extremity injuries in frontal and side impacts

  4b) Upper extremity injuries in frontal and side impacts

  4c) Brain injuries in frontal and side impacts

  4d) Soft tissue neck injuries in frontal and side impacts

  - Explore how these injuries could assessed
    - review ideas on injury criteria & tools to assess them (physical tools and or virtual tools)
    - Discuss and explore how identified knowledge gaps can be closed
  - Collect inputs for CBA to evaluate benefit for assessing the respective injury types.

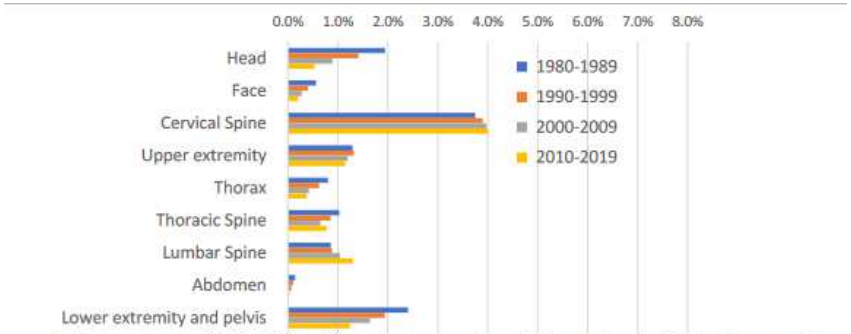

Fig. 4. Development of risk for PMI to different body regions for males for cars launched for the 10-year periods 1980–89 to 2010–19.

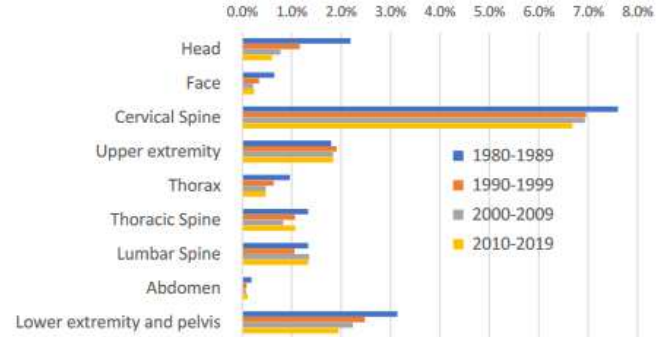

Fig. 5. Development of risk for PMI to different body regions for females for cars launched for the 10-year periods 1980–89 to 2010–19.

Kullgren et al., 2020 http://www.ircobi.org/wordpress/downloads/irc20/pdf-files/14.pdf

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Task Force 5: Drafting Team – Report on Equity Issues

- Report will capture the literature review effort and associated findings
- Report will be:
  - Distributed for review within CP organizations
  - Summarize and discuss findings (including where conflicts exist in the literature)
  - Conclusions will be clearly supported by the summarized findings of the literature review
  - Peer-reviewed and published

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