DRAFT MINUTES
4TH GTR-7 REAR IMPACT MEETING, BERLIN
SEPTEMBER, 2010

1 Approval of the Agenda

The agenda (GTR7-04-01) was approved.

2 Minutes of the Last Meeting

The minutes (GTR7-03-01) were approved with two minor changes.

It was agreed that the actions would be covered under the relevant agenda items.

3 HR Height

3.1 Measurement of (Effective) Height

Presentation from Mr Ammerlaan, NL (GTR7-04-02)

Mr Ammerlaan gave an overview of the background to the work, from documents GTR7-02-015 and GTR7-01-03, and noted that OICA had commented that a more detailed definition of the HRMD position for different occupant heights was needed.

As a result, the NL contracted TNO Human Factors to investigate the head position for NL 5th to 95th percentile male, using DELMIA software v5.19. The DELMIA model was positioned at the H-point, and the body weight, length, sitting height, menton-to-top-of-head were adjusted to represent different percentiles of occupant (with a backset angle of 25°; slumped position based on UMTRI; level head).

It was found that the 95th NL male will be 39 mm more rearward and 94 mm higher than the HRMD position. It was noted that this did not include spine straightening and ramping up in a dynamic impact, which should be included.

Mr Ammerlaan concluded that this potentially makes the NL proposed height measurement method (with the rods) complicated, but the NL is reviewing an adaptation to the method that should make this simpler.

Dr Ono noted that ramping up figures are available for standard car seats, and could provide some figures on this. Ramping up is usually not as large in a standard car seat as in a rigid lab seat.

OICA commented that the idea to use just 50th and 95th positions, rather than the whole range of positions, seemed like an improvement and that they would review this in detail. **Action OICA** to review the updated proposal from the NL.

Mr Petit remarked that there was a need to understand the validation of the DELMIA model for this application.

Mr Asada asked if it is feasible to work with a contact surface? Mr Ammerlaan replied that the NL is still reviewing how to couple backset to the important concept of a contact surface. Mr Asada asked when a validated proposal will be available? Mr Ammerlaan replied that the NL is working on this, but to get a robust assessment and procedure it is necessary to have assessment at other labs to ensure that the written procedure is well

understood. **Action OICA** to trial the procedure when a new draft is available. **Action NL to** review the effect of the method on HR height cf. Reg17, and backset cf. GTR-7.

OICA noted that the accident basis for this is now somewhat dated, and it would be useful to demonstrate a need for the 95th measurement height in recent vehicle models.

Mrs Meyerson remarked that it is very important to couple the benefits to the measurement technique. Heights were referenced to the H-point, with the assumption that the R-point is the same. This assumption may be adequate for simple seats with limited adjustment, but may not be sufficient for more complex, highly adjustable seats. The US is looking at this – in the field, occupant may adjust the seat pan up considerably (independently of the seat back), which will affect the effectiveness of a given head restraint height. It may be possible to do something similar to the different H-point and R-point based limits in GTR-7.

Mr Ammerlaan reiterated that the dynamic test only ensures protection for smaller occupants, and it is important that the geometric test extends the protection to taller occupants.

Mr Frost summarised the discussion: there appear to be two steps: 1) agree what to measure; 2) agree how to measure it. **Action NL and OICA** to discuss how to collaborate on this and establish whether there can be a common understanding on what to measure (Step 1).

4 Sled Pulse, Evaluation Criteria

4.1 Phase 2 Dynamic Evaluation Condition and Criteria Proposal

Presentation from Mr Asada, Japan (GTR7-04-03)

Based on the Terms of Reference approved in ECE/TRANS/WP.29/2009/130, Japan proposed a relationship between GTR-7 and UNECE R17 using a three stage approach:

1. GTR Phase 1 (done). Static backset or dynamic Hybrid III test (delta-*v* 17.3 km/h; rearward head angle), to be selected by the manufacturer.
2. GTR Phase 2 Step 1 – merge with R17. Static backset or BioRID II dynamic evaluation, at manufacturer's choice. Delta-v 16 km/h mid Euro NCAP pulse. Dynamic backset, plus NIC, Fx, Fz, My.
3. GTR Phase 2 Step 2 – as originally proposed. BioRID II dynamic evaluation. Delta-v around 20 km/h. Measurements set to reduce long-term injury.

It was noted that the GTR Phase 1 pulse (17.3 km/h; 10 g) and Phase 2 proposed pulse (16 km/h; 11 *g*) are quite similar. Dynamic backset proposed thresholds were compared with static backset and NIC. Proposed Phase 2 criteria thresholds were compared with JNCAP and Euro NCAP upper and lower performance limits.

Japan proposed to finalise R17 at the May 2011 GRSP.

Mr Hartlieb, noted that Mr Asada mentioned that the GTR-7 Phase 1 pulse did not always activate reactive head restraints and wondered why. He also, wondered what the proposal for triggering active head restraints was (ones that would be triggered by sensors in the vehicle). Mr Asada replied that this was discussed in Phase 1, and it was agreed to have the manufacturer propose a triggering time. Mr Broertjes noted that this is easy to implement, but we may be testing something that would not happen in reality – how do we deal with this? Mr Asada replied that it is common in Type Approval to have manufacturer provide evidence such as this.

Mr Frost noted that the first objective of the Informal Group is to have a single harmonised approach to regulation. Currently GTR-7 is written such that this can be used by a Contracting Party (CP) if they adopt it in national law. Does the Group believe that we should continue with the option for CPs to adopt a local regulation, and what timeline should be proposed to WP.29 for step 2?

Mrs Meyerson noted that the approach was good, but will need to be reviewed. It is possible that the Hybrid III requirement could be replaced by the BioRID requirement if the dummy proves acceptable – this would give a single, harmonised approach. Putting BioRID in with a rotational criterion could be a quicker alternative for 1958 countries. Overall, the approach seems good, but the timeline [proposal to GRSP in May 2011] is optimistic.

