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Item 8.8 of the provisional agenda

**Other business – Harmonization of side impact dummies  
in the framework of the 1958 and 1998 Agreements**

### **Second progress report of the informal group on harmonized WorldSID dummies**

#### **Submitted by the representative of United States of America\***

This document contains the first progress report of the informal group on the development of the 50<sup>th</sup> percentile male and 5<sup>th</sup> percentile female WorldSID dummies. This document is based on the text of Informal document WP.29-153-08 distributed during the 153<sup>rd</sup> session of WP.29 (ECE/TRANS/WP.29/1089, para. 113). It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and the Executive Committee (AC.3) of the 1998 Agreement for consideration.

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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. Introduction**

1. During the 126<sup>th</sup> session of WP.29 of March 2002, the Executive Committee of the 1998 Agreement adopted a programme of work, which includes the exchange of information on side impact issues. At the 148<sup>th</sup> session of WP.29 of June 2009, the importance of harmonizing test tools was discussed and there was general agreement to explore opportunities to complete the development of the world side impact dummy (WorldSID) 50<sup>th</sup> percentile male and 5<sup>th</sup> percentile female side impact dummies. The United States of America hosted a meeting in November 2009 to discuss the status of the dummies and develop a task list and tentative timeline. At the 149<sup>th</sup> session of WP.29 of November 2009, the representative of the United States of America (USA) submitted in an informal document proposing the establishment of an informal group to focus on the development of the two WorldSID dummies. WP.29 provided verbal approval of this informal group, pending the approval of the formal proposal (ECE/TRANS/WP.29/2010/82). The USA volunteered to lead the group's efforts.

2. The informal group met to discuss the development of the two WorldSID dummies on:

- (a) 5 November 2009, (Washington, D.C., USA)
- (b) 4 February 2010 (Tokyo, Japan);
- (c) 12 April 2010 (Detroit, USA); and
- (d) 23 September 2010 (Berlin, Germany)

3. The Contracting Parties represented on the informal group are Australia, Canada, France, Japan, Korea, Germany, Netherlands, United Kingdom of Great Britain and Northern Ireland (UK), United States of America and the European Commission. Experts from European Association of Automotive Suppliers (CLEPA), International Organization of Motor Vehicle Manufacturers (OICA), and ISO are also participants.

4. The next meeting is scheduled for the week of February 28<sup>th</sup>, 2011 in Brussels.

5. This report summarizes the main issues discussed by the informal group in evaluating the proposal to develop a WorldSID 50<sup>th</sup> percentile male and a WorldSID 5<sup>th</sup> percentile female dummy.

## **II. History and description of the WorldSID dummies**

### **A. WorldSID 50th percentile male**

6. Development of the WorldSID 50<sup>th</sup> percentile male dummy began in June 1997 with a resolution by the International Organization for Standardization (ISO) ISO/TC22/SC12/WG5 to establish a task group. This task group consisted of many government and industry organizations worldwide. Through this collaboration, the group conducted extensive testing and evaluation, and prepared the drawings and users manual. In 2008, the task group finished the biofidelity assessment. They are currently working on risk curves for the injury measures and a practical seating procedure.

7. The WorldSID 50<sup>th</sup> percentile male dummy has a standing height of 1753 mm, seating height of 911 mm, and a mass of 77.3 kg. It has symmetrical response (left/right) and is able to be used in side impacts up to  $\pm 30^\circ$  from the pure lateral impact direction. The dummy biofidelity was evaluated using both the ISO TR9790 method and the Highway

Traffic Safety Administration (NHTSA) Biofidelity Ranking System (BioRank) method. In both cases, the WorldSID dummy was shown to have considerably better biofidelity than the Euro Side Impact Rib Extension dummy (ES-2re). NHTSA's preliminary evaluation of the dummy's durability, repeatability, and reproducibility indicate that the dummy appears to be suitable for regulatory testing.

## **B. WorldSID 5th percentile female**

8. The development of the WorldSID 5<sup>th</sup> percentile female dummy began in 2004 and was coordinated under the Advanced Protection Systems project (APROSYS). This group was a consortium of 51 partners, including automobile manufacturers, suppliers, research organizations, and universities, and led by the Nederlands Instituut voor Toegepaste Geowetenschappen (TNO). This group developed a working prototype of the dummy and conducted biofidelity, reproducibility, repeatability tests, and preliminary injury criteria. The group effort was completed in March 2009. Additional durability and component and system testing will be necessary.

