Transmitted by the chairman and vice-chairman of the IG GTR9-PH2

Informal document **GRSP-52-33**
(52nd GRSP, 11 – 14 December 2012,
agenda item 4(a))

GTR No. 9 – Draft proposal for Amendment 2

Note: The text reproduced below was prepared by the chairman and vice-chairman of the informal working group on the global technical regulation No. 9 (Pedestrian safety)-Phase 2 proposing the use of a flexible pedestrian lower legform impactor in the global technical regulation No. 9 (pedestrian safety) - Phase 2. The modifications to the current text of gtr No. 9 on pedestrian safety are marked in bold for new or strikethrough for deleted characters. Text in square brackets is still under discussion and consideration of the informal group.

I. Proposal

A. Statement of technical rationale and justification

Paragraph 64., amend to read:

"64. The lower legform ….in the United Kingdom, **and then called as European Enhanced Vehicle-safety Committee (EEVC) pedestrian lower legform impactor (called as "EEVC lower legform impactor" hereafter)**. However, it is known to also have certain limitations regarding the biofidelity and the repeatability of the test results. Therefore, Japan proposed to use a completely new legform, the so-called flexible Pedestrian Legform Impactor **(called as "flexible lower legform impactor" hereafter)**. As the **flexible lower legform impactor** ~~FlexPLI legform~~ is considered by some to have high biofidelity and an excellent ability to assess potential leg injuries, the **flexible lower legform impactor** ~~FlexPLI~~ should be considered to replace **Lower legform I** ~~lower legform impactor~~ in the future. However, because of the lack of experience in using the **flexible lower legform impactor** ~~FlexPLI~~ as a certification tool **at the timing of 2004**, a further confirmation process **was** ~~is~~ needed. Therefore, a Technical Evaluation Group (TEG) was established to evaluate the reliability of the **flexible lower legform impactor** ~~FlexPLI~~ as a certification tool (TRANS/WP.29/GRSP/36). The TEG **had been worked to assess** ~~is currently assessing~~ the **flexible lower legform impactor until 2010** ~~FlexPLI and will advise GRSP by the end of 2007~~ as to the suitability of the **flexible lower legform impactor** ~~FlexPLI~~ for testing and compliance verification purposes (TRANS/WP.29/GRSP/**48**~~37~~). ~~The TEG is also expected to provide its recommendation as to the effective date of entry into force and the date on which the FlexPLI could replace the rigid lower legform impactor. TEG will also consider a transitional period during which the FlexPLI and the rigid lower legform impactor can be used as alternatives.~~ [**After the TEG activity, GRSP considered ECE/TRANS/WP.29/GRSP/2011/13 and GRSP-49-15 concerning the introduction of the flexible lower legform impactor into the gtr in May 2011. However, the expert from the United States of America made a presentation (GRSP-49-23) showing the outcome of a comparison research study conducted in his country between the flexible lower legform impactor and the current EEVC lower legform impactor. He concluded that additional research, testing and additional world fleet data is needed to address the injury criteria concerns and to justify the**

introduction of the flexible lower legform impactor. The expert from Japan gave a presentation (GRSP-49-24), showing that the flexible lower legform impactor and the current legform have a totally different structure and injury criteria. Therefore, he concluded that direct comparison between the two legforms would take misleading results. GRSP agreed that pending issues should be addressed by an informal group, Germany (chair), Japan (vice-chair) and OICA (secretariat), and aimed at finalizing proposals for the introduction of the flexible lower legform impactor into the gtr and in the draft Regulation on pedestrian safety in the same time. The informal working group is named "informal working group on Global technical regulation No.9 Phase 2 (IG GTR9-PH2)". The IG had been worked by [March 2013], then developed a draft Global technical regulation No.9 Phase 2 using flexible lower legform impactor.]"

Paragraph 102., amend to read:

"102. For vehicles….Therefore, the group recommends to use the upper legform to bumper test as an optional alternative to the lower legform to bumper test for these vehicles. [**The IG GTR9-PH2 also agreed on that the test methods for high bumper vehicles can be applied not only when using both the EEVC lower legform impactor as well as the flexible lower legform impactor.]**"

Paragraph 106., amend to read:

"106. It was agreed….However, it was also recommended to consider the possible future use of the **flexible lower legform impactor** ~~Flex-PLI~~, which is considered by some to be more biofidelic and expected to be highly usable and repeatable, following the evaluation to be conducted by the Technical Evaluation Group **(TEG)** (INF GR/PS/106). [19] **[The TEG had finalized their technical evaluation activity on the flexible lower legform impactor in 2010, then informal working group on Global technical regulation No.9 Phase 2 (IG GTR9-PH2) was developed a draft Global technical regulation No.9 Phase 2 using the flexible lower legform impactor in [March 2013]].**"

"110. These studies…..For these reasons, a bending limit of 19º was selected for **the EEVC lower legform impactor for GTR9 Phase 1** ~~this gtr~~. **With regards to the flexible lower legform impactor for GTR9 Phase 2, a limit of medial collateral ligament (MCL) elongation at the knee was set at 22 mm based on the agreement of the TEG from a biomechanical point of view (based on Bundesanstalt fuer Strassenwesen (BASt – German Federal Highway Research Institute) correlation study and Japan Automobile Manufacturers Association (JAMA) biomechanical study, TEG-127). [IG GTR9-PH2 had carefully reviewed then agreed on that.]**"

Paragraph 111., amend to read:

"111. With regard to knee shearing limits, the informal group selected a limit of 6 mm **for the EEVC lower legform impactor for GTR9 Phase 1**, based on the analysis of PMHS by EEVC WG17 and WG10 that showed that a 6 mm shear displacement corresponds to a 4 kN shear force. The 4 kN shear force in the **EEVC lower legform impactor** ~~TRL device~~ approximates the 3 kN average peak shearing force acting at the knee joint level that was found associated in the PMHS tests with diaphysis/metaphysis failure. **With regards to the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) elongations for the flexible lower legform impactor for GTR9 Phase 2, [IG GTR9-PH2 carefully**

reviewed TEG discussions (TEG-127) then agreed ACL and PCL elongations shall not exceed 13 mm based on available a few number of PMHS test data]."

Paragraph 112., amend to read:

"112. With regard…..To protect a higher proportion of the population at risk, the informal group recommends a maximum lateral tibia acceleration limit of 170g **for the EEVC lower legform impactor for GTR9 Phase 1. With regards to the limit of tibia bending moment for the flexible lower legform impactor for GTR9 Phase 2 is set at 340 Nm based on the agreement of the TEG from a biomechanical point of view (TEG-127). [IG GTR9-PH2 had carefully reviewed then agreed on that].**"

Paragraph 113., amend to read:

"113. In summary…at the following limits:

EEVC lower legform impactor (for GTR9 Phase 1)

Maximum lateral knee bending angle ≤ 19.0°;

Maximum lateral knee shearing displacement ≤ 6.0 mm;

Maximum lateral tibia acceleration ≤ 170g.

flexible lower legform impactor (for GTR9 Phase 2)

Maximum MCL elongation ≤ 22 mm;

Maximum Tibia bending moment ≤ 340 Nm;

Maximum ACL and PCL elongation ≤ 13 mm.

"

Paragraph 114., amend to read:

"114. These values **for the EEVC lower legform impactor for GTR9 Phase 1** are identical to those **that were** under consideration by the EC in its review of the Phase 2 requirements of the European directive."

Paragraph 115., amend to read:

"115. In order…..For feasibility reasons, this gtr allows manufacturers to nominate bumper test widths up to 264 mm in total where the acceleration measured at the upper end of the tibia **of the EEVC lower legform impactor for GTR9 Phase 1** shall not exceed 250g. The relaxation zone of 264 mm corresponds to an area that is twice the width of the legform. **With regards to the flexible lower legform impactor for GTR9 Phase 2, on the need for a tibia relaxation zone for the bumper area, TEG proposes to introduce relaxation zones with a total width of 264 mm, allowing a maximum tibia bending moment of 380 Nm. [IG GTR9-PH2 had carefully reviewed then agreed on that.]**"

Insert a new section 10., to read:

"**10. METHOD OF INTRODUCING THE FLEXIBLE LOWER LEGFORM IMPACTOR**

133. As for the smooth introduction of the new lower legform impactor, flexible lower legform impactor, by each Contracting Party, the Working Party on Passive Safety (GRSP) and some TEG members provided the following recommendations:

(a) GRSP recommended that if a Contracting Party chooses to use the flexible lower legform impactor in its national legislation, the Contracting Party shall consider setting a recommended minimum

period of lead time based upon considerations of reasonableness and practicability (see paragraph 4.1.3.3. of Article 4 of the 1998 Agreement).

[(b) **Some TEG as well as IG GTR9-PH2 members propose that a vehicle model once certified using the EEVC lower legform impactor based on GTR9 Phase 1, would not need to be re-certified using the flexible lower legform impactor.**"]

Section 10 (former), renumber as section 11 and amend to read:

"…

INF GR/PS/188	Draft meeting minutes of the 10th meeting
INF GR/PS/189	Attendance list 10th meeting
GRSP-47-18/Rev.2	(USA) Proposal for amendments to global technical regulation No. 9 (Pedestrian safety)

A list of working papers used by the FlexTEG group is available on the UNECE WP.29 website: www.unece.org/trans/main/wp29/wp29wgs/wp29grsp/pedestrian_FlexPLI.html

Number of working paper	*Title of Flex TEG document*
TEG-001	**Agenda for 1st Meeting of Flex PLI Technical Evaluation Group.doc**
TEG-002	**Flex-G_General_Information_050904.pdf**
TEG-003	**Flex-G_Preparation_Manual_050904.pdf**
TEG-004	**2005.09.02 - BASt Flex-G Test Programme.pdf**
TEG-005	**Revised Agenda for 1st Flex-G_MT.pdf**
TEG-006	**2005_06_ESV_JAMA-Flex.pdf**
TEG-007	**2005_06_ESV_JMLIT-Flex.pdf**
TEG-008	**2005_06_ESV_NHTSA_TRL-Flex.pdf**
TEG-009	**Attendance list 1st Flex-PLI Meeting**
TEG-010	**Draft minutes 1st Flex PLI meeting_051011.pdf**
TEG-010-R1	**Modified_Minutes 1st Flex PLI meeting_051122.pdf**
TEG-011	**Agenda for 2nd Meeting of Flex-TEG.pdf**
TEG-011-R1	**Modified_Agenda for 2nd Meeting of Flex-TEG.pdf**
TEG-012	**Flex-G_Minor_Modifications_onto_SN01_051122.pdf**
TEG-013	**Flex Repeatability and Reproducibility for Thigh Leg Knee.pdf**
TEG-014	**Flex_Assembly_Test_Results_and_Tentative_Corridors_051122.pdf**
TEG-015	**Report_on_Flex-G_Car_Test_Results_051122_final.pdf**
TEG-016	**Flex-TEG_Schedule_051115.pdf**
TEG-016-R1	**Flex-TEG_Schedule_051122.pdf**
TEG-017	**Attendance list 2nd Flex-PLI .pdf**
TEG-018	**DRAFT Minutes 2nd Flex-TEG_060228.pdf**

Number of working paper	*Title of Flex TEG document*
TEG-018-R1	**FINAL Minutes 2nd Flex-TEG_060424.pdf**
TEG-019	**Draft Agenda for 3rd Meeting of Flex-TEG_060327.pdf**
TEG-020	**Status Report on Action Items_060424.pdf**
TEG-021	**Flex-GT-alpha_General_Information_060424.pdf**
TEG-022	**Flex-GT-alpha_Injury_Assessment_Ability_060424.pdf**
TEG-023	**TRL-LFI_Retry_Test_060424.pdf**
TEG-024	**Flex-GT-alpha_Typical_Dynamic_Assembly_Calibration_Test_Result_060424.xls**
TEG-025	**Attendance list 3rd Flex-TEG_060424.pdf**
TEG-026	**DRAFT Minutes 3rd Flex-TEG**
TEG-026-R1	**Final_Minutes_3rd_Flex-TEG_MT_070402.pdf**
TEG-027	**ACEA_draft_comments_Flex-GT-alpha_060530.pdf**
TEG-028	**Chairperson_Answer_on_the_ACEA_draft_comments_Flex-GT-alpha_060606.pdf**
TEG-029	**Draft_Agenda_on_4th_Flex-TEG_Meeting_070316.pdf**
TEG-029-R1	**Final_Agenda_on_4th_Flex-TEG_Meeting_070402.pdf**
TEG-030	**Status_Report_on_Action_Items_070402.pdf**
TEG-031	**Development of an FE Biofidelic flexible Pedestrian Legform Impactor Model (FLEX-GT-prototype Model)**
TEG-032	**Development of a Biofidelic flexible Pedestrian Legform Impactor Type GT (FLEX-GT)**
TEG-033	**Information on flexible Pedestrian Legform Impactor Type GT (FLEX-GT)**
TEG-034	**flexible Pedestrian Legform Impactor Type GT (FLEX-GT) Evaluation Test Results**
TEG-035	**flexible Pedestrian Legform Impactor Type GT (FLEX-GT) Car Test Results**
TEG-036	**Flex-GT-alpha BASt/ACEATests**
TEG-037	**Handling and Usage (Flex-GT-alpha)**
TEG-038	**Certification Histories (Flex-GT-alpha)**
TEG-039	**ACEA Preliminary Test Results with FlexPLI-alpha**
TEG-040	**Attendance list of 4th Flex-TEG meeting**
TEG-041	**Draft minutes of 4th Flex-TEG meeting**
TEG-041-Rev.1	**Finalized_the_4th_Flex-TEG_Meeting_Minutes_071207**

