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### Economic Commission for Europe

#### Inland Transport Committee

#### World Forum for Harmonization of Vehicle Regulations

##### One-hundred-and-fifty-seventh session

Geneva, 26-29 June 2012

Item 16.4 of the provisional agenda

**Progress on the development of new global technical regulations (gtrs) and of amendments to established global technical regulations (gtrs) — gtr No. 9 (Pedestrian safety)**

### **First progress report for Phase 2 of gtr No. 9 (Pedestrian safety)**

#### **Submitted by the Chair of the informal working group on Phase 2 of gtr No. 9\***

The text reproduced below was prepared by the Chair of the informal working group. It is based on informal document WP.29-156-11, distributed at the 156<sup>th</sup> session (ECE/TRANS/WP.29/1095, paragraph 119). This document, if adopted, shall be appended to the amendment to the gtr in accordance with the provisions of paras. 6.3.4.2., 6.3.7. and 6.4. of the 1998 Agreement.

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\* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

## **I. Objective of this proposal**

1. The representatives of Japan and Germany proposed the development of Phase 2 of global technical regulation (gtr) No. 9. The main objective is the development of a draft proposal to amend the global technical regulation No. 9 - Phase 2 on pedestrian safety by introducing the flexible pedestrian legform impactor (FlexPLI) as a single harmonized test tool in order to enhance the level of protection for lower legs of pedestrians.
2. The work of the informal working group shall not be limited to draft proposals to amend gtr No. 9, but shall cover the development of a complementary draft proposal to amend the draft UN Regulation on pedestrian safety.
3. The group may also review proposals to improve and or clarify aspects of the legform test procedure.

## **II. Background**

4. At the 154<sup>th</sup> session of the World Forum for Harmonization of Vehicle Regulations (WP.29) and the thirty-second session of the Executive Committee of the 1998 Agreement (AC.3) it was agreed to set up an informal working group to solve the pending issues for incorporating the FlexPLI in Phase 2 of gtr No. 9 and in the draft Regulation on pedestrian safety, subject to the submission to WP.29 and to AC.3 of appropriate terms of references (document ECE/TRANS/WP.29/1091, paras. 36 and 100).
5. Japan and Germany informed WP.29 and AC.3 that this informal working group, named IG GTR9 - Phase 2, will be co-sponsored by Japan and Germany.
6. The informal working group started its work on 3 November 2011 with a constitutional meeting in Bonn, Germany, to draft a document on the terms of references, the operating principles, the schedule and the work plan. At this occasion the participants agreed to the proposal of Japan and Germany that the informal working group will be managed by Germany (chair), Japan (vice-chair) and International Organization of Motor Vehicle Manufacturers (OICA) (secretary).
7. At the 155<sup>th</sup> session of WP.29 and the thirty-third session of AC.3, Japan and Germany informed delegates about the ongoing activities of the informal working group on gtr No. 9 Phase 2 (document WP.29-155-35). The delegates were informed about the constitutional meeting and the management of the group. The information was given that the first meeting was planned for 1 and 2 December 2011 to start the technical discussion and to finalize the draft terms of references as well as the work plan for submission to the Working Party on Passive Safety (GRSP) in December 2011.
8. The first meeting of the informal working group was held on 1 and 2 December 2011 in Geneva, Switzerland. The technical discussion began and the draft document on the terms of references, the operating principles, the schedule and the work plan for submission to GRSP in December 2011 was finalised. This document and the first progress report are planned to be submitted to WP.29 for the 156<sup>th</sup> session and to the AC.3 for its thirty-fourth session in March 2012.

### III. Subjects for review and tasks to be undertaken (terms of reference)

9. The informal working group has set up a list of activity to address remaining items for introducing the FlexPLI:

1. Review and consideration of remaining items:
  - (a) Review of Flex-TEG activities → to reach a common understanding;
  - (b) Assessment of biofidelity (comparison of FlexPLI and European Enhanced Vehicle-Safety Committee (EEVC) lower legform impactor);
  - (c) Cost-benefit analysis (injury reduction, additional benefit compared to EEVC lower legform impactor);
  - (d) Technical specifications (drawings) and PADI (user manual);
  - (e) Evaluation of durability;
  - (f) Test procedure (rebound phase, best practice, velocity measurement etc.);
  - (g) Certification tests;
  - (h) Review and exchange of test results;
  - (i) Evaluation of reproducibility and repeatability;
  - (j) Evaluate and decide on performance / injury criteria and threshold values;
  - (k) Evaluation of vehicle countermeasures (assessment of technical feasibility).
2. Develop a draft proposal to amend gtr No. 9 - Phase 2.
3. Develop a complementary draft proposal to amend draft Regulation on Pedestrian Safety (including a recommendation for transitional provisions based on item 1).