9. The WorldSID 5th female dummy was designed to the anthropometric specifications defined in a study conducted for NHTSA and has a total weight of 48.3 kg. The biofidelity responses of the dummy female dummy were scaled from the WorldSID 50<sup>th</sup> male dummy. In biofidelity testing conducted by APROSYS, the WorldSID 5<sup>th</sup> female was found to have a similar biofidelity rating to that of the WorldSID male and superior biofidelity when compared to the Side Impact Dummy IIs (SID-IIs). A series of tests conducted on three dummies showed the results to be repeatable and reproducible. Additional pole tests conducted suggest the dummy is suitably robust.

## **C. Status of research on WorldSID dummies**

### **1. NHTSA**

10. NHTSA has extensively tested the WorldSID 50<sup>th</sup> percentile male dummy for durability, repeatability, reproducibility and biofidelity. NHTSA concluded that WorldSID 50<sup>th</sup> percentile male dummy has better biofidelity than the ES-2re dummy and is continuing its testing of the WorldSID 50<sup>th</sup> percentile male dummy in full vehicle crash tests. NHTSA has published its analysis of WorldSID 50<sup>th</sup> at Enhanced Vehicle Safety 2009 and other venues. NHTSA is conducting the final review of the drawings and plans to complete the full evaluation of this dummy by mid 2011.

11. NHTSA has received two WorldSID 5<sup>th</sup> percentile female dummies in April 2010, one of which has the updated legs. NHTSA has begun a full evaluation of the dummy per NHTSA standard protocol. Humanetics has provided the 5<sup>th</sup> percentile female dummy drawing package to NHTSA for a confidential review. With regard to public accessibility of the drawing of the 5<sup>th</sup> percentile female dummy, NHTSA is in discussions with Humanetics at this time and hopes to resolve the problem soon. The evaluation of the 5<sup>th</sup> female WorldSID is expected to continue until the 3<sup>rd</sup> quarter of 2013.

### **2. Transport Canada**

12. Transport Canada is currently focusing on several WorldSID activities which include evaluation of multi-point sensing techniques (e.g., Ribeye), onboard data acquisition, and finalization of the seating procedure (with ISO).

13. Additionally they are conducting crash testing and biofidelity assessment of the WorldSID 5<sup>th</sup> female dummy. Canada is working with Humanetics to update their two 5<sup>th</sup>

female dummies. One will have the old legs; the other will have the revised legs. It will take several months to evaluate the test data before the results can be reported.

### **3. Ford**

14. Ford has an early version of the WorldSID 5<sup>th</sup> percentile female dummy, but has no budget at this time to update it.

### **4. General Motors (USA)**

15. General Motors (GM) has purchased a 5<sup>th</sup> Female dummy and expects delivery by the end of 2011. They also announced that the Occupant Safety Research Partnership (OSRP) is developing a collaborative plan to start evaluating repeatability and reproducibility of the WorldSID 5<sup>th</sup>.

### **5. Humanetics**

16. Humanetics has two fully updated WorldSID 5<sup>th</sup> percentile female dummies. A two-dimensional Infra-Red Telescoping Rod for the Assessment of Chest Compression (2D IR-TRACC) is now available for this dummy and a rib ballast clamp has been developed. There has been a lower leg update which is called the replacement leg. There was discussion about the various incarnations of the dummy and it was agreed that there was an original dummy, a revised dummy also called Phase II and now a replacement leg. The APROSYS work was done with both the original and revised dummies. The current build level of the 5<sup>th</sup> female is "C".

17. At the second WorldSID meeting in Tokyo, there was discussion concerning the difficulty in adjusting the feet of the 50<sup>th</sup> percentile male dummy. A preliminary design for the 50<sup>th</sup> ankle has been developed. This presentation discusses options for using a scaled version of the 50<sup>th</sup> ankle for the design of the 5<sup>th</sup> percentile female ankle. Neither the 50<sup>th</sup> percentile male or 5<sup>th</sup> percentile female ankle has been evaluated against biofidelity corridors. FTSS is open to comment and suggestions on these proposed modifications.