Number of working paper	*Title of Flex TEG document*
TEG-042	**FlexPLI Comments ACEA 20070808 TFPapproved**
TEG-043	**ACEA/BASt Joint Project Report on Tests with the flexible Pedestrian Legform Impactors Flex GT alpha and Flex GT**
TEG-044	**5th_Flex-TEG_Meeting_DRAFT_Agenda**
TEG-044-Rev.1	**Revised 5th Flex-TEG Meeting DRAFT Agenda_071204**
TEG-044-Rev.2	**Finalized 5th Flex-TEG Meeting Agenda 071207**
TEG-045	**J-MLIT Flex-GT Simplified Car Test Results 071129**
TEG-045-Rev.1	**J-MLIT Flex-GT Simplified Car Test Results 080331**
TEG-046	**JAMA-JARI Answer for the ACEA Comments Sep 2007 071129**
TEG-047	**Flex-GT Full Calibration Test Procedures 071129**
TEG-048	**Review of Injury Criteria and Thresholds for Flex 071129**
TEG-049	**Evaluation of Protection Level Provided by Flex-PLI 071129**
TEG-050	**Status of Action Items 071130**
TEG-051	**BAST/ACEA Joint Project Preliminary Report on Flex-GT Repeatability and Reproducibility of Assembly Certification and inverse test results**
TEG-052	**FTSS Design Review of Flex-GT and FLEX-GTR Development dec14-07**
TEG-053	**Draft Minutes of the 5th Flex-TEG Meeting, 080124**
TEG-053-Rev.1	**Final Minutes of the 5th Flex-TEG Meeting, 080331**
TEG-054	**Flex-GTR_Mechanical_Design_080229**
TEG-054-Rev.1	**Flex-GTR_Mechanical_Design_080331**
TEG-055	**Flex-GTR_Instrumentation_Electrical_Design_080229**
TEG-055-Rev.1	**Flex-GTR_Instrumentation_Electrical_Design_080331**
TEG-056	**Flex-GTR_Full_Calibration_Test_Procedure_080229**
TEG-056-Rev.1	**Flex-GTR_Full_Calibration_Test_Procedure_080331**
TEG-057	**Flex-GTR_Optional_Instrumentation_080304**
TEG-057-Rev.1	**Flex-GTR_Optional_Instrumentation_080327**
TEG-058	**M=BUS_Onboard_DAS_Information_080305**
TEG-058-Rev.1	**M=BUS_Onboard_DAS_Information_080331**
TEG-059	**Slice_Onboard_DAS_Information_080331**
TEG-060	**Draft_Agenda_6th_Flex-TEG_Meeting_080314**
TEG-060-Rev.1	**Final_Agenda_6th_Flex-TEG_Meeting_080331**

Number of working paper	*Title of Flex TEG document*
TEG-061	**Status of the Action Items_080331**
TEG-062	**BASt Proposal for a Full Assembly Certification Test_080331**
TEG-063	**NHTSA_Flex-GT_Test_summary_080331**
TEG-064	**NHTSA_Flex-GT_Certification_Tests_080331**
TEG-065	**NHTSA_Design_Upper_Body_Mass_080331**
TEG-066	**TIPS_for_Measurement_Cable_Repairment_080331**
TEG-067	**Repeatability_of_Dynamic_Assembly_Test_Stopper_Material_080331**
TEG-068	**Draft Minutes of the 6th Flex-TEG Meeting**
TEG-068-Rev.1	**Finalized_Minutes_of_the_6th_Flex-TEG_Meeting_081208**
TEG-069	**Draft_Agenda_7th_Flex-TEG_Meeting_081208**
TEG-069-Rev.1	**Finalized_Agenda_7th_Flex-TEG_Meeting_081208**
TEG-070	**Status_Action_Items_081208**
TEG-070-Rev.1	**Finalized_Status_Action_Items_081208**
TEG-071	**FTSS_Flex_GTR_prototype_Development_071208**
TEG-071-Add.1	**Bone_Core_Durability_Improvement_081208**
TEG-071-Add.2	**Develop_Dynamic_Assy_Calibration_Test_Methods**
TEG-072	**Japan_Flex-GTR-prototye_Evaluation_Report**
TEG-072-Rev1	**Japan_Flex-GTR-prototye_Evaluation_Test Result**
TEG-073	**MESSRING_ISO_MME_corde_Flex_Proposal**
TEG-073-Rev1	**MESSRING_Suggest_ISO_MME_corde_Flex**
TEG-074	**FTSS_Flex_Pendulum_Dynamic_Calbration_Proposal**
TEG-075	**BASt_Flex_Inverse_Dynamic_Calibration_Proposal**
TEG-076	**JAMA_Proposal_MCL_Threshod_Value**
TEG-077	**JAMA_Proposal_Tibia_Threshod_Value**
TEG-078	**BASt_Proposal_ACL-PCL-MCL_Threshod_Value**
TEG-079	**JAMA_Proposal_Flex-GTR-prot_Evaluation_Schedule**
TEG-080	**J-MLIT proposal for the Flex-TEG working schedule**
TEG-081	**JAMA_Flesh_Sensitivity_TRL_Flex**
TEG-082	**BASt_Flesh_Sensitivity_TRL**
TEG-083	**Draft Minutes of the 7th Flex-TEG Meeting**

Number of working paper	*Title of Flex TEG document*
TEG-083-Rev1	**Finalized_Minutes_7th_Flex-TEG_Meeting**
TEG-084	**JAMA_Proposal_Tibia_Injury_Criteria**
TEG-085	**Draft_Agenda_8th_Flex-TEG_Meeting**
TEG-085-Rev1	**Finalized_Agenda_8th_Flex-TEG_Meeting**
TEG-086	**Draft_Status_Report_Action_Items**
TEG-086-Rev1	**Finalized_Status_Report_Action_Items**
TEG-087	**JAMA-JARI_L-R_Symetric_Bumper_Corner_Test_0903011**
TEG-088	**JAMA_Flex-GTR-proto_Round_Robin_Test**
TEG-089	**BASt_BGS_Flex_Test_Report**
TEG-090	**ACEA_Summary**
TEG-091	**Opel_Report**
TEG-092	**FTSS_Proposal**
TEG-093	**JAMA-JARI_Study_for_Inverse_Test_090517**
TEG-094	**BASt_Tentative_Corridor_Inverse_Test**
TEG-095	**JAMA_Investigation_Human_MCL_Injury_Criteria**
TEG-096	**Correlation_Flex-GTR-proto_and_Human_Lower_Limb_Output**
TEG-097	**JAMA_Proposal_Flex-GTR-proto_Tibia_MCL_Threshold**
TEG-098	**BASt_Proposal_Flex-GTR-proto_Tibia_Threshold**
TEG-099	**Evaluation_Test_Schedule_Flex-GTR-proto**
TEG-100	**DRAFT_Minutes_8th_Flex-TEG_Meeting_090812**
TEG-100-Rev.1	**Final: 8th Flex-TEG Minutes**
TEG-101	**DRAFT: 9th Flex-TEG Agenda**
TEG-101-Rev.1	**Final: 9th Flex-TEG Agenda**
TEG-102	**Review of Dynamic Calibration Corridor Making Method**
TEG-103	**DRAFT: Status of Action Items**
TEG-103-Rev.1	**Final: Status of Action Items**
TEG-104	**Pushing surface Information for Flex-GTR-prototype for Flex-GTR-prototype**
TEG-105	**JAMA Round Robin Test Results Flex-GTR-prototype (SN03)**
TEG-106	**ACEA Comments, 9th TEG meeting**
TEG-107	**9th Flex-TEG Meeting Discussion Results of day 1**

Number of working paper	*Title of Flex TEG document*
TEG-108	**Refinement of (tentative) Certification Corridors for the Dynamic Full Assembly (Inverse) Certification Test Procedure**
TEG-109	**DRAFT: 9th Flex-TEG Minutes**
TEG-109-Rev.1	**Final: 9th Flex-TEG Minutes**
TEG-110	**DRAFT: 10th Flex-TEG Agenda**
TEG-110-Rev.1	**Final: 10th Flex-TEG Agenda**
TEG-111	**DRAFT: Status of Action Items**
TEG-111-Rev.1	**Final: Status of Action Items**
TEG-112	**Flex-GTR Testing, NHTSA**
TEG-113	**KATRI Round Robin Tests Using the Flex-GTR-Prototype (SN03)**
TEG-114	**ACEA Comments, 10th Flex-TEG Meeting**
TEG-115	**Influence of Test Parameter Variations on The Flex GTR Joint Project of ACEA and BASt**
TEG-116	**Impact Parameter Tolerances for Inverse Certification Test and Vehicle Testing, BASt**
TEG-117	**Minor updates and pusher plate discussion for Flex Pli GTR, FTSS**
TEG-118	**General Status from FLEX Pli GTR Model Consortium, FTSS**
TEG-119	**Finalization of Impact and Assessment Conditions for Inverse Certification Test, BASt**
TEG-120	**Requirement Corridor (BASt-Method) for Pendulum Type (Type 3) Dynamic Calibration Test Method, JAMA-JARI**
TEG-121	**Flex-GTR Flesh Dimensions and Mass Tolerance, JAMA-JARI with FTSS communications**
TEG-122	**Flex-GTR (Mass, COG, Inertia) Tolerances , JAMA-JARI with FTSS communications**
TEG-123	**SLICE Updates for FLEX-GTR, DTS**
TEG-124	**DRAFT Minutes** **10th Flex-PLI Technical Evaluation Group (Flex-TEG) Meeting**
TEG-124-Rev.1	**Finalized Minutes** **10th Flex-PLI Technical Evaluation Group (Flex-TEG) Meeting**
TEG-125	**Draft Agenda** **11th Flex-PLI Technical Evaluation Group (Flex-TEG) Meeting**
TEG-125-Rev.1	**Finalized Agenda**

Number of working paper	*Title of Flex TEG document*
	11th Flex-PLI Technical Evaluation Group (Flex-TEG) Meeting
TEG-126	**Status Report on Action Items at 11th Flex-TEG meeting**
TEG-127	**Technical Background Information Document for the UN-ECE GRSP explaining the Derivation of Threshold Values and Impactor Certification methods for the FlexPLI version GTR agreed by the FlexPLI-TEG at their 9th Meeting**
TEG-128	**ACEA; Injury values : impact vs rebound**
TEG-129	**ACEA Comments**
TEG-130	**BASt; Flex-GTR: Proposal for ACL/PCL injury threshold**
TEG-131	**TEG Agreement on the Tibia and ACL Issues (Finalized)**
TEG-132	**FTSS; Flex PLI Catch Rope and Bracket Proposal**
TEG-133	**FTSS; 400 Nm Tibia Gage Loading Results**
TEG-134	**FTSS; FLEX PLI GTR Model development status**