Mr Frost agreed that the timeline is extremely optimistic. If the proposal from Japan is to move along with the Reg17 proposal, *including* injury criteria, this seems even more difficult. The original proposal from EEVC was for a simple dynamic backset measure to control head restraint position (equivalent to the Hybrid III test), not to include injury criteria. Mr Frost asked if Japan proposes to add injury criteria to the R17 proposal. Mr Asada answered that this will be done if possible, but Japan is aware that it may not be feasible at this time and would consider just a dynamic backset requirement.

Mr Frost suggested that the content and timing of the Informal Group's activities had to be put to WP29 and that this discussion would take place under item 10.

4.2 Influence of Cervical Vertebral Motion on Occupant-HR Interaction

Presentation from Fusako Sata, JARI (GTR7-04-04)

The presentation was noted to be a more detailed overview of the information presented at IRCOBI the previous week. It was presented that the neck injury mechanism is not clarified yet, but facet joint injury most common clinically, likely to be related to excessive intervertebral deflection. Japan has taken a combined FE modelling and physical testing approach to developing injury criteria for low-speed rear impact:

1. Validation of human FE model at delta-v 16 km/h cf. PMHS tests.
2. Investigation of the relationship between the intervertebral soft tissue strain and occupant motion.

Upper neck Fz, lower neck Fz and lower neck Fx had the best correlation with maximum disc and facet joint strain. Max disk strain occurred at C3/4 – correlated with max disc displacement; max capsule stain occurred at C4/C5 – correlated with facet joint displacement. Rotation was maximum at C5/C6. Max strains occurred at max head engagement with the HR.

It was noted that the best R^2 (displacement vs. WAD level) was 0.39, and that the main limitation of the study were that only one seat model used and accident data was only available for only one vehicle model.

Mr Broertjes asked whether the seats were modelled according to the real-world accident vehicle model. Dr Ono replied that the accident data were from Folksam, so only one seat type was in the accident data. He confirmed that the crash pulse was recorded in the car for each collision.

Dr Donnelly commented that there didn't seem to be any spine straightening in the model (except cervical spine). Dr Ono answered that the spine did straighten a little, but there is not much ramping up with this seat type.

Mr Petit noted that R^2 was less than 0.4 in the best case, and asked if this is this enough for regulation? Dr Ono replied that the 95th percentile confidence limits for the same data are shown in the Stapp 2009 paper and may be more useful than the R^2.

Mr Ridella commented that the approach is similar to that which NHTSA is using with the SIMon head model, and is generally a good approach. However, he was concerned that no dummy being considered will have 2 mm shear, as is shown in the slides for the PMHS. **Action Dr Ono** to compare the biofidelity of the model with the NHTSA PMHS data when it becomes available.

Mr Frost noted that to identify injury criteria (not surrogate measurements) is a significant task for the group and that Japan and the US were leading the way on this issue. **It was agreed that NHTSA will collaborate with JARI** on this, to try and identify an injury criterion in the human, although it should be noted that a dummy criterion would be a further step.

Mr Frost asked if a resolution is likely by the end of 2011. NHTSA and JARI commented that this was the plan.

4.3 Sled Testing R&R

Presentation from Mr Hartlieb, PDB (GTR7-04-05)

Mr Hartlieb gave an overview of PDB's experience with BioRID II over the last five years of testing. The focus was on the dummy, with consideration of seat and pulse as well. PDB have investigated the potential causes of the variances observed in their testing with 8 BioRID II, at low, medium and high Euro NCAP pulses, with standard vehicle and hard bucket seats (to minimise seat-to-seat variation). Tests were conducted at two labs, plus certification tests. In total over 200 tests have been conducted.

PDB did not find any one issue that could be identified as the cause of the observed variations. Of the 12 potential injury criteria examined in the study, 5 had a CV<10%; 3 had a CV ~11%; 4 had a CV >>10%. Generally:

- Accelerations had a CV of 5-10%
- NIC had a CV of ~8%
- Forces and moments 9-37% (upper neck My up to 46.7% during head contact)
- Dynamic backset had a CV < 10% (It was noted that this was measured the same way for all tests and Euro NCAP identified issues if measuring different ways (e.g. on-board and off-board cameras; different analysis software)

PDB reported a minor influence on R&R from friction (cables, head contact switch, neck bolts) and no influence from the stiffness of the pelvis flesh.

Mr Frost noted that this presentation (from ESV 2009) has been a useful catalyst for the GBUM and TEG work to improve the certification and, if necessary, the dummy.

Dr Ono asked was the hard bucket seat more repeatable than standard seats? Mr Hartieb answered that the repeatability was similar to the standard seats used in PDBs 2007 study. The dummy measures tended to be higher in these tests than standard seats, but repeatability was similar to standard seats. PDB also used the low-severity pulse to ensure that the loading was not too severe.

Mr Frost noted that the tests were performed early 2009 and that two dummies in particular caused the most variation. All the dummies passed the old certification test, but a lot of work has been done since then to improve the certification. He asked whether there had been any investigation as to whether all of these dummies would pass the new certification? Mr Hartlieb replied that this has not been investigated; however, he would expect that the reproducibility would improved with better certification or improved dummy hardware.

Mr Jensen asked were the same four hard seats (including foam) used for all 96 tests? Mr Hartlieb replied yes, but there was no effect on the welds and no permanent

deformation of the foam. Analysis showed no seat effect, but a slight left-to-right effect of the position of the seat on the sled.

4.4 Whiplash Criteria: Repeatability with Different Dummies and Sleds

Presentation from Ms Levallois, Faurecia (GTR7-04-06)

9 tests with BioRID IIg (old certification test), end 2008. Euro NCAP mid pulse. Mid-performing Euro NCAP seats (1.5 points out of 4), serial from one batch. Static backset of 25 mm with HRMD. Two sleds, two dummies. Sled accel +/- 5%. One sled acceleration, one deceleration.