18. At the 4<sup>th</sup> WorldSID meeting in Berlin, it was noted that the WorldSID 50th and WorldSID 5<sup>th</sup> differ in shoulder design. There were questions concerning the differences. Some experts of the informal group preferred the same design in both dummies, but further analysis is needed on the new design. Humanetics believes there is no major change in biofidelity.

### **6. Autoliv**

19. Autoliv presented the results of testing with the WorldSID 5<sup>th</sup> and 50<sup>th</sup>. Tests were used to assess side impact airbags and included Car-to-Car/SUV, high severity Mobile Deformable Barrier (MDB), EuroNCAP MDB, and EuroNCAP pole tests. Autoliv used their own WorldSID 50th dummy and borrowed a WorldSID 5th female (Level B) from Humanetics. Both dummies had the 2D-IRTACC installed to assess thorax displacement and rotation. The injury risk curves used for the WorldSID 5th were those developed in the APROSYS project. The seating for the WorldSID 5th and the SID-IIs were matched to the H-points. Based on this testing, Autoliv concluded that the WorldSID 5th and 50th dummies appear to be a good tool. The 50th dummy showed better spine flexibility than the ES-2re. The dummies were also more sensitive to different airbag concepts than the ES-2. The dummies also responded well in low and high severity crashes. Autoliv is also working with the University of Virginia to examine rib rotation and shoulder kinematics of the WorldSID 50th and will compare results with an earlier cadaver study.

## **7. European Enhanced Vehicle-safety Committee (EEVC)**

20. The WorldSID 50<sup>th</sup> percentile male dummy was extensively tested by European Enhanced Vehicle-safety Committee (EEVC) Working Group 12 (WG12). They concluded that the 50<sup>th</sup> percentile male dummy had better biofidelity than the ES-2 dummy and that the design requirements were fulfilled. There is some concern over the IR-TRACC deflection measurement method and also the WorldSID 50<sup>th</sup> is smaller than the ES-2 dummy depending on the seating position used. WG12 would like to review NHTSA WorldSID test data when available, help in the analysis of injury risk curves and set up a test program to continue evaluation based on previous information.

21. At the recent Steering Committee meeting of EEVC, there was discussion of research focused on the WorldSID 5<sup>th</sup> female, but there are no firm programs in place.

## **8. European Commission**

22. The APROSYS project was funded by the European Commission and its mission focused on the development and assessment of the WorldSID 5<sup>th</sup> female dummy. The dummy showed good biofidelity, repeatability, and reproducibility, although only a few dummies are available at this time for testing. Preliminary risk curves were developed but more test data is required to gain confidence in the data. Some crash reconstructions were performed with the dummy and it performed well while sustaining little damage from the severe tests. The EEVC recommends a coordinated evaluation programme for the dummy to address the issues raised in the development. EEVC has prepared a status report on all the information relative to testing of this dummy.

23. The European Commission is planning on funding a project to aid with the WorldSID research efforts. Specific details on the research programme on are not yet available.

## **9. International Organization for Standardization**

24. ISO WorldSID group is conducting their biofidelity rating process based on the results from the APROSYS 5<sup>th</sup> evaluation project. The existing tests included in the biofidelity study as specified in the ISO 9790 procedure were reviewed and it was noted that some are being deleted and others are being added. For the WorldSID 5<sup>th</sup> percentile female dummy, it was noted that the drop tests have not been done, because a testing organization has not yet been identified to conduct the testing. Additionally for impactor tests, the WorldSID seat should not be used and the dummy should be seated upright. Also, it was noted that the spherical impactor face should be used for pelvis tests. It is not clear which version of the dummy was used for the neck testing in the APROSYS tests. For sled testing, no foam supports should be used because they affect the dummy response as compared to the post mortem human subjects (PMHS) response. It was suggested that the prototype WorldSID 5<sup>th</sup> should not be used for either biofidelity or injury risk curve development. It is expected that the new ISO 9790 tests should be completed soon, but an exact date could not be specified.