A list of working papers used by the IG GTR9-PH2 group is available on the UNECE WP.29 website:

https://www2.unece.org/wiki/pages/viewpage.action?pageId=3178637

Number of working paper	*Title of IG GTR9-PH2 document*
GTR9-C-01	**Agenda for the constitutional meeting of the Informal Group on Pedestrian Safety Phase 2 (IG PS2)**
GTR9-C-01-Rev.1	**Final agenda of the Constitutional Meeting of the Informal Group on GTR No 9 - Phase 2 (IG GTR9-PH2) (Revised)**
GTR9-C-02	**Draft minutes of the Constitutional Meeting of the IG GTR9-PH2**
GTR9-C-02 - Rev.1	**Draft minutes of the Constitutional Meeting of the IG GTR9-PH2 (Revised)**
GTR9-C-03	**Draft Terms of Reference for the Informal Group on Pedestrian Safety Phase 2 (IG PS2)**
…	**This table will be finalized at the timing of the IG GTR9-PH2 work is completed.**

"

B. Text of the regulation

Paragraph 5.1.1., amend to read:

"5.1.1. **When tested in accordance with paragraph 7.1.1. (lower legform to bumper), the maximum dynamic medial collateral ligament elongation at the knee shall not exceed 22 mm, and the dynamic bending moments at the tibia shall not exceed 340 Nm. The maximum dynamic anterior cruciate ligament and posterior cruciate ligament elongation shall not exceed 13 mm. In addition, the manufacturer may nominate bumper test widths up to a maximum of 264 mm in total where the tibia bending moment shall not exceed 380 Nm. A Contracting Party may restrict application of the relaxation zone requirement in its domestic legislation if it decides that such restriction is appropriate.**

~~When tested in accordance with paragraph 7.1.1. (lower legform to bumper), the maximum dynamic knee bending angle shall not exceed 19°, the maximum dynamic knee shearing displacement shall not exceed 6.0 mm, and the acceleration measured at the upper end of the tibia shall not exceed 170g. In addition, the manufacturer may nominate bumper test widths up to a maximum of 264 mm in total where the acceleration measured at the upper end of the tibia shall not exceed 250g.~~"

Paragraph 6.3.1.1., amend to read:

"6.3.1.1. **flexible lower** ~~Lower~~ legform impactor:"

The flexible lower legform impactor shall consist of flesh, flexible long bone segments (representing femur and tibia), and a knee joint as shown in Figure 12.

The overall length of the impactor shall be 928 ± 3 mm, having a required mass of 13.2 ± 0.7 kg including flesh. The length of the femur, knee joint, and tibia shall be 339 ± 2 mm, 185 ± 1 mm, and 404 ± 2 mm respectively. The knee joint centre position shall be 94 ± 1 mm from the top of the knee joint.

Brackets, pulleys, protectors, connection parts, etc. attached to the impactor for the purpose of launching and/or protecting may extend beyond the dimensions shown in Figure 12 and Figure 13.

~~The lower legform impactor shall consist of two foam covered rigid segments, representing femur (upper leg) and tibia (lower leg), joined by a deformable, simulated knee joint. The overall length of the impactor shall be 926 ± 5 mm, having a required test mass of 13.4 ± 0.2 kg (see Figure 12).~~

~~Brackets, pulleys, etc. attached to the impactor for the purpose of launching it, may extend the dimensions shown in Figure 12.~~

6.3.1.1.1. **The cross-sectional shape perpendicular to the Z-axis of the femur and tibia main bodies shall be 90 ± 2 mm in width along the Y-axis, and 84 ± 1 mm in width along the X-axis as shown in Figure 13 (a). The impact face shall be 30 ± 1 mm in radius, 30 ± 1 mm in width along the Y-axis, and 48 ± 1 mm in width along the X-axis as shown in Figure 13 (a).**

The diameter of the femur and tibia shall be 70 ± 1 mm and both shall be covered by foam flesh and skin. The foam flesh shall be 25 mm thick foam type CF-45 or equivalent. The skin shall be made of neoprene foam, faced with 0.5 mm thick nylon cloth on both sides, with an overall thickness of 6 mm.

6.3.1.1.2. **The cross-sectional shape perpendicular to the Z-axis of the knee joint shall be 108 ± 2 mm in width along the Y-axis, and 118 ± 1 mm in width along the X-axis as shown in Figure 13 (b). The impact face shall be 103 ± 1 mm in radius, 12 ± 1 mm in width along the Y-axis, and 86 ± 1 mm in width along the X axis as shown in Figure 13 (b).**

The knee joint shall be fitted with deformable knee elements from the same batch as those used in the certification tests.

6.3.1.1.3. **The masses of the femur and tibia without flesh, including the connection part to the knee joint, shall be 2.46 ± 0.12 kg and 2.64 ± 0.13 kg respectively. The mass of the knee joint without flesh shall be 4.28 ± 0.21 kg. The total mass of the femur, knee joint and tibia shall be 9.38 ± 0.47 kg.**

The centre of gravity of the femur and tibia without flesh, including the connection part to the knee joint, shall be 159 ± 8 mm and 202 ± 10 mm respectively from the top, but not including the connection part to the knee joint, of each part as shown in Figure 12. The centre of gravity of the knee shall be 92 ± 5 mm from the top of the knee joint as shown in Figure 12.

The moment of inertia of the femur and tibia without flesh, including the connection part inserted to the knee joint, about the X-axis through the respective centre of gravity shall be 0.0325 ± 0.0016 kg m² and 0.0467 ± 0.0023 kgm² respectively. The moment of inertia of the knee joint about the X axis through the respective centre of gravity shall be 0.0180 ± 0.0009 kg m².

The total masses of the femur and tibia shall be 8.6 ± 0.1 kg and 4.8 ± 0.1 kg respectively, and the total mass of the impactor shall be 13.4 ± 0.2 kg. The centre of gravity of the femur and tibia shall be 217 ± 10 mm and 233 ± 10 mm from the centre of the knee respectively. The moment of inertia of the femur and tibia, about a horizontal axis through the respective centre of gravity and perpendicular to the direction of impact, shall be 0.127 ± 0.010 kgm² and 0.120 ± 0.010 kgm² respectively.

6.3.1.1.4. **For each test, the impactor (femur, knee joint, and tibia) shall be covered by flesh composed of synthetic rubber sheets (R1, R2) and neoprene sheets (N1F, N2F, N1T, N2T, N3) as shown in Figure 14. The sheets are required to have a compression characteristic as shown in Figure 15. The compression characteristic shall be checked using the same batch of sheets as those used for the impactor flesh. The size of the sheets shall be within the requirements described in Figure 15.**

For each test the impactor shall be fitted with new foam flesh cut from one of up to four consecutive sheets of foam type CF-45 flesh material or equivalent, produced from the same batch of manufacture (cut from one block or 'bun' of foam), provided that foam from one of these sheets was used in the dynamic certification test and the individual weights of these sheets are within ± 2 percent of the weight of the sheet used in the certification test.

6.3.1.1.5. **The test impactor or at least the flesh shall be stored for at least four hours in a controlled storage area with a stabilized temperature of 20 ± 2°C prior to impactor removal for calibration. After removal from the storage, the impactor shall not be subjected to conditions other than those pertaining in the test area.**

~~The test impactor or at least the foam flesh shall be stored during a period of at least four hours in a controlled storage area with a stabilized humidity of 35 percent ± 15 percent and a stabilized temperature of 20 ± 4°C prior to impactor removal for calibration. After removal from the storage the impactor shall not be subjected to conditions other than those pertaining in the test area.~~

6.3.1.1.6. Lower legform instrumentation

6.3.1.1.6.1. **Four transducers shall be installed in the tibia to measure bending moments applied to the tibia. The sensing locations of each of the transducers are as follows: tibia-1: 134 ± 1 mm, tibia-2: 214 ± 1 mm, tibia-3: 294 ± 1 mm and tibia-4: 374 ± 1 mm below the knee joint centre respectively as shown in Figure 16. The measurement axis of each transducer shall be the X-axis of the impactor.**

~~A uniaxial accelerometer shall be mounted on the non-impacted side of the tibia, 66 ± 5 mm below the knee joint centre, with its sensitive axis in the direction of impact.~~

6.3.1.1.6.2. **Three transducers shall be installed in the knee joint to measure elongations of the medial collateral ligament (MCL), anterior cruciate ligament (ACL), and posterior cruciate ligament (PCL). The measurement locations of each transducer are shown in Figure 16. The measurement locations shall be within ± 4 mm along the X-axis from the knee joint centre.**

~~A damper shall be fitted to the shear displacement system and may be mounted at any point on the rear face of the impactor or internally. The damper properties shall be such that the impactor meets both the static and dynamic shear displacement requirements and prevents excessive vibrations of the shear displacement system.~~

6.3.1.1.6.3. **The instrumentation response value channel frequency class (CFC), as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and 400 Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate or bend until these values.**

~~Transducers shall be fitted to measure knee bending angle and knee shearing displacement.~~

6.3.1.1.6.4. **The measurements for the flexible lower legform impactor shall be taken only for the major impact with the vehicle prior to the rebound phase. All maxima occurring during or after the rebound phase shall be ignored. For example, the zero crossing after the maximum of the MCL elongation or of the tibia bending moments shall be considered as the end of the major impact with the vehicle.**

~~The instrumentation response value channel frequency class (CFC), as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC~~

response values, as defined in ISO 6487:2002, shall be 50° for the knee bending angle, 10 mm for the shearing displacement and 500g for the acceleration. This does not require that the impactor itself be able to physically bend and shear to these angles and displacements.

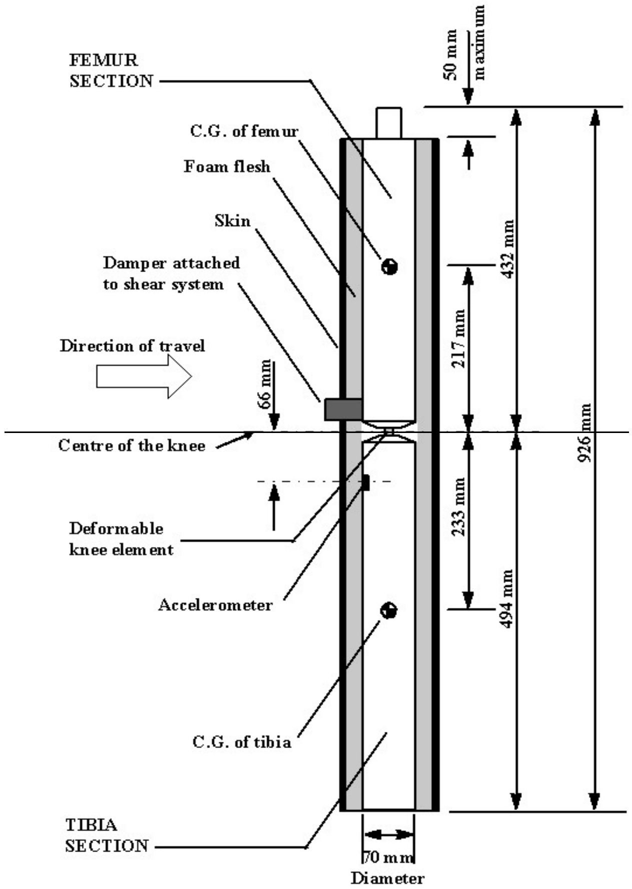
6.3.1.1.7. **flexible lower legform impactor** Lower legform certification

6.3.1.1.7.1. The **flexible lower legform impactor** lower legform shall meet the performance requirements specified in paragraph 8.

6.3.1.1.7.2. **The impactor shall be certified according to the inverse type dynamic certification test described in paragraph 8.1.3. After the initial inverse type dynamic certification test, the certified impactor shall be re-certified according to the pendulum type dynamic certification test described in paragraph 8.1.2. after every 10 vehicle tests, except that the inverse type dynamic certification test will be repeated instead after every 30 vehicle tests.**

The certified impactor may be used for a maximum of 20 impacts before re-certification. With each test new plastically deformable knee elements should be used. The impactor shall also be re-certified if more than one year has elapsed since the previous certification, if any impactor transducer output, in any impact, has exceeded the specified CAC or has reached the mechanical limits of the leg impactor deformation capability."