No CV results were given, because there were only three tests at each condition. Instead, the means of each set of three results were compared. Upper neck Fx +/- 11%. For Nkm, Fx variations compensated for My variations to give variation of 11%.

For some parameters, more variation was due to the sled type than the dummy. T1 accel differences identical to sled differences.

Dynamic backset had the largest variation – mostly due to the difference in acceleration and deceleration sleds – one brings the head closer to the HR early on.

Another comparison with two different acceleration sleds planned for later in the year.

Mr Frost asked what work has been done in terms of round-robin testing of sleds to understand the contribution of sled type to BioRID results? Ms Levallois noted that Euro NCAP had performed round-robin testing.

Mr Lorenz commented that it looks like the pulses shown would not meet Euro NCAP requirements – acceleration at T0 was too high. The Euro NCAP labs had more problems with the set-up of the dummy than the type of sled, but the acceleration corridors are very demanding (particularly with a deceleration sled).

Mr Ammerlaan noted that there have been similar experience with acceleration and deceleration sleds for R44 CRS and R16 Safety Belts. The test speed for both was 50 km/h, but always incorporating rebound. R16 therefore actually 56 km/h; R44 54 km/h. The pulse for acceleration sleds therefore has to be tuned to be comparable. There was a task force on this and the results are in the regulations. Also there are now deceleration sleds without rebound, which would require different tuning. Mr Asada noted that it is difficult to get R16 and 44 pulses with an acceleration sled. For rear impact tests, the dummy's head will move during acceleration of a deceleration sled.

Mr Hartlieb asked if the same H-point machine and staff used? Mrs Levallois replied that one common test engineer was present for all tests.

DH noted that the peak Nkm, Fx were at 110-120 ms, which is after the pulse should reach a nominal zero value – what was pulse variation at this time? Ms Levallois replied that Faurecia did not find much influence of the later part of the sled pulse.

Dr Ono recommended that the boundary conditions – sled type etc. – should be stated for all presentations to the Informal Group. **Action All** to state sled type and pulse in presentations.

5 Bio RID II TEG

5.1 Dummy drawing, PADI status

Presentation from Mr Depinet, Humanetics (GTR7-04-07).

Mr Depinet presented the status of the BioRID II drawing package, PADI and inspection checklists:

The draft drawing package has been submitted to GRSP. **Action Humanetics** to check if the 3D data is there.

PADI – waiting to finalise certification tests to complete updates.

Inspection checklists – both to be included in PADI

- Design verification checklist
- Maintenance checklist

Most of the information already in the manual, but aiming to get a more streamlined presentation to ensure that it is used. Draft available for review today – comments welcome.

It was noted that many dummies in the field are not compliant with *all* items on the two checklists.

Mr Frost noted that it is critical that all tests moving forward use dummies that are fully compliant with these lists, and maybe we need to incorporate this in regulation and he requested that the checklists reference the drawing package. **Action Humanetics**

Mr Asada proposed to have the PADI and checklists on the UNECE website as part of the drawing package. Mr Depinet noted that this is the intention.

5.2 Certification Procedure

Presentation from Mr Depinet, Humanetics (GTR7-04-08). Effect of lateral tilt.

Mr Depinet presented the results of a series of 24 tests examining the effect of head lateral tilt adjustment on BioRID certification test results. The head restraint was adjusted to give 70 mm backset, and the neck adjusted to give -1°, -0.5°, 0° and +0.5° lateral OC plate angle. This was achieved by adjusting the muscle representation tension, which changes the neck shape slightly – which then changes the backset.

Mr Depinet concluded that no clear effect of the adjustments could be seen compared to the overall test variation, but it will probably be necessary to tighten up the levelling procedure.

Dr Hynd asked if all the +0.5 degree tests were done in series, or the test conditions mixed up? Mr Depinet replied that it was a randomised matrix, with tests done in pairs.

It was asked if the OC plate angle drifts in service, or is it consistent once set? Mr Depinet replied that this is not known, because it has not been monitored this precisely before. Mr Schmitt noted that Humanetics do not routinely check the lateral angle when a dummy is returned for certification or maintenance. A lot of users compare the lateral angle to the T1 angle, and can get within 0.2° quite easily.

Presentation from Mr Depinet, Humanetics (GTR7-04-09). Possible sources of dummy-to-dummy variation.

Overview of what has and has not been investigated, and what appears to affect dummy-to-dummy variation.

Presentation from PD, Humanetics (GTR7-04-10): Review and approval of recommended certification tests for BioRID II.

Mr Depinet presented an overview of the current status of the new certification tests (without HR, with HR, jacket test, pelvis flesh test), and proposed that the old certification test be considered obsolete.

Mr Depinet proposed the following certification process

- Run component tests annually – jacket impact, pelvis bottom, pelvis back
- Certify dummy without HR – weight package test first to calibrate sled
- Certify dummy with HR – HR foam tests and weight package test first

The detailed test conditions for each of these test types were presented, along with an overview of the proposed new corridors.

Mr Depinet asked whether the proposed test conditions and corridors can be agreed, and the old certification test made obsolete. It was noted that Humanetics found two dummies recently that pass old test, but fail the new. After maintenance, both dummies pass both old and new certification requirements.

No corridors are available yet for the with-HR test – more tests with more dummies, at multiple labs, are required to develop these. Humanetics are particularly keen to test known outlier dummies. One certification lab is set up in the US, one is about to be ready in Germany, and should be one in Japan in one month if the group wants to use this test. A head restraint foam corridor will be proposed soon.

Mr Frost asked how many people need to contribute to the certification assessment in order to get meaningful results. Mr Depinet replied that data from at least 20-30 dummies would be needed. Mr Frost asked for commitments to contribute to the programme.

- PDB agreed to support the certification activity.
- Ford agreed to support with one dummy, possibly a second.
- GM agreed to contribute with one dummy.
- NHTSA will loan a dummy to Humanetics for testing.
- Japan agreed to participate.
- **Action Ms Levallois** to check the possibility to contribute and to let ASch know.
- **Action Dr Xu Chrysler** to check whether they can participate.