25. There was a question on whether oblique tests would be conducted and it was noted that currently there are no oblique thoracic tests in the ISO procedure. It was agreed that this was important, but ISO 9790 requirements should be the priority.

26. It was recommended that there be detailed descriptions of the test conditions that are being performed such that others can be sure of what exactly is being measured so that there is no confusion or uncertainty with the results. Similarly, the data processing should be clearly described. It was stated that the collaboration on the WorldSID 50<sup>th</sup> percentile male dummy under the auspices of the ISO WorldSID Group, has been excellent and that it should be the model for the 5<sup>th</sup> evaluation. This statement met with general agreement.

**10. Japan Automobile Manufacturers Association, Inc.**

28. Japan Automobile Manufacturers Association, Inc. (JAMA) conducted an evaluation of the WorldSID 50<sup>th</sup> percentile male and the 5<sup>th</sup> female dummies. This work was completed in 2008-2009 and included shoulder and thoracic impact data. The results were quite good. Results from one Federal Motor Vehicle Safety standard (FMVSS) 214-type full-scale test were also presented. Some differences were noted between the WorldSID 5<sup>th</sup> and SID IIs response in the test, however the WorldSID 5<sup>th</sup> was judged to be quite good as compared to the SID IIs. It was indicated that the dummies were equipped with 1D IRTRACC versus 2D. JAMA will have further discussions on whether they will be able to conduct more testing using the 5th female, if one becomes available.

**11. Australia**

29. Halfway through 2010, Australia conducted a series of side impact pole tests using WorldSID 50th dummies in the front outboard seating positions. Six tests were conducted at 32 km/h, some tests were a perpendicular pole test, and the others were an oblique pole test. Both dummies were borrowed from Transport Canada. The driver dummy was instrumented with Ribeye and the front passenger dummy was instrumented with an IRTRACC in the thorax. The dummy was seated using the draft 5.2 WorldSID procedure, which seemed straightforward. The dummy was durable. There were some problems, but they were easily resolved.

30. An analysis of the Rib eye response showed the peak thorax and abdomen rib deflections were predominantly lateral in both oblique tests; there was very little movement in the vertical direction. The Ribeye lateral result matched the theoretical IRTRACC results. There was some loss of data at the higher deflections.

31. Further analysis and discussion will be presented at the November 2010 Pole GTR meeting in Bonn, Germany.

**D. Discussion of Work**

32. The informal group has developed a list of tasks the need to be completed for each dummy and an estimated schedule for completion (see Table 1).

**1. Drawings**

33. The ISO WorldSID group has indicated that they will modify then the drawings of the 50<sup>th</sup> percentile male dummy accordingly in collaboration with NHTSA to exclude vendor names, part numbers or product specific descriptions included. Until the on-board data acquisition specification effort is complete, the drawings cannot be finalized.

34. During the discussions, it was requested that the drawing package for both dummies would be in three dimensions. It was indicated this would be a desirable development for dummy drawings. The question was discussed with no conclusion.

**2. User's manual**

35. There are several versions of the WorldSID 50<sup>th</sup> percentile male dummy manual: ISO, WorldSID task group, and NHTSA. ISO was tasked to draft a manual in ISO format. Revision 1 of this manual is expected to be completed in the next couple of months. While the ISO manual is expensive, the manual developed by the WorldSID task group is free. Additionally, NHTSA is finalizing its Procedures for Assembly, Disassembly, and Inspection (PADI) manual. At this time there is no problem having the three manuals, as long as there are no contradictions, but the group will need to review various versions and decide on submission of a final package to WP.29.

### 3. Onboard data acquisition system

36. A need has been identified to allow for the use of an onboard data acquisition system (DAS) in both the 50<sup>th</sup> percentile male and 5<sup>th</sup> percentile female dummies. An ISO WorldSID meeting was held in the fall of 2009, in which an approach to resolving this issue was developed in collaboration with NHTSA personnel. Areas within the dummy envelope will be identified as "gray space" where data acquisition components can be located. These spaces will be similar to existing space used by the DAS components, but will be enlarged to the extent possible. Any data acquisition supplier can utilize this gray space for their equipment, but they cannot change the regional and overall mass properties of the dummy more than a given tolerance. That tolerance will be determined through an analytical modeling effort.