Delete Figures 12, to read:



~~Figure 12: Lower legform impactor (see paragraph 6.3.1.1.)~~

Insert new Figures 12 to 16, to read:

"

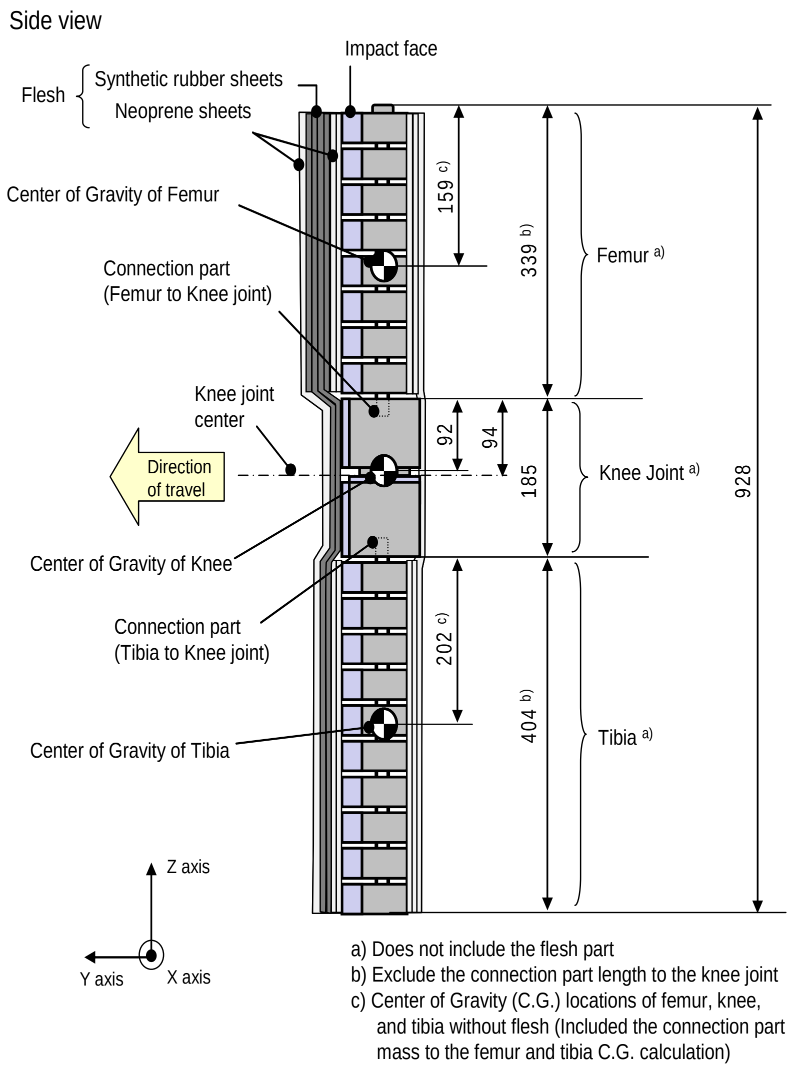


Figure 12 Flexible lower legform impactor; Dimensions and C.G. locations of femur, knee joint and tibia (Side view)

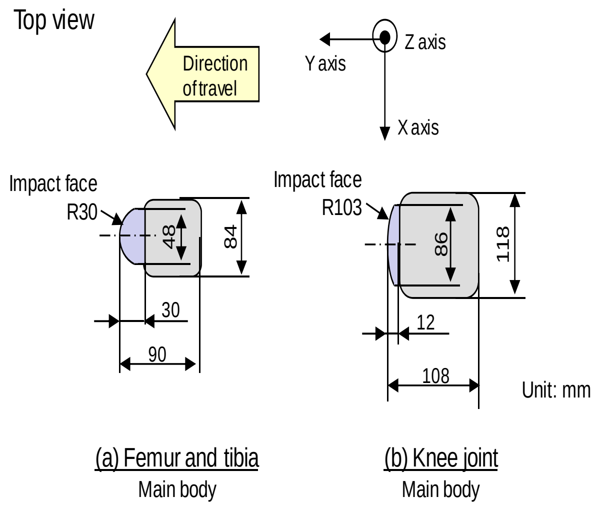


Figure 13 flexible lower legform impactor; femur, tibia, and knee dimensions (Top view)

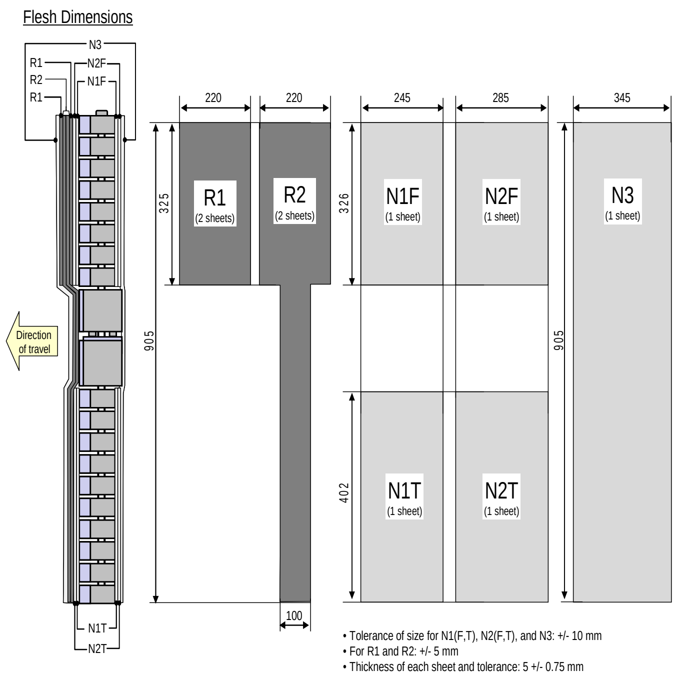
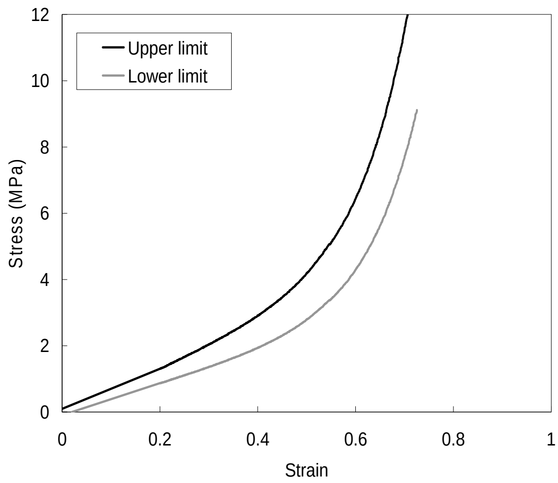
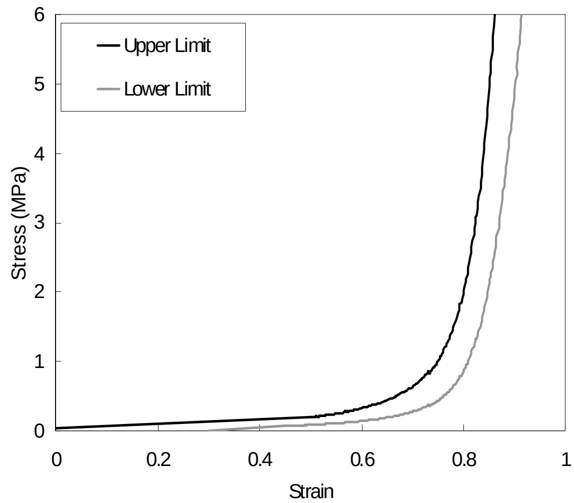


Figure 14 Flexible lower legform impactor; flesh dimensions



(a) Synthetic rubber sheets



(b) Neoprene sheets

Figure 15 Flexible lower legform impactor; flesh compression characteristics

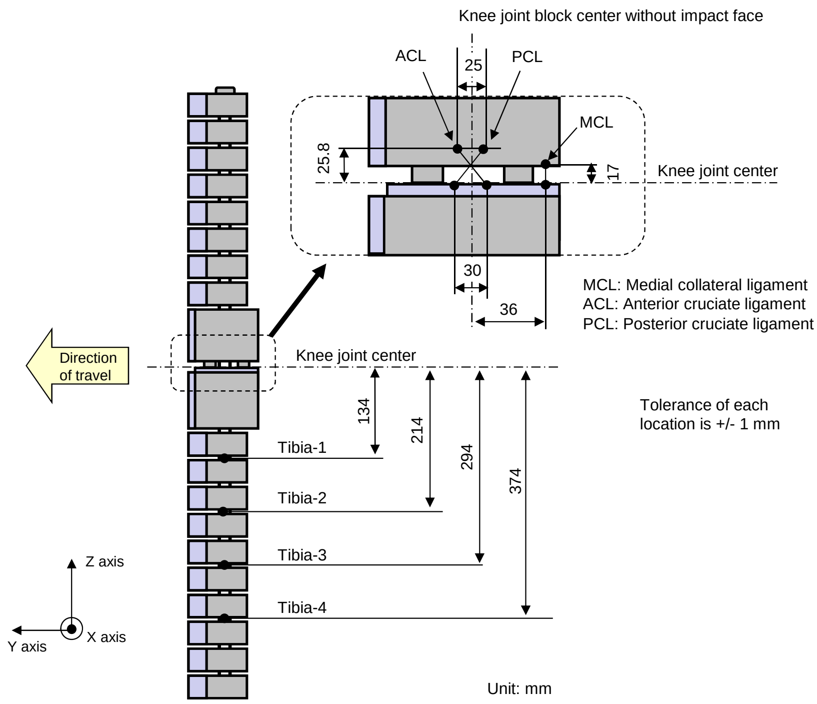


Figure 16 flexible lower legform impactor; instrument locations

"

Paragraph 6.3.1.2., amend to read:

"…, foam covered at the impact side, and 350 ± 5 mm long (see Figure ~~13~~**17**)."

Paragraph 6.3.1.2.9.1., amend to read:

"…in three positions, as shown in Figure ~~13~~**17**, each using a separate channel. …."

Paragraph 6.3.1.2.9.2., amend to read:

"…at positions 50 mm either side of the centre line (see Figure ~~13~~**17**)."

Title of Figure 13(former), renumber as Figure 17.

Paragraph 6.3.2.1., amend to read:

"6.3.2.1. Child headform impactor (see Figure ~~14~~**18**)

The child………"

Paragraph 6.3.2.1.1., amend to read:

"6.3.2.1.1. … axis perpendicular to the mounting face A (see Figure ~~14~~**18**) and …"

Figure 14 (former), renumber as Figure 18.

Paragraph 6.3.2.2., amend to read:

"6.3.2.2. Adult headform impactor (see Figure ~~15~~**19**)

The adult … as shown in Figure ~~15~~**19**. The mass …"

Figure 15 (former), renumber as Figure 19.

Paragraph 6.3.2.2.1., amend to read:

"6.3.2.2.1. … axis perpendicular to the mounting face A (see Figure ~~15~~**19**) and …"

Figure 16 (former), renumber as Figure 20.

Paragraphs 7.1.1. to 7.1.1.4., amend to read:

"7.1.1. **Flexible lower legform impactor** ~~Lower legform~~ to bumper test procedure:

Each test shall be completed within two hours of when the impactor to be used is removed from the controlled storage area.

7.1.1.1. The selected target points shall be in the bumper test area.

7.1.1.2. **The direction of the impact velocity vector shall be in the horizontal plane and parallel to the longitudinal vertical plane of the vehicle. The tolerance for the direction of the velocity vector in the horizontal plane and in the longitudinal plane shall be ± 2° at the time of first contact. The axis of the impactor shall be perpendicular to the horizontal plane, with a roll and pitch angle tolerance of ± 2° in the lateral and longitudinal plane. The horizontal, longitudinal and lateral planes are orthogonal to each other (see Figure 20).**

~~The direction of the impact velocity vector shall be in the horizontal plane and parallel to the longitudinal vertical plane of the vehicle. The tolerance for the direction of the velocity vector in the horizontal plane and in the longitudinal plane shall be ± 2° at the time of first contact. The axis of the impactor shall be perpendicular to the horizontal plane with a tolerance of ± 2° in the lateral and longitudinal plane. The horizontal, longitudinal and lateral planes are orthogonal to each other (see Figure 16).~~

7.1.1.3. **The bottom of the impactor shall be at 75 mm above ground reference plane at the time of first contact with the bumper (see Figure 21), with a ± 10 mm tolerance. When setting the height of the propulsion system, an allowance must be made for the influence of gravity during the period of free flight of the impactor.**

~~The bottom of the impactor shall be at 25 mm above ground reference plane at the time of first contact with the bumper (see Figure 17), with a ± 10 mm tolerance. When setting the height of the propulsion system, an allowance must be made for the influence of gravity during the period of free flight of the impactor.~~

7.1.1.3.1. **The lower legform impactor for the bumper tests shall be in 'free flight' at the moment of impact. The impactor shall be released to free flight at such a distance from the vehicle that the test results are not influenced by contact of the impactor with the propulsion system during rebound of the impactor.**

The impactor may be propelled by any means that can be shown to meet the requirements.