Jacket impact tests. Two of six jackets tested were clearly different from the other four. One pair of these have previously been shown to give different certification results. Up to 18 months ago, all jackets made to the same recipe, but there were differences from batch to batch. 18 months ago batch testing tightened this up. Humanetics will make 10 more jackets in the next month to evaluate how much the jacket spec can be tightened. I.e. the recipe on its own is not sufficient to define the performance of the jacket.

Pelvis flesh test. Can feel the difference in different pelvis fleshes, although the PDB presentation earlier found this was not an issue.

Skull cap switch option. Can this be put in the drawing package as an option, so that people can test it?

Upright spine certification. Could do this on the standard sled with some adaptors, if this work goes ahead.

Propose optional use of new certification tests from 22 September, 2010; required use (old tests obsolete) from 31 December, 2010.

Mr Frost noted that these are very important questions and we have been working to get to the point of making these decisions.

The following questions were raised by Ms Kim by email (teleconferencing was not available on Day 1):

Is there a biofidelity test that the new HR procedure is based on? If not, how do we know what the performance should be, or has a 'good' dummy been picked. Mr Depinet replied that the original certification test was based on some biofidelity tests, but the HR test isn't. However, it has been typical in the past to collect lots of data from dummies that are considered good (and once the community is happy with the biofidelity) and set the certification requirements from this.

Is the jacket test done with or without water in the belly? How is it known that the tested part of the jacket influences the test results? If failure is determined, can this be fixed? Is this a test for the manufacturer only? Mr Depinet showed lots of examples of differences in certification tests that tracked the changes in the jacket, not other parameters, in with-HR and without-HR tests. It was noted that this has not been demonstrated to affect seat tests, though.

If the pelvis flesh fails, how is it fixed? What is the procedure for testing the upper posterior region of the flesh? Mr Depinet answered that they can perform the pelvis test at any location, we just need to agree where – and that the test is really needed.

How was a 1 year certification cycle determined for jacket and pelvis? Why not 3 e.g. months? Mr Depinet replied that one year is proposal, based on experience with the materials. A pelvis can shrink and change shape over several years. We may find we need a different interval, but one year seems a sensible place to start. The first question, though, is whether the test is needed at all.

Can we finalise corridors when we don't know how to fix the dummy if it fails?

Mr Asada recommend the with-HR test, because variation in seat test results is during HR contact. Mr Depinet noted that the without-HR test may be needed to check e.g. the bumpers, and that we may be able to make this a less frequent test in the future, once we get some more experience.

Decision: It was agreed not to include a pelvis flesh test.

Decision: It was agreed that drawings for the skull cap switch could be added to the drawing package on the GRSP web site.

Decision: It was agreed that the skull switch cap should be used in the upcoming certification test programme, with additional tests done with each labs standard set-up to investigate whether the switching affects performance.

Decision: It was agreed that the jacket test would be run by the manufacturer when the jacket is made, and then (provisionally) annually by users to check for aging effects.

It was agreed that lower spine performance should be kept in mind for the future.

There was considerable discussion of the potential benefits and disbenefits of adjusting the head restraint in the with-HR certification test to give a fixed backset.

Action Humanetics to document the without-HR and with-HR certification test procedures, so that they can formally replace the old certification procedure. This is to be finalised at a TEG within the next two weeks so that it can be adopted by this Group as early as possible. The with-HR certification procedure should include a definition of the backset tolerance that is implied by the ±3 mm tolerance on spine shape (not the

±5 mm used by some users) when the spine is assembled, and what to do if the dummy does not meet this tolerance – Adjust the dummy and eliminate the dummy if it can't be adjusted to meet the backset requirement?

It was also noted that this means that the adjustable head restraints will have to be marked such that they can be placed in standard position, and that it will take some time to work out how to do this and to distribute the updated HR amongst the certification labs.

Action Mr Depinet and Mr Lorenz to set a date for the next TEG.

5.3 Durability

Mr Frost noted that the outstanding action were a) for Korea to update on the durability concerns, and b) for all participants to raise any other concerns they may have. There were no updates on either action. Mr Lorenz noted that this was discussed at a recent TEG webex, and it seemed to be an isolated incident related to bonding of the neck bumpers, i.e. it is understood not to be a general problem. Mr Depinet noted that there is now a tool and an item on the checklist to control this.

5.4 Biofidelity

Presentation from Dr Donnelly, NHTSA (GTR7-04-13): Preliminary BioRID II repeatability and biofidelity assessment.

The repeatability and biofidelity tests use a laboratory seat with a yielding seatback (30° rotation, based on a Toyota Camry seat), at 16.7 kph 8.5 *g*; and 24 kph, 10.5 *g*. Both on a HyGe sled. NHTSA are looking at biofidelity at both of these exposures, with each cervical vertebra instrumented to give 6-DoF data, and they will use the Shaw 2006 Stapp approach to biofidelity evaluation. NHTSA are currently using BioRank, but will also look at other biofidelity rating methods such as ORM, CORA etc.

The assessed internal and external biofidelity parameters were presented, based on the dummy tests and the first three of six planned PMHS subjects. It was noted that the PMHS ramped up much more than the dummies, so the head angular displacements are from a somewhat different interaction with the HR.

The external biofidelity was presented. Seat back loads were good for RID^{3D}, best for BioRID, with Hybrid III forces being much too high. Head restraint x-axis loads were much higher for the dummies than the PMHS. The PMHS compressed the top of the head restraint, by overriding it, but the dummies did not ramp up enough to do this.

Dr Donnelly indicated that NHTSA hope to have a full set of PMHS tests by the next meeting.

Mr Depinet asked if both upper and lower neck loads were measured? Dr Donnelly replied that they were for BioRID, but upper neck only for the RID^{3D} and Hybrid III. **Action Humanetics** to check whether the BioRID used fully meets the specification in the build and maintenance checklists?