37. NHTSA and the Partnership for Dummy Technology and Biomechanics (PDB) have been communicating on how to go forward with a simulation effort. PDB has committed to supporting the project and held an internal PDB meeting to discuss how they would support. NHTSA, PDB, and ISO needed to discuss how to finalize the effort. Humanetics has a Finite Element (FE) model for the 5<sup>th</sup> female, but it needs to be upgraded. A model of a 50<sup>th</sup> percentile male dummy has been in existence for some time. This discussion continues.

### 4. Seating procedure

38. The ISO group is continuing work to develop seating procedures for the 50<sup>th</sup> percentile male dummy in the front seat. They are having problems resolving differences in how to address seat back height and seat back angle. The group is currently incorporating new data and plan to provide an update on the efforts in February 2011. Once the issues are resolved, the ISO group will start the development of rear seat seating procedures for the 50<sup>th</sup> percentile male dummy and then start the seating procedures for the 5<sup>th</sup> percentile female dummy. It was brought up that a fundamental question is whether the seating position should be the most frequently observed or the one with the most injury risk.

### 5. Advanced instrumentation

39. There are some concerns about the one dimension (1D) IRTRACC's ability to measure deflection in the chest and the durability of the device. Humanetics now recommends using the 2D IRTRACC. In a study conducted by TRL for the EEVC, oblique and offset pendulum impacts were used to compare deflection results from the Ribeye with those of the 1-D and 2-D IRTRACC. The Ribeye uses 3 LEDs to measure deflection in the x-, y-, and z- directions, at 3 points on the ribs. The 1-D IRTRACC measures deflection in the y-direction and the 2-D IRTRACC measures deflections in the x- and y-directions. There were some issues with durability of the Ribeye system with regard to the communication of the data between the dummy and computer. Overall, the Ribeye instrumentation worked well. In comparison, it was found that the 1D-IRTRACC seemed to underestimate the rib deflection, especially in oblique loads. The lateral movement measured with the 2D\_IRTRACC was similar to the movement measured with Ribeye. There was only a small amount of movement in the z-direction measured. Similar results were found in the testing conducted by Australia. The benefit of using the Ribeye system over the IRTRACC will depend on the evaluation criteria chosen.

40. NHTSA stated that they plan to conduct research with the 2D IRTRACC in the 5<sup>th</sup> percentile female dummy.

41. Transport Canada has also been conducting testing with the RibEye deflection measurement system. This testing has produced a lot of data that needs to be analyzed. The Medical College of Wisconsin has offered to assist in the data analysis. Additionally,

they may be able to do some sled testing to compare the RibEye and the ITRACC measurement devices.

**6. Data Repository for WorldSID 5<sup>th</sup> female data**

42. The ISO group will verify that they can use the WorldSID 50<sup>th</sup> percentile dummy archive website to store data from the WorldSID 5<sup>th</sup> percentile dummy. Dynamic Research Inc. can provide a simple data archive resource for the group, but there will still be a need for some sort of data review to ensure the quality of the information. This discussion continues.

**7. Certification procedures for 5<sup>th</sup> female**

43. Humanetics has a 5<sup>th</sup> percentile female dummy User's Manual that they can provide to the group. This can be used as a starting point. The group will need to define a set of test procedures to ensure repeatability among labs. Before NHTSA begins the evaluation of its two 5<sup>th</sup> percentile female dummies, it will host a meeting to develop/define the reproducibility and repeatability procedures.

*(a) Injury risk curves*

44. The ISO group is continuing to work on developing injury risk curves and the work seems to be going quickly. Preliminary 50<sup>th</sup> percentile male dummy risk curves were published at the 2009 Stapp Conference and the ISO group is working on determining which curves best represent the data used. They also indicate that they will be starting the 5<sup>th</sup> percentile female dummy risk curve analysis using scaling techniques. ISO plans to provide a summary of the test configurations in which 5<sup>th</sup> percentile female dummy and PMHS data is still needed. An excel spreadsheet will be distributed with proposed tests. European Car Manufacturers Association (ACEA) has committed to begin funding this research in this area starting at the end of 2010.