~~The lower legform impactor for the bumper tests shall be in 'free flight' at the moment of impact. The impactor shall be released to free flight at such a distance from the vehicle that the test results are not influenced by contact of the impactor with the propulsion system during rebound of the impactor.~~

~~The impactor may be propelled by an air, spring or hydraulic gun, or by other means that can be shown to give the same result.~~

7.1.1.3.2. **At the time of first contact the impactor shall have the intended orientation about its vertical axis, for the correct operation of its knee joint, with a yaw angle tolerance of ± 5° (see Figure 20).**

~~At the time of first contact the impactor shall have the intended orientation about its vertical axis, for the correct operation of its knee joint, with a tolerance of ± 5° (see Figure 16).~~

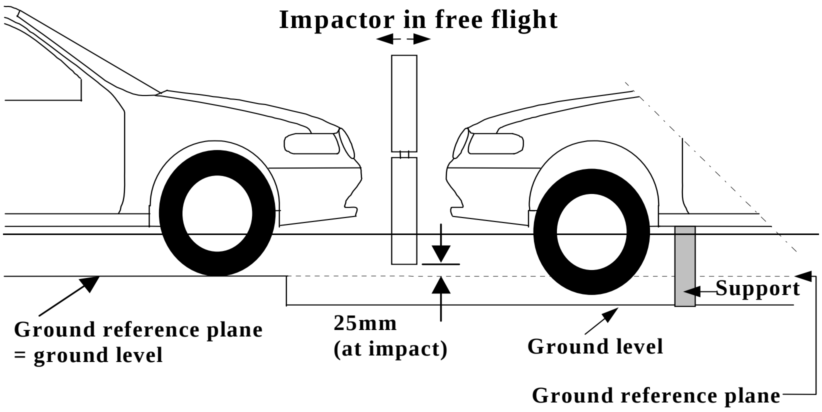
7.1.1.3.3. At the time of first contact the centre line of the impactor shall be within a ± 10 mm tolerance of the selected impact location.

7.1.1.3.4. During contact between the impactor and the vehicle, the impactor shall not contact the ground or any object which is not part of the vehicle.

7.1.1.4. The impact velocity of the impactor when striking the bumper shall be 11.1 ± 0.2 m/s. The effect of gravity shall be taken into account when the impact velocity is obtained from measurements taken before the time of first contact."

Figures 17(former), renumber as Figure 21 and amend to read:

"



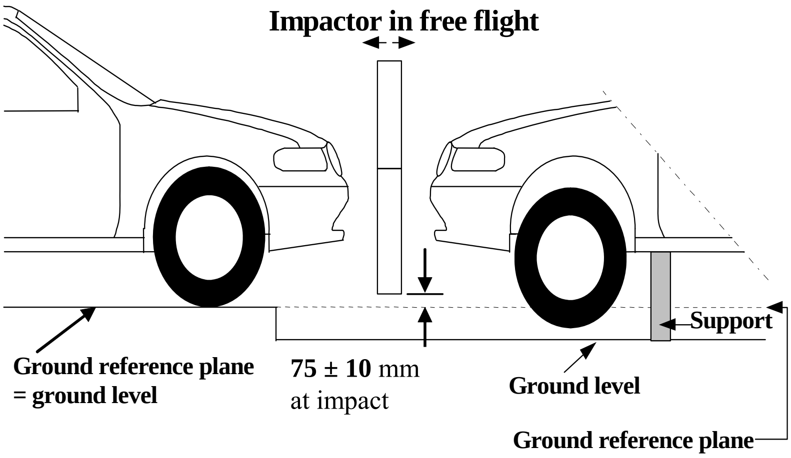


Figure ~~17~~ **21 Flexible lower legform impactor** ~~Lower legform~~ to bumper tests for complete vehicle in normal ride attitude (left) and for cut-body mounted on supports (right) (see paragraph 7.1.1.3.) "

Paragraphs 8.1. to 8.1.3.4.4., to read:

"8.1. **Flexible lower legform impactor** ~~Lower legform impactor~~ certification

8.1.1. Static **certification** tests

8.1.1.1. **The femur and tibia of the flexible lower legform impactor shall meet the requirements respectively specified in paragraph 8.1.1.2. when tested as specified in paragraph 8.1.1.4. The knee joint of the lower legform impactor shall meet the requirements specified in paragraph 8.1.1.3. when tested as specified in paragraph 8.1.1.5. The stabilized temperature of the impactor during the certification tests shall be 20° ± 2°C.**

The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and 4 kN for the applied external load. For these tests, low-pass filtering at an appropriate frequency is permitted to remove higher frequency noise without significantly affecting the measurement of the response of the impactor.

~~The lower legform impactor shall meet the requirements specified in paragraph 8.1.1.2. when tested as specified in paragraph 8.1.1.4. and the requirements specified in paragraph 8.1.1.3. when tested as specified in paragraph 8.1.1.5.~~

~~For both tests the impactor shall have the intended orientation about its longitudinal axis, for the correct operation of its knee joint, with a tolerance of ± 2°.~~

~~The stabilized temperature of the impactor during certification shall be 20° ± 2°C.~~

~~The CAC response values, as defined in ISO 6487:2002 shall be 50° for the knee bending angle and 500 N for the applied force when the impactor is loaded in bending in accordance with paragraph 8.1.1.4., and 10 mm for the shearing displacement and 10 kN for the applied force when the impactor is loaded in shearing in accordance with paragraph 8.1.1.5. For both tests low-pass filtering at an appropriate frequency is permitted, to remove higher frequency noise without significantly affecting the measurement of the response of the impactor.~~

8.1.1.2. **When the femur and tibia of the impactor are loaded in bending in accordance with paragraph 8.1.1.4., the applied moment and generated deflection at the centre of the femur and tibia (M_c and D_c) shall be within the corridors shown in Figure 22.**

~~When the impactor is loaded in bending in accordance with paragraph 8.1.1.4., the applied force/bending angle response shall be within the limits shown in Figure 18. Also, the energy taken to generate 15.0° of bending shall be 100 ± 7 J.~~

8.1.1.3. **When the knee joint of the impactor is loaded in bending in accordance with paragraph 8.1.1.5., the MCL, ACL, and PCL elongations and applied bending moment or force at the centre of the knee joint (M_c or F_c) shall be within the corridors shown in Figure 23.**

~~When the impactor is loaded in shearing in accordance with paragraph 8.1.1.5., the applied force/shearing displacement response shall be within the limits shown in Figure 19.~~

8.1.1.4. **The edges of the femur and tibia, not bending parts, shall be mounted to the support rig firmly as shown in Figure 24 and Figure 25. The Y-axis of the impactor shall be parallel to the loading axis within 180 ± 2° tolerance. In order to avoid friction errors, roller plates shall be set underneath the support rigs.**

The centre of the loading force shall be applied at the centre of the femur and tibia within ± 2° tolerance along the Z-axis. The force shall be increased at a rate between 10 and 100 mm/minute until the bending moment at the centre part (M_c) of the femur or tibia reaches 400 Nm.

~~The impactor, without foam covering and skin, shall be mounted with the tibia firmly clamped to a fixed horizontal surface and a metal tube connected firmly to the femur, as shown in Figure 20. The rotational axis of impactor knee joint shall be vertical. To avoid friction errors, no support shall be provided to the femur section or the metal tube. The bending moment applied at the centre of the knee joint, due to the mass of the metal tube and other components (excluding the legform itself), shall not exceed 25 Nm.~~

~~A horizontal normal force shall be applied to the metal tube at a distance of 2.0 ± 0.01 m from the centre of the knee joint and the resulting angle of knee deflection shall be recorded. The load shall be increased at a rate between 1.0 and 10°/s until the angle of deflection of the knee is in excess of 22°. Brief excursions from these limits due, for instance, to the use of a hand-pump shall be permitted.~~

~~The energy is calculated by integrating the force with respect to the bending angle in radians, and multiplying by the lever length of 2.0 ± 0.01 m.~~

8.1.1.5. **The edges of the knee joint, not bending parts, shall be mounted to the support rig firmly as shown in Figure 26. The Y-axis of the impactor shall be parallel to the loading axis within 180 ± 2°. In order to avoid friction errors, roller plates shall be set underneath the support rigs. To avoid impactor damage, a neoprene sheet shall be set underneath the loading ram and the impactor face of the knee joint which is described in the Figure 13 shall be removed. The neoprene sheet used in this test shall have compression characteristics as shown in Figure 15.**

The centre of the loading force shall be applied at the centre of the knee joint within ± 2° tolerance along the Z-axis. The external load shall be increased at a rate between 10 and 100 mm/minute until the bending moment at the centre part of the knee joint (M_c) reaches 400 Nm.

~~The impactor, without foam covering and skin, shall be mounted with the tibia firmly clamped to a fixed horizontal surface and a metal tube connected firmly to the femur and restrained at 2.0 m from the centre of the knee joint, as shown in Figure 21.~~

~~A horizontal normal force shall be applied to the femur at a distance of 50 mm from the centre of the knee joint and the resulting knee shearing displacement shall be recorded. The load shall be increased between 0.1 and 20 mm/s until the shearing displacement of the knee is in excess of 7.0 mm or the load is in excess of 6.0 kN. Brief excursions from these limits due, for instance, to the use of a hand-pump shall be permitted.~~

8.1.2. Dynamic **certification** tests **(pendulum type)**

8.1.2.1. The **flexible lower legform impactor** ~~lower legform impactor~~ **(femur, knee joint and tibia are connected/assembled firmly)** shall meet the requirements specified in paragraph 8.1.2.3. when tested as specified in paragraph 8.1.2.4.

8.1.2.2. Certification

8.1.2.2.1. **The test facility used for the certification test shall have a stabilized temperature of 20 ± 2 °C during certification.**

~~The foam flesh for the test impactor shall be stored during a period of at least four hours in a controlled storage area with a stabilized humidity of 35 ± 10 percent and a stabilized temperature of 20 ± 2°C prior to impactor removal for calibration. The test impactor itself shall have a temperature of 20° ± 2°C at the time of impact. The temperature tolerances for the test impactor shall apply at a relative humidity of 40 ± 30 percent after a soak period of at least four hours prior to their application in a test.~~

8.1.2.2.2. **The temperature of the certification area shall be measured at the time of certification and recorded in a certification report.**

~~The test facility used for the calibration test shall have a stabilized humidity of 40 ± 30 percent and a stabilized temperature of 20 ± 4°C during calibration.~~

~~8.1.2.2.3. Each calibration shall be completed within two hours of when the impactor to be calibrated is removed from the controlled storage area.~~

~~8.1.2.2.4. Relative humidity and temperature of the calibration area shall be measured at the time of calibration and recorded in a calibration report.~~

8.1.2.3. Requirements

8.1.2.3.1. **When the flexible lower legform impactor is used for a test as specified in paragraph 8.1.2.4., the maximum bending moment of the tibia at tibia-1 shall be not more than 272 Nm and not less than 235 Nm, the maximum bending moment at tibia-2 shall be not more than 219 Nm and not less than 187 Nm, the maximum bending moment at tibia-3 shall be not more than 166 Nm and not less than 139 Nm, and the maximum bending moment at tibia-4 shall be not more than 111 Nm and not less than 90 Nm. The maximum elongation of MCL shall be not more than 24.0 mm and not less than 20.5 mm, the maximum elongation of ACL shall be not more than 10.5 mm and not less than 8.0 mm, and the maximum elongation of PCL shall be not more than 5.0 mm and not less than 3.5 mm.**

For all these values, the readings used shall be from the initial impact timing to 250 ms after the impact timing.