Mr Petit asked if the position of the HR was adjusted to give the same backset for each subject? Dr Donnelly replied that the dummies were positioned within 1 cm using a FARO arm, and the head restraint was not moved.

Dr Hynd asked whether the 30° degree rotation of the seat back was defined at the low or mid speed and if it had been validated for the other speed? Dr Donnelly replied that it was validated at 24, need to check at 16 – this was added later because it seemed to be a useful contribution the Informal Group. The seat is repeatable at both severities. Dr Hynd noted that the relatively large seatback rotation (cf. typical European seat tests) is a good complement to some of the biofidelity requirements that the EEVC set, which used quite upright, rigid seat backs.

Mr Asada commented that the Hybrid III head angular displacement was quite different to BioRID in the EEVC analysis and wondered why this was not the case in the NHTSA tests? Dr Donnelly confirmed that this was not understood but could be due to the different seat back rotations.

Mr Lorenz noted that the BioRID II repeatability looked very good, as also shown in other studies, and better then the Hybrid III.

Presentation from Dr Donnelly, NHTSA (GTR7-04-14): Compatibility between two rear impact dummies and two rear impact pulses.

Dr Donnelly presented NHTSA's planned test programme to compare the effect of the 202a pulse and Annex 9 pulse (Euro NCAP mid-pulse) - four levels of backset will be used (100, 75, 50, 25 mm); BioRID II and Hybrid III in both pulses. The objective is to determine whether the different combinations of dummy and pulse rate seats similarly. The requirements for FMVSS 202, Euro NCAP whiplash points, and JNCAP points will be used to assess the effect of the pulse.

Testing is complete. Data analysis and reporting should be ready by end November.

Dr Ono noted that there was a recent ESAR paper presenting the effect of different pulse shapes using modelling, which may useful extra information.

Mr Asada noted that NHTSA are using a laboratory seat, which gives a consistent baseline, but e.g. a reactive head restraint may expose other differences.

Action Mr Donnelly to identify the HR height that was used in these tests.

5.5 BioRID II Seating Procedure for Standard Seat

Presentation from Mr Asada, Japan (GTR7-04-15). BioRID II Seating procedure proposal.

It was proposed that the IIWPG procedure (25° torso angle) should be changed to design torso angle, backset tolerance should be reduced from ±5 mm to ±2 mm, and a special case should be made for more upright seats. A comparison of design and actual torso angle for a range of vehicle types was presented, showing that the design angle was similar to the use angle across the range of seats studied.

The results of JNCAP at design torso angle and IIWPG at 25° for the same seats were compared (JNCAP delta-*v* slightly higher). No consistent relationship between the change in torso angle for the two test and backset or NIC was observed. NIC increased for some tests when the design torso angle was more upright than IIWPG. Similar results were observed for upper neck forces and moments.

It was concluded that the seat design was more important than the test torso angle.

Currently, the upright spine option for BioRID works well for some upright seats, but the head cannot be levelled for the most upright seats so it was proposed to postpone the upright option to Phase 2 Step 2. Static testing for upright seats will therefore be necessary for Phase 2 Step 1.

Mrs Meyerson noted that NHTSA will review the new information on the effect of using the design torso angle rather than the fixed angle of 25°. Mr Frost noted that WP.29 have approved considering a more upright seat/BioRID as a second step.

Mr Hartlieb commented that the presentation showed a smaller BioRID backset for more upright torso angles. PDB's experience is that you get a smaller backset with the HRMD, but the backset of the BioRID actually increases. Mr Asada noted that HRMD backset should reduce by approximately 3.5 mm for each 1° reduction in torso angle. BioRID angle also usually reduces from 25-20°, but not always for more upright seats, such as 15° torso angle. This is another reason to consider a more upright version of BioRID for

more upright seats. Mr Hartlieb noted that PDB have started to look at the influence of more upright seat angles. From simulations, NIC seemed to be very sensitive to the torso angle. PDB will perform a small number or tests to validate the simulation work.

Presentation from OICA (GTR7-04-16) on design torso angles in the World fleet.

It was presented that 12% of vehicles have a design torso angle between 10 and 19°, mostly in Japan and some small European vehicles. Most of the upright seats are category 1-1 (73%), with 1% in category 1-2 and 23% in category 2-1. The information was based on sales figures for 2009, including 19.9 million vehicles.

Mr Frost commented that the worldwide data seems support the approach of focussing on standard seats in Step 1, with more upright seats in Step 2. Mr Broertjes agreed and commented that the European Commission wants to have a dynamic option in Step 1 and could consider just static for more upright seats.

Japan noted that their analysis indicated that 45% of vehicles in Japan have a design torso angle less than 20°.

5.6 Seating Procedure for Upright Seats

Not to be considered in detail until Phase 2 Step 2.

6 Timescales and Phases

Mr Frost asked to revisit the timescales that were proposed by Japan yesterday.

Presentation from Mr Asada (GTR7-04-03??)

The Phases as proposed by Japan were defined as:

- Phase 1 – the existing GTR-7, including a BioRID equivalent of the Hybrid III test procedure as an option if adopted in national regulation
- Phase 2 – is the future work that is the responsibility of this Informal Group
    - Step 1 is proposed to have a dynamic backset test, with the option to have a static backset measurement. This would replace the Hybrid III test. It would be aligned with the proposed update to UNECE Regulation 17 (R17-09), *except* that it is proposed to include other dummy measures such as NIC, neck forces and neck moments. To be applied to all vehicles.
    - Step 2 is a mid-to-long term solution for a single dynamic test, including injury criteria focussed on reducing long-term injuries

OICA commented that the Hybrid III test should be retained as an option in Step 1, at least while it is still used e.g. in FMVSS 202a.