### IV. History of the discussions

10. At the constitutional meeting the informal working group drafted the objectives of the group, terms of references, a work plan and schedule. The objectives of the group were discussed extensively. It was finally agreed that the main objective of the group should be the amendment of gtr No. 9 through the work of the group shall not be limited to this task, but shall cover the development of a complementary draft proposal on amending the draft Regulation on pedestrian safety. It was also agreed, that the group should review proposals to improve the test procedure with the lower legform impactor.

11. The informal working group has set up an activity list to review and discuss remaining items. The schedule of work was discussed and agreed upon.

12. During the constitutional meeting, the participants were informed about the past activities of the technical evaluation group (TEG) to improve the FlexPLI. A document matrix was prepared by the secretary to ease the work for experts when reviewing the TEG

documents. It was also agreed to install a task force on reviewing and updating the certification corridors (TF-RUCC) for the calibration procedure for the FlexPLI. This task force is chaired by Japan.

13. At the first meeting of the informal working group, the draft terms of references were finalised for submission to GRSP. The technical discussion was started on several items.

#### **A. Status of FlexPLI**

14. The representative of Humanetics gave an update on the current status of the FlexPLI development. Information was provided on the number of legs produced up to now. The representative informed the participants about the activities to resolve open issues on the certification corridors. Especially for the inverse testing further investigations have to be undertaken. These will be mainly covered by the TF-RUCC. Experts requested a description of the build level of the different legform impactors including a clear documentation. Humanetics was asked to provide such information for discussion in the informal working group.

#### **B. Durability**

15. OICA has presented information on the long-term durability of the FlexPLI. Several items were mentioned, of which the durability of the bone core material led to extensive discussions. The bone core material suffers during the testing resulting in small cracks of the material. While several experts mentioned that the performance is still acceptable with these minor damages, information was given by the company Bertrandt that deviations in the performance may be seen during calibration of the legform impactor. Experts will further investigate this issue and present further information on the long-term performance of the leg at the second meeting of the informal working group.

16. The representative of the United States of America presented further information on the durability of the FlexPLI. During the comparison tests of the earlier and the current version of the FlexPLI, it was found that the durability had improved for the current version of the impactor and therefore is not a major issue for the moment.

#### **C. Benefit and costs**

17. The Japan Automobile Standard Internationalization Centre (JASIC) introduced detailed information on the possible benefit related to tibia injuries that can be expected with the introduction of the FlexPLI. Based on accident data, it was presumed that tibia fractures mainly occur due to indirect loading (approx. 80 per cent). Only in a minor number of cases the fracture of the tibia occurs due to direct loading of the bumper. It was also shown that the most significant improvement can be achieved by mitigation of leg fractures.

18. It was concluded that the FlexPLI can provide improved biofidelity for the tibia and the knee. Relative to the currently used legform impactor the cost savings due to mitigation of tibia fractures were estimated to be 100 million of United States dollars for the United States of America and 50 million of United States dollars for Japan based on calculation models using the annual medical costs for such types of injuries.

## **D. Biofidelity**

19. Another presentation from JASIC highlighted the improved biofidelity of the FlexPLI compared to the legform impactor currently used in gtr No. 9. The superior biofidelity was shown at component and assembly level using both, testing and simulation tools. Especially the improvements in the knee and tibia area were presented. For the performance limits a comparison study of the FlexPLI and post-mortem human subject (PMHS) test data was done, showing that the FlexPLI is behaving more human-like with regard to the injury mechanism of the tibia.

## **E. Performance / injury criteria**

20. JASIC introduced information on the performance and injury criteria for the FlexPLI. The validation of criteria for the tibia fracture and the medial collateral ligament (MCL) and anterior cruciate ligament (ACL) failure was presented in detail and compared to the legform impactor currently used in gtr No. 9. The results are mainly based on data coming from different sources of specimen testing. From this data a probability function for the injury risk was developed. Performance limits for the tibia bending moment, the criteria ACL and MCL were presented to participants.

21. The expert from the United States of America raised some concerns regarding the injury thresholds that were chosen for the FlexPLI in relation to the EEVC legform impactor. With the ability of the flexible impactor it may be possible to achieve better protection with more stringent criteria. The United States of America does not see a necessity to just achieve a protection level that is comparable to the EEVC legform impactor. The National Highway Traffic Safety Agency (NHTSA) will investigate this in more detail.