~~When the impactor is impacted by a linearly guided certification impactor, as specified in paragraph 8.1.2.4., the maximum upper tibia acceleration shall be not less than 120g and not more than 250g. The maximum bending angle shall be not less than 6.2° and not more than 8.2°. The maximum shearing displacement shall be not less than 3.5 mm and not more than 6.0 mm.~~

~~For all these values, the readings used shall be from the initial impact with the certification impactor and not from the arresting phase. Any system used~~

~~to arrest the impactor or certification impactor shall be so arranged that the arresting phase does not overlap in time with the initial impact. The arresting system shall not cause the transducer outputs to exceed the specified CAC.~~

8.1.2.3.2. **The instrumentation response value CFC, as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and 400 Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate and bend to these values.]**

~~The instrumentation response value CFC, as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 50° for the knee bending angle, 10 mm for the shearing displacement and 500g for the acceleration. This does not require that the impactor itself be able to physically bend and shear to these angles and displacements.~~

8.1.2.4. Test procedure

8.1.2.4.1. **The flexible lower legform impactor, including flesh, shall be suspended from the dynamic certification test rig 15 ± 1° upward from the horizontal as shown in Figure 27. The impactor shall be released from the suspended position, whereupon the impactor falls freely against the pin joint of the test rig as shown in Figure 27.**

~~The impactor, including foam covering and skin, shall be suspended horizontally by three wire ropes of 1.5 ± 0.2 mm diameter and of 2000 mm minimum length, as shown in Figure 22. It shall be suspended with its longitudinal axis horizontal, with a tolerance of ± 0.5°, and perpendicular to the direction of the certification impactor motion, with a tolerance of ± 2°. The impactor shall have the intended orientation about its longitudinal axis, for the correct operation of its knee joint, with a tolerance of ± 2°. The impactor must meet the requirements of paragraph 6.3.1.1., with the attachment bracket(s) for the wire ropes fitted.~~

8.1.2.4.2. **The knee joint centre of the impactor shall be 30 ± 1 mm below the bottom line of the stopper bar, and the tibia impact face without flesh shall be located 13 ± 2 mm from the front upper edge of the stopper bar when the impactor is hanging freely as shown in Figure 27.**

~~The certification impactor shall have a mass of 9.0 ± 0.05 kg, this mass includes those propulsion and guidance components which are effectively part of the impactor during impact. The dimensions of the face of the certification impactor shall be as specified in Figure 23. The face of the certification impactor shall be made of aluminium, with an outer surface finish of better than 2.0 micrometers.~~

~~The guidance system shall be fitted with low friction guides, insensitive to off-axis loading, that allow the impactor to move only in the specified direction of impact, when in contact with the vehicle. The guides shall prevent motion in other directions including rotation about any axis.~~

~~8.1.2.4.3. The impactor shall be certified with previously unused foam.~~

~~8.1.2.4.4. The impactor foam shall not be excessively handled or deformed before, during or after fitting.~~

~~8.1.2.4.5. The certification impactor shall be propelled horizontally at a velocity of 7.5 ± 0.1 m/s into the stationary impactor as shown in Figure 23. The certification impactor shall be positioned so that its centreline aligns with a position on the tibia centreline of 50 mm from the centre of the knee, with tolerances of □ 3 mm laterally and □ 3 mm vertically.~~

8.1.3. Dynamic certification tests (inverse type)

8.1.3.1. The flexible lower legform impactor with flesh (femur, knee joint, and tibia are connected/assembled firmly) shall meet the requirements specified in paragraph 8.1.3.3. when tested as specified in paragraph 8.1.3.4.

8.1.3.2. Certification

8.1.3.2.1. The test facility used for the certification test shall have a stabilized temperature of 20 ± 2 °C during certification.

8.1.3.2.3. The temperature of the certification area shall be measured at the time of certification and recorded in a certification report.

8.1.3.3. Requirements

8.1.3.3.1. When the flexible lower legform impactor is used for the test specified in paragraph 8.1.3.4., the maximum bending moment of the tibia at tibia-1 shall be not more than 272 Nm and not less than 230 Nm, the maximum bending moment at tibia-2 shall be not more than 252 Nm and not less than 210 Nm, the maximum bending moment at tibia-3 shall be not more than 192 Nm and not less than 166 Nm, and the maximum bending moment at tibia-4 shall be not more than 108 Nm and not less than 93 Nm. The maximum elongation of the MCL shall be not more than 21.0 mm and not less than 17.0 mm, that of the ACL shall be not more than 10.0 mm and not less than 8.0 mm, and that of the PCL shall be not more than 6.0 mm and not less than 4.0 mm.

For all these values, the readings used shall be from the initial impact timing to 50 ms after the impact timing.

8.1.3.3.2. The instrumentation response value CFC, as defined in ISO 6487:2002, shall be 180 for all transducers. The CAC response values, as defined in ISO 6487:2002, shall be 30 mm for the knee ligament elongations and 400 Nm for the tibia bending moments. This does not require that the impactor itself be able to physically elongate and bend to these values.

8.1.3.4. Test procedure

8.1.3.4.1. The fully assembled flexible lower legform impactor (with flesh and skin) shall be stationary suspended vertically from a test rig as shown in Figure 28. It is then impacted by the upper edge of a linearly guided Al honeycomb impactor, covered by a thin (less than 1 mm thickness) paper cloth, at an impact speed of 11,1 ± 0,2 m/s. The legform is to be released from the test rig within 10 ms after the time of first contact to ensure a free flight condition.

8.1.3.4.2. The honeycomb of 5052 alloy, which is attached in front of the moving ram, shall have a crush strength of 75 psi ± 10 per cent and dimensions of l = 200 ± 5 mm, w = 160 ± 5 mm and d = 60 ± 2 mm. To ensure a consistent and good level of repeatability, the honeycomb should either have a 3/16 inch cell size or a 1/4 inch cell size. The honeycomb should

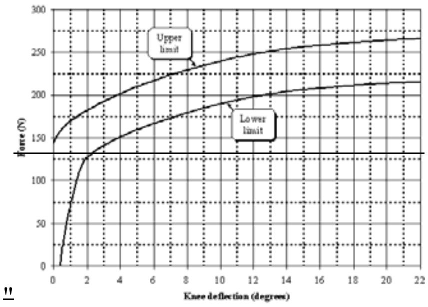
have a density of 2.0 pcf in combination with a 3/16 inch cell size or a density of 2.3 pcf in combination with a 1/4 inch cell size.

8.1.3.4.3. The upper edge of the honeycomb face is to be in line with the rigid plate of the linearly guided impactor. At the time of first contact, the upper edge of the honeycomb is to be in line with the knee joint centre line within a vertical tolerance of 0 ± 2 mm. The honeycomb shall not be deformed before the impact test.

8.1.3.4.4. The flexible lower legform impactor pitch angle and therefore the pitch angle of the velocity vector of the honeycomb impactor (rotation around Y-axis) at the time of first contact shall be within a tolerance of 0 ± 2° in relation to the lateral vertical plane. The flexible lower legform impactor roll angle and therefore the roll angle of the honeycomb impactor (rotation around X-axis) at the time of first contact shall be within a tolerance of 0 ± 2°in relation to the longitudinal vertical plane. The flexible lower legform impactor yaw angle and therefore the yaw angle of the velocity vector of the honeycomb impactor (rotation around Z-axis) at the time of first contact shall be within a tolerance of 0±2°, to ensure a correct operation of the knee joint."

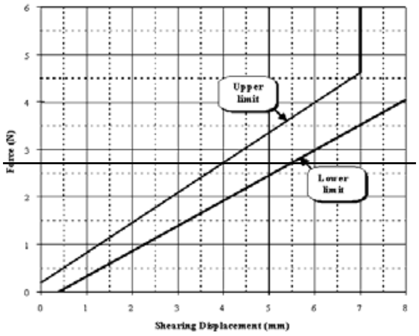
Delete Figures 18 to Figure 21, to read:

"

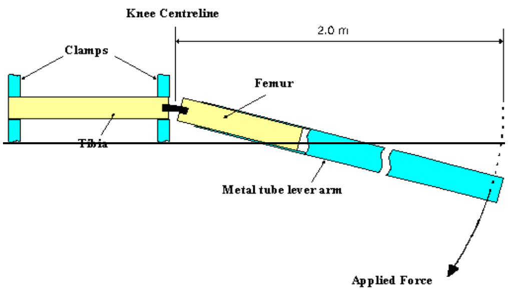


"

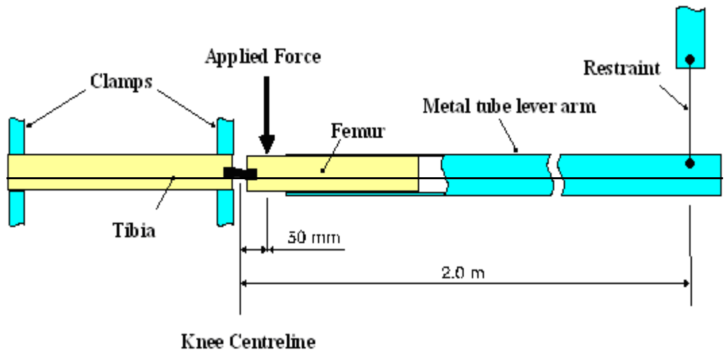
~~Figure 18: Force versus angle requirement in static lower legform impactor bending certification test (see paragraph 8.1.1.2.)~~



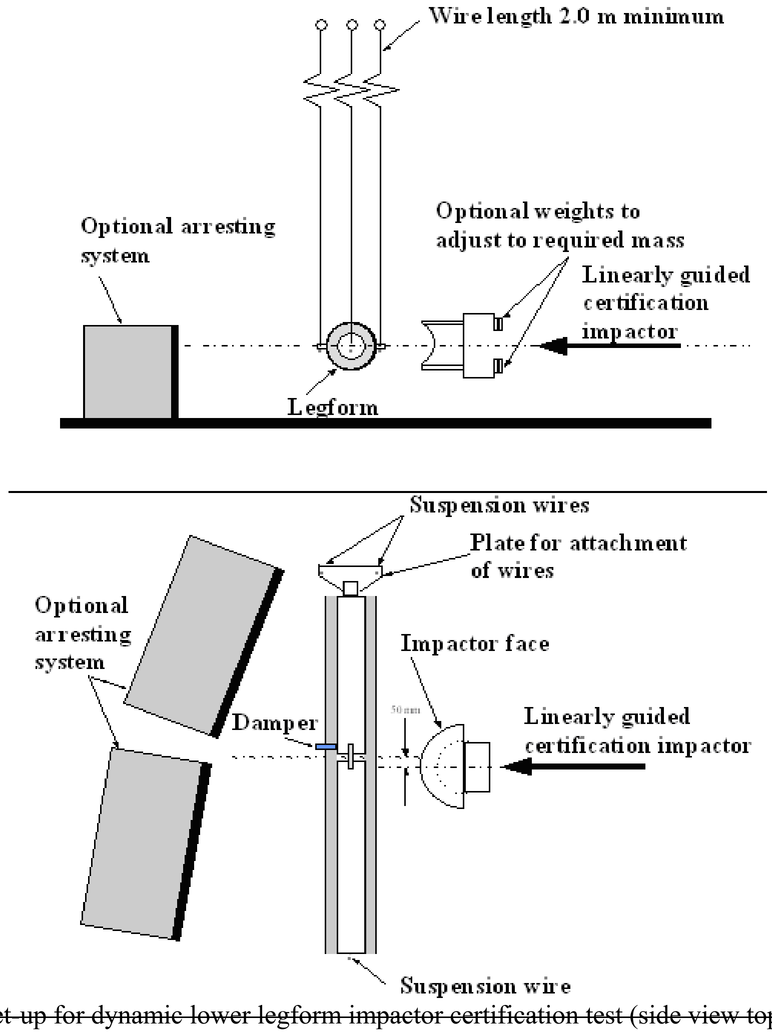
~~Figure 19: Force versus displacement requirement in static lower legform impactor shearing certification test (see paragraph 8.1.1.3.)~~



~~Figure 20: Top View of Test set-up for static lower legform impactor bending certification test (see paragraph 8.1.1.4.)~~



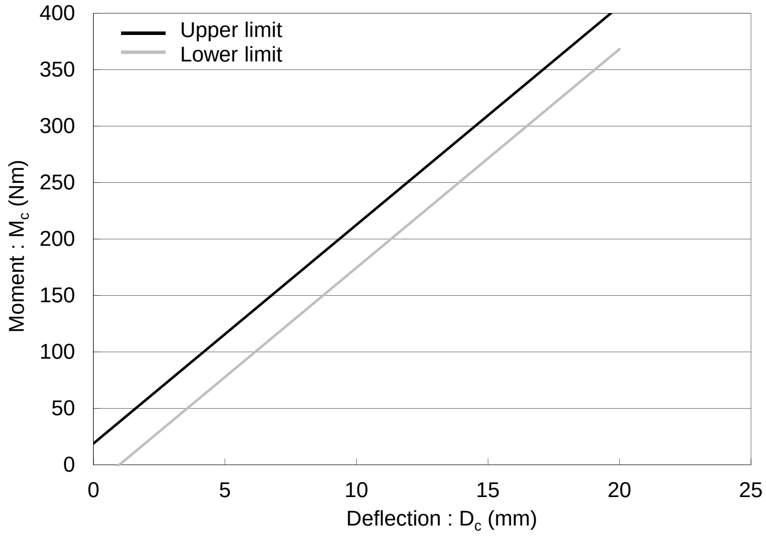
~~Figure 21: Top View of Test set-up for static lower legform impactor shearing certification test (see paragraph 8.1.1.5.)~~