7 3-D H Point Machine and HRMD Calibration

Presentation from Dr Lawrence Smythe, SAE HADD Committee (GTR7-04-17). SAE HADD J826 3D CAD H-Point Machine - Comparisons to VDA Model

Dr Lawrence presented an overview of the progress of the SAE HADD committee to develop a CAD model of the SAE J826 3-D H Point Machine (HPM), and to compare the shape of the SAE CAD model with the recent VDA model. SAE have made a surface model from scans of two official SAE/Technosports J826 manikins, noting that Technosports were instructed to prioritise control points from actual manikins over the

original drawings when fabricating the manikin. The SAE model was reported to match the scans within 1 mm in all key areas.

SAE will formally request VDA to share their model so that the SAE HADD committee can evaluate both. However, based on the geometry already available differences have already been identified, particularly at the back-pan.

SAE J286 Recommendations:

- Improvements could be made to Technosports HPM-1 fixtures to improve build accuracy and ease of using the fixture.
- New moulds for seat and back pans could be considered to more accurately reflect the J826 CAD model.

The SAE HADD members will discuss the SAE CAD model, VDA geometry and GTR-7 feedback at a meeting 20 October, 2010. Mid-term work will include defining the surface of the inside of the seat and back-pan model shells, and exploring options for tightening the tolerances for HRMD / HPM head restraint assessment.

Mr Frost noted that one of the issues raised in the GTR-7 group was certification of the HPM – currently this can only be done by returning the tool to the manufacturer, which is not ideal.

Dr Smythe noted that the SAE has been looking at backset measurement, including the method proposed by TNO in the NL.

Mr Asada asked when the SAE CAD mode will l be available? Dr Smythe answered that it will be available after the 20 October meeting of the HADD committee, provided there are no issues raised by the committee. The model will not be an official final release at that time, but will be made available for evaluation.

Mr Hartlieb noted that J826 specifies only the HPM, not HRMD. For head restraint work we need the combined HPM and HRMD and we need a defined common standard for these. Are the SAE working on combining the two? Dr Smyth replied that the HADD committee is aware of the need, and is starting to work on this. The HADD committee would like to discuss this with VDA and the GTR group.

Mr Frost noted that it was mentioned that HPM made before 1989 were not so well controlled – can the user identify whether they have a newer, better controlled HPM? Dr Smythe replied that the user could tell by the build or calibration date sticker on the tool.

Mr Frost asked if the certification specification for the HPM will be defined and freely available? Dr Smythe confirmed that it will be freely available.

Action Dr Smythe to provide an update from the SAE meeting in late October, before the next GTR-7 IG meeting on 6 December.

8 Test Speed – Mid- or High-speed Test

The different pulses for seat assessment tests were discussed.

For the 24 km/h pulse, NHTSA scaled-up the 16 km/h 202a sine-wave pulse; both of these are different in shape from e.g. the Euro NCAP pulses with similar delta-*v*.

Japan proposed a Euro NCAP mid pulse for Phase 2 Step 1, and a 20 km/h delta-*v* pulse as proposed by EEVC for Phase 2 Step 2 for focussing on long-term injury mitigation. Mr Asada noted tests in Japan have found that seat back deformation under 20 km/h is elastic, but tends to become plastic above 20 km/h. This sort of pulse would mean changes to seat back structures. Japan would like to understand what sort of pulse will be focussed on so that they can target their research. **Action Mr Asada** to distribute the

information on the change from elastic to plastic deformation with increase in test delta-*v*.

Dr Hynd clarified the background to the EEVC 20 km/h pulse recommendation which was focussed on long-term injury. There was no consideration of the suitability of the test tool. Mr Lorenz clarified that the majority of injuries are at lower pulse, but they also tend to be less severe injuries – a second, lower-speed pulse would ensure performance of seats for the large number of less severe injuries.

Ms Pietsch asked if it is known whether 20 km/h would still be appropriate with modern seats with good ratings? Dr Hynd noted that the analysis by WG20 was from existing accident data, so covering ten or more years up to the publication of the report in 2007.

Mrs Meyerson asked if seat performance in a 20 km/h pulse is significantly worse than at e.g. 16 km/h. Mr Asada gave an overview of his presentation from the 2nd GTR-7 meeting. 16 to 22 km/h estimated delta-*v* was the group with the highest incidence of long-term injury, so Japan could agree to the 20 km/h proposal. Reproducibility was poor at 20 km/h in the tests previously presented by Japan, which was primarily due to the plastic deformation of the seat at this severity (rather than dummy variability). Mrs Meyerson commented that it appears from this presentation that the seats become unstable because they are not designed for this higher speed. It also appears that there should be a significant increase in benefit for long-term injuries by going to the higher pulse. Mr Asada noted that they cannot comment on dummy variability at higher speeds until they identify a more stable seat to test with.

Ms Levallois commented that seats are usually not unstable even at 24 km/h in Euro NCAP tests, and are ranked almost the same at 16 and 24 km/h – the problem is much greater variability of the measurements at the higher speed.

Mr Meyerson noted that the preliminary data from the NHTSA biofidelity tests, with a repeatable seat, so far show that the dummy is repeatable at the higher speed. Ms Kim commented that dummy durability is more of a problem at the higher severity. Mr Lorenz agreed that plastic deformation is not usual at the Euro NCAP higher pulse (24 km/h delta-*v*), and noted that Euro NCAP also wanted to cover the range of impact severities.

Mr Asada commented that the Europe and Japan 20 km/h proposal was targeted at long-term whiplash injury, but the US mid-pulse (18 km/h) was targeted at AIS 2+ non-whiplash injuries. He asked if the US would be content to focus on long-term whiplash injuries? Mrs Meyerson replied that a test of that severity could be applicable to both; however, it is more important to understand whether 16 and 20 km/h differentiate between seats differently. Mr Lorenz noted that it is important to note whether the AIS 2+ injuries are related to other mechanisms (such as seat back failure) and contact points in the car, that would not be addressed by a whiplash test.