## **F. TF-RUCC (certification procedures)**

22. Japan gave a status report of the activities of the task force reviewing and updating the certification corridors. It is currently planned to perform tests with several legforms in a limited number of labs to check the performance of the flexible pedestrian legform impactors. The schedule aims at finalising the task to update the certification corridors, if necessary, by the second meeting of the informal working group. The task force will prepare a recommendation for the informal working group on the certification procedures and the corridors to be used for the calibration of the FlexPLI.

## **G. Drawings and specifications**

23. Experts were informed that the drawings and specifications of the FlexPLI would be needed before the regulatory text can be approved by GRSP and adopted by WP.29 and AC.3. Humanetics confirmed that this is well known and such information will be submitted to the informal working group accordingly.

## **H. Accident analysis**

24. Participants were asked to provide accident data at one of the next meetings. This request would also be raised at the fiftieth session of GRSP by the Chair of the informal working group. The expert of the United States of America informed the group that they

were investigating if information on accidents with pedestrians can be supplied for discussion.

**I. Finite element models**

25. Faurecia requested information on the development of finite element models for the FlexPLI. It was decided that the informal working group would not develop such models but would serve as a platform for a regular exchange of information on this subject. This task will be started at the second meeting of the informal working group and participants were invited to submit information accordingly.

**J. User manual / Procedures for Assembly, Disassembly, and Inspection (PADI)**

26. Several items were raised in relation to the user manual for the FlexPLI. Humanetics will provide the group with an updated user manual incorporating the proposals that were raised during the meeting.

**V. Work schedule**

27. Work schedule

**Overall Schedule**

P.R.: Progress Report

| Year        | 2011 |             |          | 2012 |   |          |   |          |   |   |   |   |          |    |    | 2013 |   |   |   |   |   |   |   |   |    |    |  |
|-------------|------|-------------|----------|------|---|----------|---|----------|---|---|---|---|----------|----|----|------|---|---|---|---|---|---|---|---|----|----|--|
| Month       | 10   | 11          | 12       | 1    | 2 | 3        | 4 | 5        | 6 | 7 | 8 | 9 | 10       | 11 | 12 | 1    | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |  |
| WP29        |      | ○<br>Report |          |      |   |          |   |          |   |   |   |   |          |    |    |      |   |   |   |   |   |   |   |   |    |    |  |
| GRSP        |      |             |          |      |   |          |   |          |   |   |   |   |          |    |    |      |   |   |   |   |   |   |   |   |    |    |  |
| IG-GTR9-PH2 |      | ○<br>const  | ○<br>1st |      |   | ○<br>2nd |   | ○<br>3rd |   |   |   |   | ○<br>4th |    |    |      |   |   |   |   |   |   |   |   |    |    |  |

- May 2011 Proposal of Draft ToR to GRSP (informal document)
- June 2011 GRSP to seek consent of WP.29 and AC.3 to mandate new informal working group on pedestrian protection
- 03 November 2011 Constitutional meeting of the IG GTR9-PH2 (Bonn, DE)
- November 2011 Report to WP.29 on activities of IG
- 01/02 December 2011 First meeting of the IG GTR9-PH2 (Geneva, CH)
- December 2011 Progress-Report to GRSP, submission of Draft ToR to WP.29
- March 2012 Progress-Report to WP.29 and adoption of ToR by WP.29 / AC.3
- 28 and 29 March 2012 Second meeting of the IG GTR9-PH2 (Osaka, JP)
- May 2012 Progress-Report to GRSP
- 29 and 30 May 2012 Third meeting of the IG GTR9-PH2 (Paris, FR)
- September 2012 Fourth meeting of the IG GTR9-PH2

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|---------------|---|
| November 2012 | Progress-Report to WP.29  |
| December 2012 | Fifth meeting of the IG GTR9-PH2  |
| December 2012 | Progress report and submission of informal draft documents to GRSP                |
| March 2013    | Sixth meeting of the IG GTR9-PH2  |
| May 2013      | Submit formal proposal to GRSP, adoption by GRSP, submit formal proposal to WP.29 |
| November 2013 | Adoption by WP.29   |