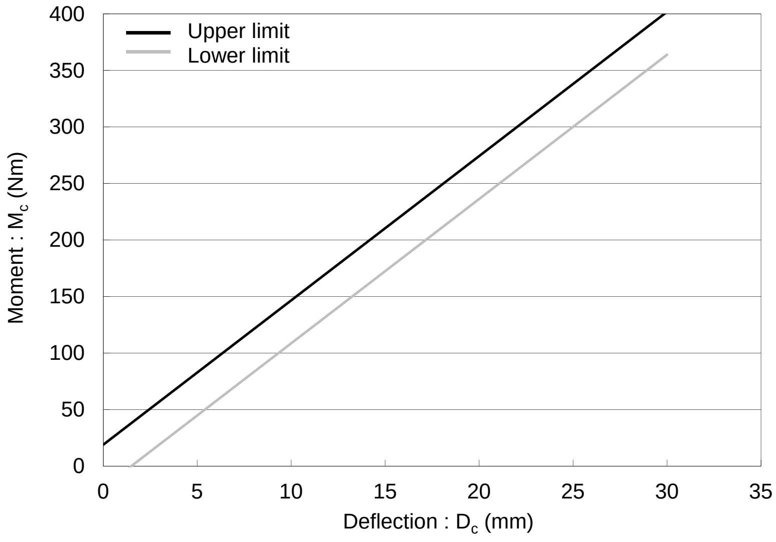
~~Figure 22: Test set-up for dynamic lower legform impactor certification test (side view top diagram, view from above bottom diagram) (see paragraph 8.1.2.4.1.)~~ "

Insert new Figures 22 to 28., to read:

"

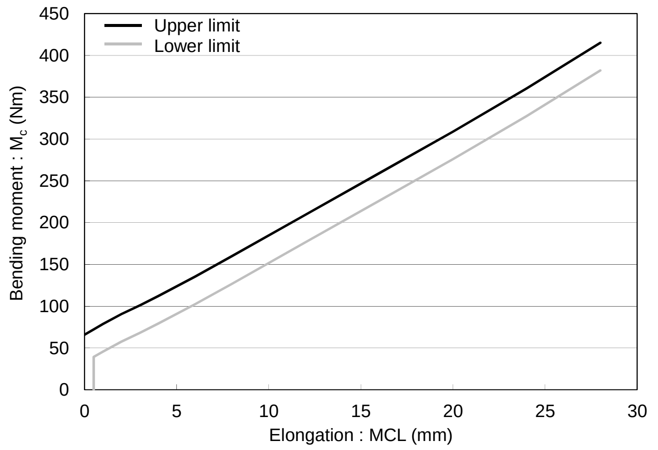


(a) Femur bending corridor

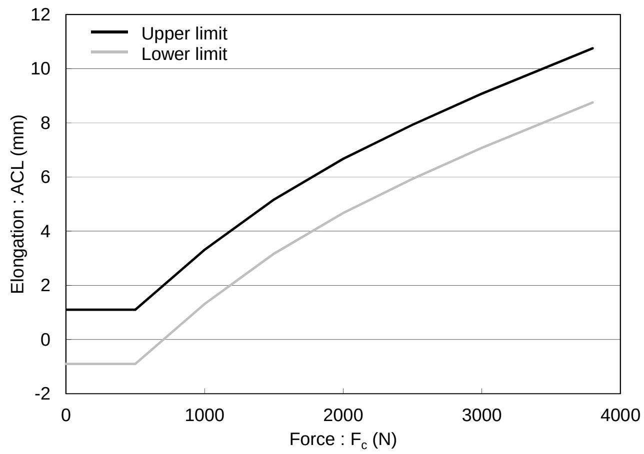


(b) Tibia bending corridor

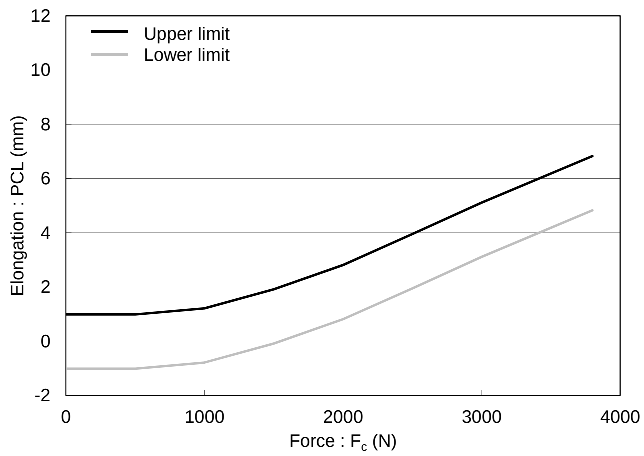
Figure 22 Flexible lower legform impactor requirement corridor of femur and tibia in static certification test (see paragraph 8.1.1.2.)



(a) for MCL

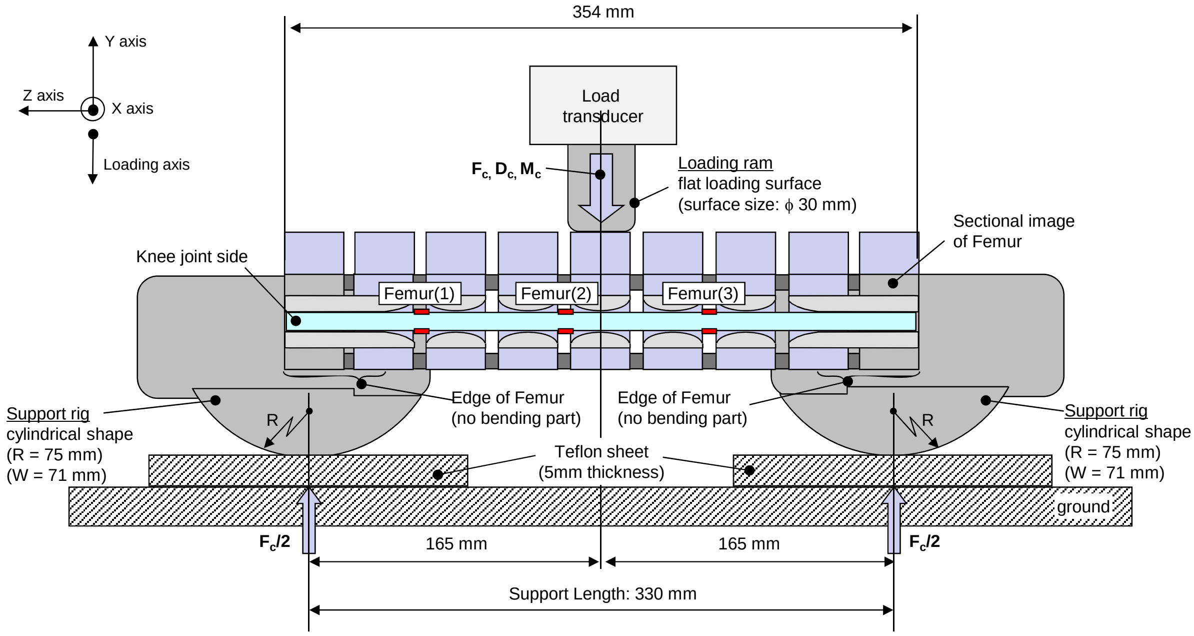


(b) for ACL



(c) for PCL

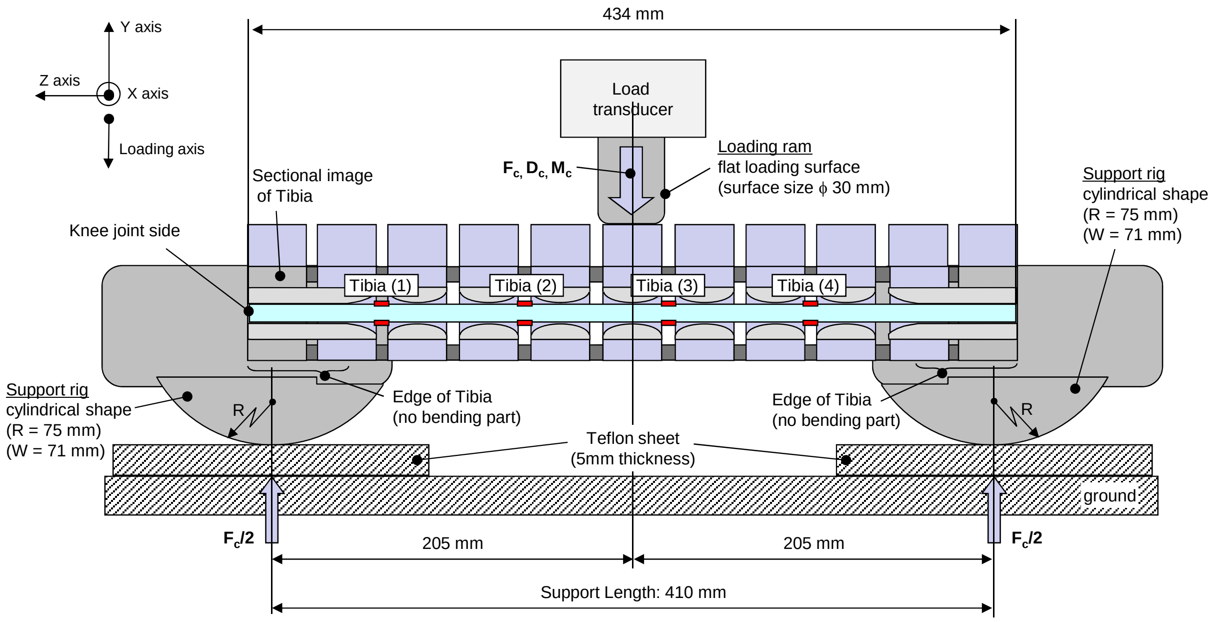
Figure 23 Flexible lower legform impactor requirement corridors for knee joint in static certification test (see paragraph 8.1.1.3.)



F_c: External loading force at center of the femur
D_c: Deflection at center of the femur
M_c: Moment Center (Nm) = F_c/2 (N) x 0.165 (m)
R: Radius, W: Width along to the side axis

Figure 24 Flexible lower legform impactor test set-up for femur in static certification tests

(see paragraph 8.1.1.4.)



F_c: External loading force at center of the tibia
D_c: Deflection at center of the tibia
M_c: Moment Center (Nm) = F_c/2 (N) x 0.205 (m)
R: Radius, W: Width along to the side axis

Figure 25 Flexible lower legform impactor test set-up for tibia in static certification test (see paragraph 8.1.1.4.)