Mr Frost recalled that the Informal Group does not have a mandate for a higher speed test at this time. It seems that the plastic failures seen in the tests from Japan are not common at this loading severity in other regions. Mr Asada noted that they chose old seats to match the accident data; more modern seats should not have the plastic deformation at 20 km/h.

Ms Pietsch cautioned against raising the whiplash test delta-*v* without considering the balance for much more severe injuries, which may be made worse.

9 Summarise each Issue Discussion Result and Next Action

Presentation from Mr Asada, Japan (GTR7-04-18): Head restraint GTR Phase 2 status and open issues.

HR height – see action list

Static backset – Japan proposes to keep the current Phase 1 static option until completing work on an upright dummy option. **Action All** to provide comment on this proposal before the next meeting. Ms Levallois asked if this would apply to rear seats. Mr Asada replied that there is no static backset requirement for rear seats. Mr Ammerlaan noted that the BioRID has the stature of a 7th percentile Dutch male, so a static measurement representing a taller occupant will be needed for all Steps. Mr Depinet commented that the effective stature of the BioRID is rather taller, but it is slouched and can't sit up straight in the way that volunteers can – the spine curvature matches the UMTRI 50th male. Mr Ammerlaan commented that this 20th NL male and US 35th male, so a static test is still required to ensure that the HR can be placed appropriately for taller occupants. Ms Kim remarked that the risk for females is twice that for males, and they tend to be shorter.

Sled pulse – Japan proposed 16 km/h Euro NCAP mid pulse. Mrs Meyerson noted that NHTSA cannot agree to a 16 km/h BioRID test without demonstration of the benefit; it is possible that 1958 parties could adopt this as an option.

It was questioned whether deceleration sleds could meet this pulse definition. Ms Levallois commented that if the corridor specification is tight, deceleration sled results are good. **Action Mr Lorenz** to review whether sled-type makes a difference, provided that the data can be released by Euro NCAP. Mr Frost and Mr Damm noted that we should not exclude a sled type at this time, only if it is demonstrated to be a problem later. [NB: Section 4.4 indicates that the pulse definition has to be somewhat different to ensure equivalence for the two types.] **Action All** to monitor the influence of sled type.

Mr Frost asked to revisit the planning proposed earlier by Japan.

Presentation from Mr Asada (GTR7-04-03)

The Phases as proposed by Japan were defined as:

- *Phase 1 – the existing GTR-7, including a BioRID equivalent of the Hybrid III test procedure as an option if adopted in national regulation*
- *Phase 2 – is the future work that is the responsibility of this Informal Group*
    - *Step 1 is proposed to have a dynamic backset test, with the option to have a static backset measurement. This would replace the Hybrid III test. It would be aligned with the proposed update to UNECE Regulation 17 (R17-09), except that it is proposed to include other dummy measures such as NIC, neck forces and neck moments. To be applied to all vehicles.*
    - *Step 2 is a mid-to-long term solution for a single dynamic test, including injury criteria focussed on reducing long-term injuries*

OICA commented that the Hybrid III test should be retained as an option in Step 1, at least while it is still used e.g. in FMVSS 202a.

Mr Frost observed that the proposal from Japan is to replace the Hybrid III test with a BioRID test including dynamic backset *and* injury indicators; he did not believe that the US would be in a position to accept this at this time. Speaking for UK (rather than as Chair) he raised a concern that the proposal would mean industry would have to respond to a new regulation, which itself could be updated two years later to include new injury assessment regulation. This regulatory instability was unlikely to be acceptable to the UK.

Mr Frost asked for comments from other regulators. Mr Broertjes noted that there is an obligation to propose a test procedure that would allow more innovative solutions from industry, that may be blocked by a static test – which is all that is available in Europe. However, the EC also don't want to see industry burdened with two new regulations in two years. The EC would be content to have a dynamic option.

Mr Ammerlaan commented that GTR-7 has two options for a dynamic test, mainly for reactive head restraints. Option 1 was the Hybrid III test, primarily for the US; Option 2 was the BioRID test, primarily for other regions. However, the experience with the latter test is limited, and limited to Japan and UK. The NL could not accept this proposal at this time.

Mr Damm remarked that while Germany is working to bring BioRID into regulation, it is not yet ready to enter Regulation 17 or GTR-7.

Mr Frost summarised that there is very little support from regulators in the room for the interim adoption of BioRID for a dynamic geometric test in GTR-7. He pointed out that each Contracting Party can adopt such a test in their national or regional regulation under GTR-7.

OICA commented that the BioRID is not yet ready for regulation, so this stepped approach is not appropriate. OICA do not want dummy options: either Hybrid III, or (when it is ready) BioRID, but not both.

Mr Asada noted that Japan will consider the retention of the Hybrid III test in the mid-term, and provide feedback to the Informal Group at the next meeting.

Mr Frost reiterated that the target of the group has always been to agree a single dummy for whiplash protection, and that this target has not changed.

Evaluation indicators – options are dynamic backset, or injury criteria. Some presentations to the Informal Group have highlighted reproducibility problems with the latter. Mr Asada asked all participants to comment on the most appropriate criteria to use in the mid-term.

Mr Frost noted that Japan and the US had agreed to look at criteria, and to complete this work by the end of 2011 when a judgement could be made about how to implement this with BioRID.

Mrs Meyerson noted that NHTSA is currently testing to establish whether Hybrid III head angle and BioRID dynamic geometry are equivalent, but this is only relevant if the regulators are willing to consider an interim regulation. NHTSA will have evaluated the equivalence of the two dummies and pulses for this type of assessment by the end of 2010.

Mr Ammerlaan noted that EEVC WG12 is also looking at suitable injury criteria.

Mr Hartlieb asked what is the level of repeatability and reproducibility of the BioRID measures that would be considered acceptable by the Informal Group. **Action All** to consider the appropriate level of CV and to report at the next meeting. Mr Donnelly noted that the NHTSA view is in Shaw *et al.* (2006 Stapp Conference).