## VI. Documents

### 28. Documents for the meetings

|                                  |                      |  |
|----------------------------------|----------------------|--|
| ECE/TRANS/WP.29/<br>GRSP/2011/13 | Japan                | Proposal for Amendment 2 to global technical regulation No. 9 (Pedestrian safety)  |
| GRSP-49-38                       | Japan and<br>Germany | Draft terms of reference for the informal group on pedestrian safety phase 2 (IG PS2)  |
| ECE/TRANS/WP.29/<br>1091         |                      | Reports of the World Forum for Harmonization of Vehicle Regulations on its 154th session, Administrative Committee of the 1958 Agreement on its forty-eighth session, Executive Committee of the 1998 Agreement on its thirty-second session, Administrative Committee of the 1997 Agreement on its eighth session |
| GTR9-C-01                        | Chair                | Agenda for the constitutional meeting of the Informal Group on Pedestrian Safety Phase 2 (IG PS2)  |
| GTR9-C-01r1                      | Chair                | Agenda for the constitutional meeting of the Informal Group on Pedestrian Safety Phase 2 (IG PS2)  |
| GTR9-C-02                        | Chair/<br>Secretary  | Minutes of the Constitutional Meeting of the Informal Group on Global Technical Regulation No. 9 – Phase 2 (IG GTR9-PH2)   |
| GTR9-C-02r1                      | Chair/<br>Secretary  | Minutes of the Constitutional Meeting of the Informal Group on Global Technical Regulation No. 9 – Phase 2 (IG GTR9-PH2)   |
| GTR9-C-03                        | Japan/<br>Germany    | Informal document GRSP-49-38: Draft Terms of Reference for the Informal Group on Pedestrian Safety Phase 2 (IG PS2)  |
| GTR9-C-04                        | Japan                | History of Development of the FlexPLI  |
| GTR9-C-05                        | Japan                | Review of the FlexPLI TEG Activities   |
| GTR9-C-06                        | OICA                 | Comments on the Draft Terms of Reference for the Informal Group on Pedestrian Safety Phase 2 (28/10/2011)  |
| GTR9-C-07                        | Chair                | Final Operating Principles and Terms of Reference for the IG GTR9-PH2  |
| GTR9-C-07r1                      | Chair                | Final Operating Principles and Terms of Reference for the IG GTR9-PH2  |
| GTR9-C-08                        | Secretary            | TEG document matrix  |
| GTR9-1-01                        | Chair/<br>Secretary  | Agenda for the 1st meeting of the Informal Group on Global Technical Regulation No. 9 - Phase 2 (IG GTR9-PH2)  |
| GTR9-1-01r1                      | Chair/<br>Secretary  | Agenda for the 1st meeting of the Informal Group on Global Technical Regulation No. 9 - Phase 2 (IG GTR9-PH2)  |

|             |                     |   |
|-------------|---------------------|---|
| GTR9-1-02   | Chair/<br>Secretary | Minutes of the 1st meeting of the Informal Group on Global Technical Regulation No. 9 - Phase 2 (IG GTR9-PH2) |
| GTR9-1-03   | Japan               | Work plan of Task Force Review and Update of Certification Corridors (TF-RUCC)                                |
| GTR9-1-03r1 | Japan               | Work plan of Task Force Review and Update of Certification Corridors (TF-RUCC)                                |
| GTR9-1-04   | OICA                | FlexPLI Version GTR Prototype SN-02 - Durability Assessment   |
| GTR9-1-05   | JASIC               | Technical Discussion - Biofidelity  |
| GTR9-1-05r1 | JASIC               | Technical Discussion – Biofidelity (revised)  |
| GTR9-1-06   | JASIC               | Technical Discussion - Injury Criteria  |
| GTR9-1-06r1 | JASIC               | Technical Discussion - Injury Criteria (revised)  |
| GTR9-1-07   | JASIC               | Technical Discussion - Benefit  |
| GTR9-1-07r1 | JASIC               | Technical Discussion – Benefit (revised)  |
| GTR9-1-08   | Humanetics          | FlexPLI GTR status 1 / 2 December 2011  |
| GTR9-1-08r1 | Humanetics          | FlexPLI GTR status 1 / 2 December 2011  |
| GTR9-1-09   | Japan/<br>Germany   | Informal document WP.29-155-35: Report to the November session of WP.29 on the activities of the IG GTR9-PH2  |
| GTR9-1-10c1 | Humanetics          | Flex-GTR changes list since prototype built, status 02 Dec. 2010 (corrected)                                  |
| GTR9-1-11   | Bertrandt           | Pendulum Test Scatter   |
| GTR9-1-12   | United<br>States    | Informal document GRSP-49-23: Update on Pedestrian Leg Testing  |

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