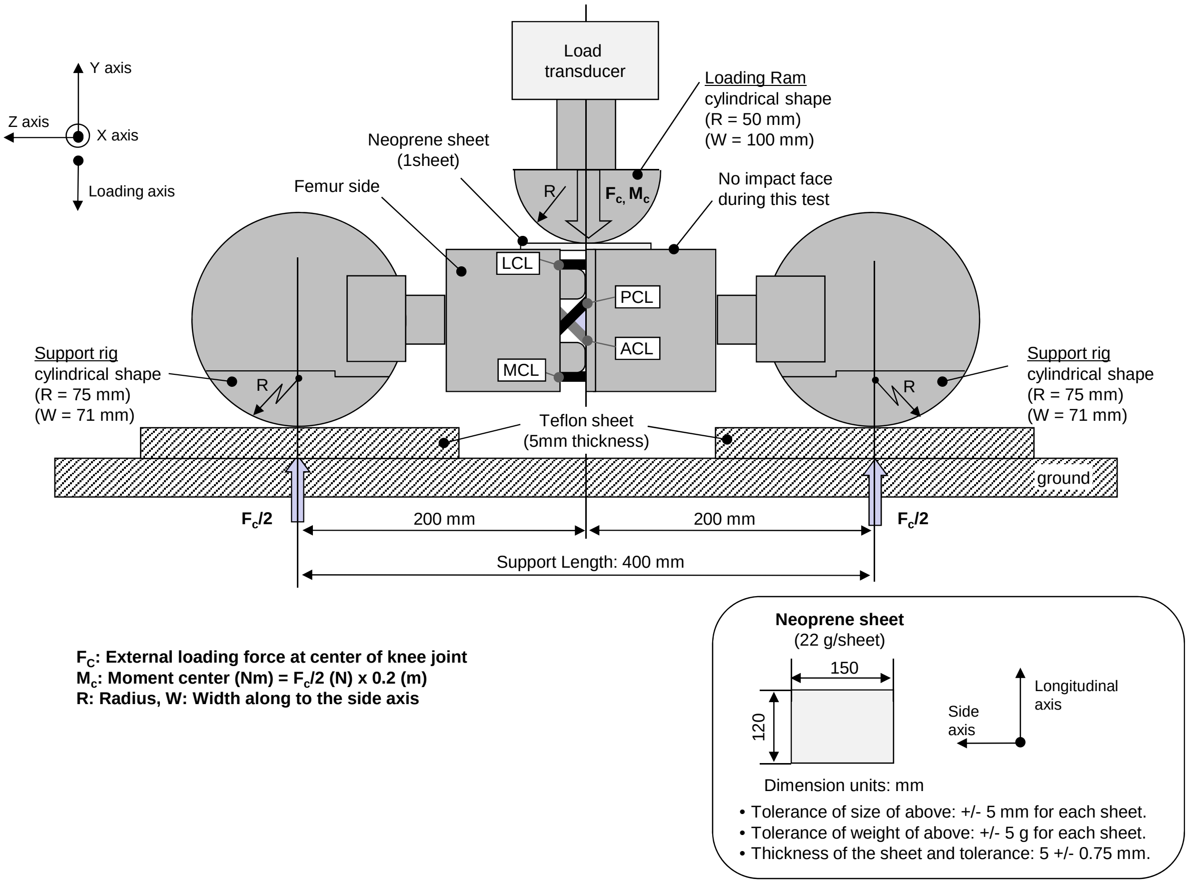


Figure 26 Flexible lower legform impactor test set-up for knee joint in static certification test (see paragraph 8.1.1.5.)

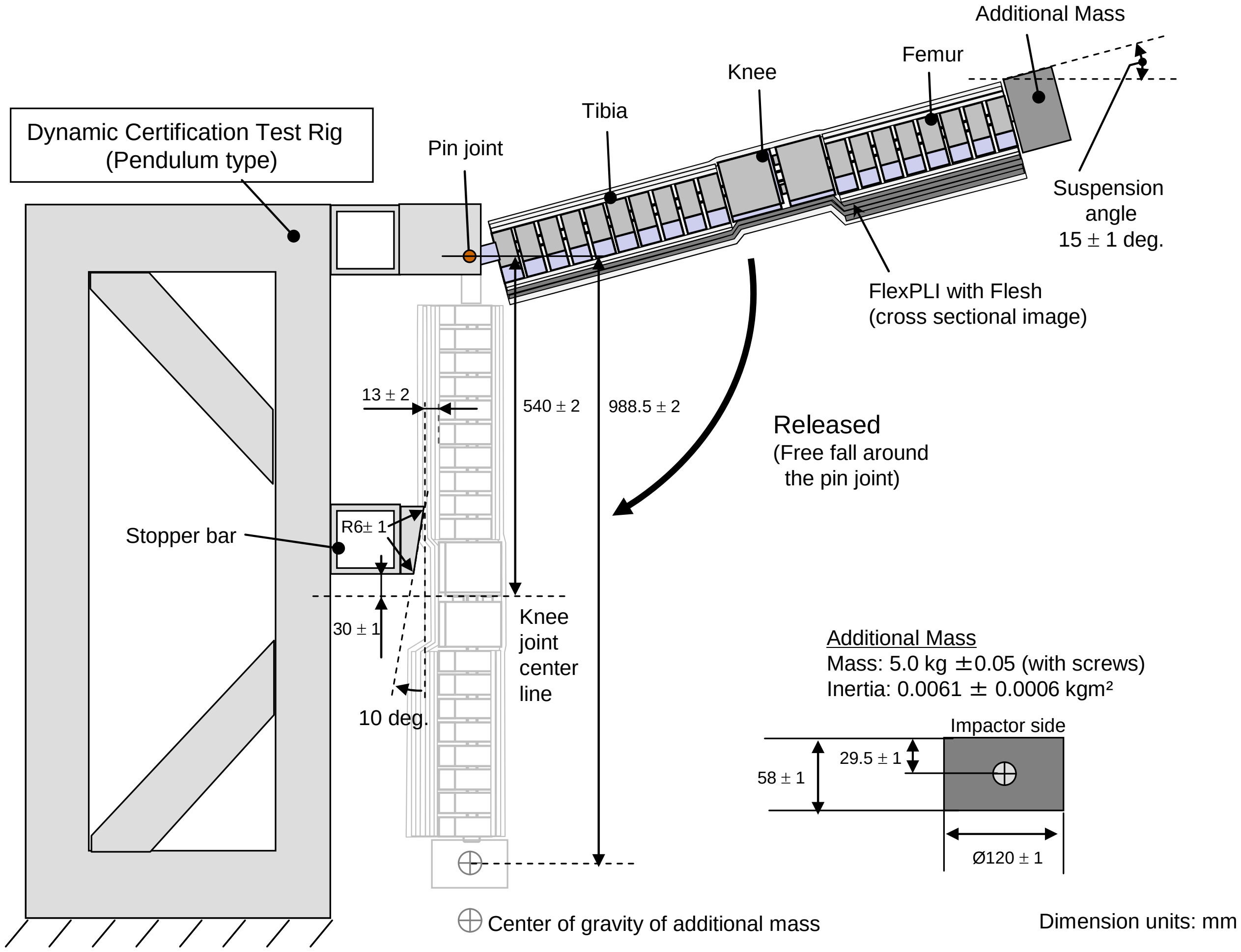


Figure 27 Flexible lower legform impactor test set-up for dynamic lower legform impactor certification test, pendulum type (see paragraph 8.1.2.4.)

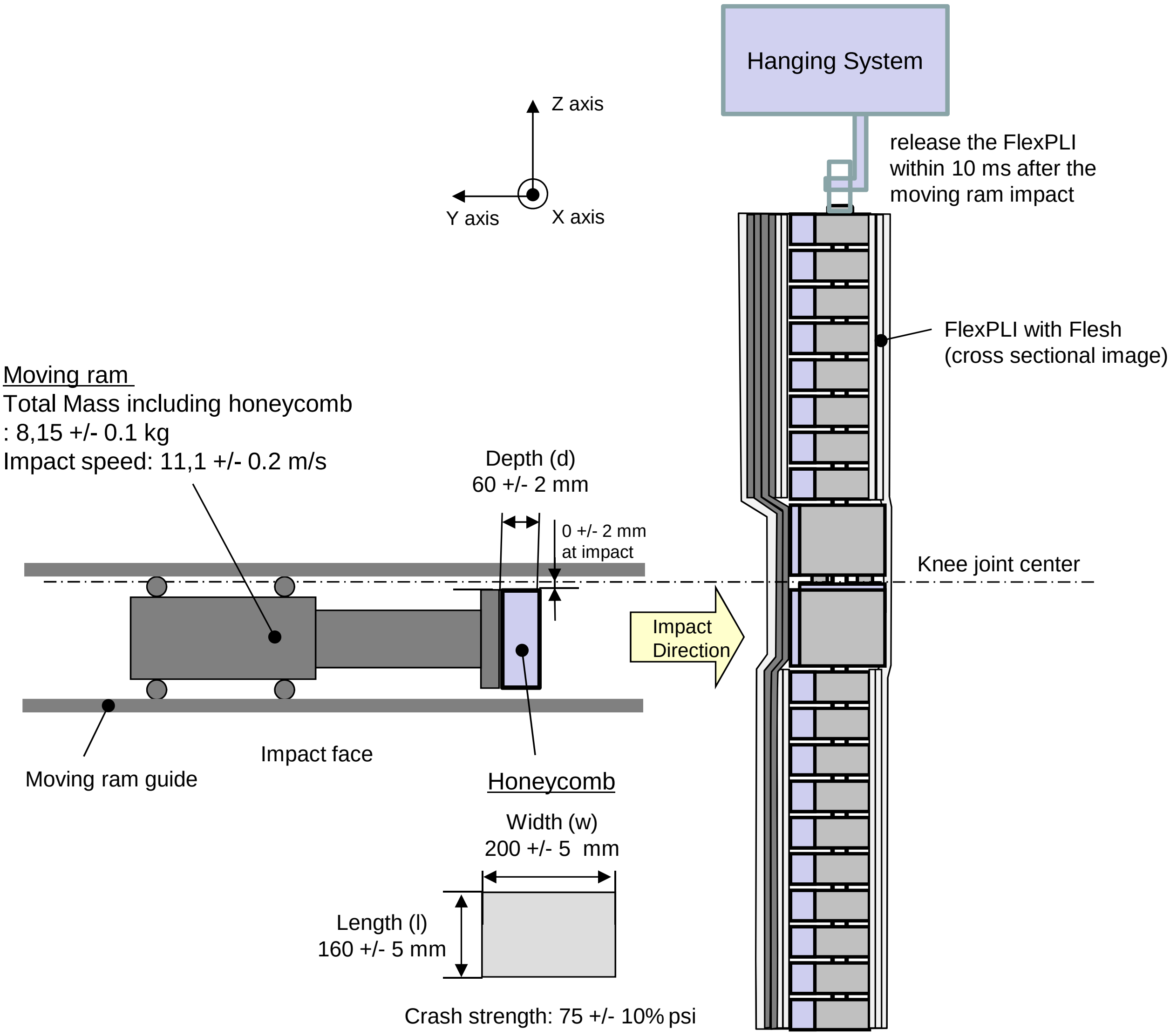


Figure 28 Flexible lower legform impactor test set-up for dynamic lower legform impactor certification test, inverse type (see paragraph 8.1.3.4.)

"

Paragraph 8.2.4.6., amend to read:

"… at a velocity of 7.1 ± 0.1 m/s into the stationary pendulum as shown in Figure ~~24~~**29**."

Paragraph 8.3.3.1., renumber as paragraph 8.4.3.1. and amend to read:

"…impactor shall be suspended from a drop rig as shown in Figure ~~25~~**30**."

Paragraph 8.3.3.3., amend to read:

"… impactor with respect to the vertical as shown in Figure ~~25~~**39**. The suspension of …"

Figures 23 to Figure 25 (former), renumber as Figures 29 to Figures 31.

II. Justification

[Based on the results of the TEG as well as IG GTR9 PH2 activities, the IG GTR9 PH2 proposes the above-mentioned draft amendments to the gtr on pedestrian protection (GTR No. 9)] .

A. Statement of technical rationale and justification

Paragraph 64: new text are added to introduce flexible lower legform impactor (editorial).

Paragraphs 102: new text are added to introduce flexible lower legform impactor (technical).

Paragraph 106: new text are added to introduce flexible lower legform impactor (editorial).

Paragraphs 110, 111, 112, 113: new text are added to introduce flexible lower legform impactor (technical).

Paragraph 114: clarification (editorial).

Paragraphs 115: new text are added to introduce flexible lower legform impactor (technical).

Insert a new section 10: new text to introduce the flexible lower legform impactor to each Contracting Party smoothly.

Section 10 (former): renumbering and new text are added to introduce flexible lower legform impactor (editorial).

B. Text of the regulation

Insert a new Paragraph 3.30.: new definitions were inserted to introduce the flexible lower legform impactor (editorial)

Paragraph 5.1.1.: replaced by flexible lower legform impactor requirements.

Paragraph 6.3.1.1. to 6.3.1.1.7.2: replaced by flexible lower legform impactor requirements.

Delete Figures 12 : delete figure for EEVC lower legform impactor.

Insert new Figures 12 to 16 : insert figures for flexible lower legform impactor.

Paragraph 6.3.1.2. to 6.3.2.2.1 and Figure 15 (former): renumbering (editorial).

Figure 16 (former): renumbering (editorial).

Paragraph 7.1.1. to 7.1.1.4.: replaced by flexible lower legform impactor requirements.

Figure 17 (former): renumbering and replaced by flexible lower legform impactor requirements.

Paragraph 8.1. to 8.1.3.4.4.: replaced by flexible lower legform impactor requirements.

Delete Figures 18 to Figure 21 : delete figure for EEVC lower legform impactor.

Insert new Figures 22 to 28 : insert figures for flexible lower legform impactor.

Paragraph 8.2.4.6. to 8.3.3.3: renumbering (editorial).

Figure 23 to Figure 25 (former): renumbering (editorial).