10 Summarise WP29 Reporting

Mr Frost reminded the Informal Group of the ToR in doc 2009-130e, and noted that he was impressed by the effort that was being applied and the progress that had been made. He commented that it is clear that the work should continue, but the likely timescales are less clear. He observed that the interim introduction of dynamic geometric requirements is not generally supported. There seem to be reproducibility problems for some BioRid data channels (which may be addressed with the new certification) – although it was not yet clear which data channels would be used for regulatory assessment. He also noted that the NHTSA-JARI injury criteria work ending end 2011 might give insight into which channels could be used to determine injury risk.

Mr Frost proposed a 24 month timescale. There was considerable discussion regarding the interpretation of the outcome of the last GRSP meeting, particularly with respect to the possibility of providing a kinematic approach to GRSP in May 2011 – whether this is considered desirable by different CPs, and whether it is in the remit of the IG.

Mr Frost noted that WP.29 has instructed the first phase of work is to introduce a low speed test with injury criteria, and that a higher speed test [>18 km/h] and more upright seats would form a second phase of the work. Three options to report to WP.29 were discussed:

1. Develop a single approach that all CPs can adopt
    a. It was agreed that it would be realistic to make a proposal for the last option (full injury assessment test procedure) to GRSP in December 2012, for consideration by WP.29 in June 2013.
    b. It was noted that this is not the preferred option for Japan.
    c. It was noted that this would be strongly supported by the EC.
2. Allow options (Hybrid III *or* BioRID kinematic test), because the US will not be able to replace Hybrid III with BioRID in the timescale
    a. Japan proposed to deliver this option to GRSP May 2011 for consideration by WP.29 in November 2011, and have already prepared a draft text. It was agreed to finalise the timeline for this option outside of this meeting.
    b. And stop work when this is delivered
    c. Does not meet the original objective to deliver injury assessment
3. Allow options (Hybrid III *or* BioRID kinematic test), because the US will not be able to replace Hybrid III with BioRID in the timescale, and stop after this.

a. And proceed to the single option BioRID injury assessment in the subsequent period – which is not favourable to industry because of the rapidly changing requirements

b. It was agreed to finalise the timeline for this option outside of this meeting

It was agreed to take options 1 and 2 above to WP.29 in November, with timescales to be finalised outside of this meeting.

11 Date of Next Meeting

Mr Frost announced that Monday 6 December is available at the UN (Room 15, Palais de Nation, Geneva), which is the day before GRSP. 09:00-17:30. Humanetics offered to provide Webex on that day. A TEG meeting will be called in 2-3 weeks.

12 Actions

Action OICA to review the updated height of head restraints test proposal from the NL, and perform some tests with the procedure when a new draft is available. **Action NL to** review the effect of the method on HR height cf. Reg17, and backset cf. GTR-7.

Action NL and OICA to discuss how to collaborate on the height of head restraints test proposal and establish whether there can be a common understanding on what to measure (Step 1, with Step 2 being *how* to measure it).

Action Dr Ono to compare the biofidelity of the model with the NHTSA PMHS data when it becomes available, particularly with respect to intervertebral shear.

Action All to state sled type and pulse in presentations.

Action Humanetics to check if the 3D data is included in the draft drawing package that has been uploaded to the GRSP web site.

Action Humanetics to ensure that the checklists reference the drawing package, and to update the checklists over the next few weeks based on user feedback.

Action Humanetics to check the exact build level of the BioRID II used in the NHTSA biofidelity tests, and whether it would comply fully with the design and maintenance checklists.

Action Mr Donnelly to identify the HR height that was used in the pulse comparison test series.

Action Humanetics to document the without-HR and with-HR certification test procedures, so that they can formally replace the old certification procedure. This is to be finalised at a TEG within the next two weeks so that it can be adopted by this Group as early as possible.

Action Mr Depinet and Mr Lorenz to set a date for the next TEG.

Action Ms Levallois to check the possibility to contribute to the new certification test programme and to let Mr Schmitt know.

Action Chrysler to check whether they can participate in the new certification test programme. Japan agreed to participate.

Action Dr Smythe to provide an update from the SAE mtg in late October, before the next GTR-7 IG meeting on December 6th.

Action Mr Asada to distribute the information on the change from elastic to plastic deformation with increase in test delta-*v*.

Action All to provide comment on the proposal from Japan to keep a static backset test option in Phase 2 Step 1, before the next meeting.

Action Mr Lorenz to review whether sled-type makes a difference, provided that the data can be released by Euro NCAP. **Action All** to monitor the influence of sled type.

Action Mr Schmitt to check the calibration history of the dummies used in the PDB study to see if there is anything to explain the variability observed in the test results (the results pre-date the new certification procedure).

Action All to consider the appropriate level of CV for reproducibility and to report at the next meeting.

13 Decisions

13.1 Injury Criteria

It was agreed that NHTSA will collaborate with JARI to identify injury criteria in the human, based on the combined modelling and physical testing approach, to be completed by the end of 2011.

13.2 Upright Seats (with Torso Angles < 20°)

The IG confirmed the agreement of WP.29 to consider the development of a BioRID option for more upright seats as a secondary objective.

13.3 Certification

It was agreed to adopt the new without-HR and with HR certification tests, and to consider the old certification procedure to be obsolete. Each dummy to be used in the new certification tests should be checked against the design and maintenance checklists to ensure consistency of dummy specification and set-up. [NB Humanetics are actioned to ensure that the checklists ensure that the dummy meets the drawing package.]

It was agreed to drop the pelvis flesh test.

It was agreed that drawings for the skull cap switch could be added to the drawing package on the GRSP web site.

It was agreed that the skull switch cap should be used in the upcoming certification test programme, with additional tests done with each labs standard set-up to investigate whether the switching affects performance.

It was agreed that the jacket certification will be run by the manufacturer, and that an annual jacket certification is run by users to check for ageing changes.