## E. Documents

- WS-1-1 - (WORLD SID) NHTSA International Dummy Meeting Washington DC November 5, 2009
- WS-1-2 - (NHTSA) Development of Dummy-Based Rotational Brain Injury Criterion
- WS-1-3 - (NHTSA) Status of WorldSID 50th Male and 5th Female ATDs
- WS-1-4 - (NHTSA) The Federalization Process USA requirements for objective dummy
- WS-1-5 - (NHTSA) Injury Risk Curves for WorldSID specification
- WS-1-6 - TASK Definitions 50th WorldSID
- WS-1-7 - (EEVC) EEVC WG12 WorldSid presentation
- WS-2-1 - (NHTSA) Status of WorldSID 50th Male and 5th Female ATDs
- WS-2-2 - (First technology) WorldSID 50th and 5th Update
- WS-2-3 - Biofidelity Tests for WorldSID 5th Female
- WS-2-4 - (JAMA/JARI) Evaluation Tests of The WorldSID 5th th Dummy
- WS-2-5 - Schedule of WorldSID Informal Working Group Proposal submitted to GRSP November 2009
- WS-2-6 - Injury Risk Curves for WorldSID 50th Male
- WS-2-7 - Draft Summary Report – WorldSID Dummy 2nd Meeting JASIC Offices, Tokyo, Japan, 4 February, 2010
- WS-3-1 - Draft agenda 3rd meeting
- WS-3-2 - Typical Components of NHTSA Durability Evaluation
- WS-3-3 - (First technology) WorldSID 5th Female Ankle Design Review
- WS-3-4 - Draft Summary Report 3rd meeting
- WS-4-1 - Draft agenda of the meeting
- WS-4-2 - (NHTSA) WorldSID 5th Evaluation
- WS-4-3 - (HUMANETICS) WorldSID small female SBL C
- WS-4-4 - (HUMANETICS) Update on 2D-IR-Tracc for WorldSID 50M
- WS-4-5 - (Autoliv) WorldSID tests Autoliv Research
- WS-4-6 - (Australia) Update: Recent Australian Pole Side Impact Tests with WorldSID 50th Thomas
- WS-4-7 - (EEVC/TRL) World SID evaluation
- WS-4-8 - (PDB) WorldSID 50th Positioning Procedure
- WS-4-9 - (Worldsid) WorldSID 50th ISO Documentation
- WS-4-10 - (UMTRI) Summary of UMTRI World SID Testing

Table 1

Research Items	V- Research ongoing/planned V(Comp)- Research completed	Schedule of WorldSID Informal Working Group																		
		Year																		
		'09		'10			'11			'12+ (Tentative)*		'13+ (Tentative)*								
		11 (146)	2 (147)	3 (148)	6 (149)	7 (150)	9 (151)	10 (152)	11 (153)	12 (154)	1 (155)	2 (156)	3 (157)	4 (158)	5 (159)	6 (160)				
		Task Def #1 (US)	Task Def #2 (JP)	Task Def #3 (K)	Task Def #4 (C)	Task Def #5 (UK)	Task Def #6 (FR)	Task Def #7 (DE)	Task Def #8 (IT)	Task Def #9 (ES)	Task Def #10 (NL)	Task Def #11 (SE)	Task Def #12 (DK)	Task Def #13 (FI)	Task Def #14 (NO)	Task Def #15 (S)				
WorldSID Dummy Devel. Process	Drawing package (2D and 3D) Certification procedures Bioidentity Repeatability & Reproducibility Generate User's Manual On board data acquisition standard Seating Procedure (front and rear) Advanced Instrumentation Set up Data Repository Acquire dummies Drawing package (2D and 3D) Inspection Certification procedures Durability and other testing Bioidentity Repeatability & Reproducibility Generate User's Manual On board data acquisition standard Injury Risk Functions and AARVs Project Management Effects on reduction of injury and cost effectiveness evaluation	Japan	EEVC	NHTSA (US)	Korea	OICA (FDB)	Dummy supplier													

\* These findings should be considered as indicative at this moment  
The delivery of regulatory proposals will be dependent upon the completion of a collaborative programme to validate the test tools and protocols  
The informal group will regularly report progress to WP29/GRSIP and agree a delivery timeline by 2012