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(Thirty-ninth session, 15-19 May 2006,
agenda item A.1.)

# PROPOSAL FOR DRAFT AMENDMENTS TO DRAFT GLOBAL TECHNICAL REGULATION (GTR) ON PEDESTRIAN SAFETY

Transmitted by the expert from the United States of America

Note: The text reproduced below was prepared by the expert from the United States of America in order to revise the technical rationale for the pedestrian head and leg protection in the draft global technical regulation (gtr) on pedestrian safety (see ECE/TRANS/WP.29/GRSP/2006/2).

The modifications to the current text of ECE/TRANS/WP.29/GRSP/2006/2 are marked in **bold** characters.

Note: This document is distributed to the Experts on Passive Safety only.

## A. PROPOSAL

Part A., STATEMENT OF TECHNICAL RATIONALE AND JUSTIFICATION,

Page 11, section V., paragraph (b), amend to read:

"(b) Applicability

The application of the requirements of this gtr refers, …..

…… of a regulatory and certification approach.

There was considerable discussion over the mass of the vehicles to which this gtr should apply. Using the categories described in S.R.1, there were several options examined.

**Some delegates wanted to limit application of the gtr to vehicles in Category 1-1 with a vehicle mass of less than 2.5 tonnes GVM. Other delegates did not agree with a 2.5 tonnes limit on GVM, believing that since the front-end structure of vehicles with 3 or 3.5 tonnes GVM usually is similar to the lighter vehicles, the application of the gtr should include the heavier vehicles. In addition, some delegates sought to limit application of the gtr to vehicles of a GVM more than 500 kg, while other delegates expressed concern about having a lower mass limit, believing that a particular jurisdiction might determine there is a need to apply the gtr requirements in that jurisdiction to vehicles with a GVM less than 500 kg. There was a suggestion that the gtr should also apply to vehicles in Category 2 that had the "same" general structure and shape forward of the A-pillars as vehicles in Category 1-1. However, some were concerned that it could be unfeasible to define objectively what was meant by "same".**

**After considering these issues, it was recommended that the gtr should be drafted to have a wide application to vehicles, to maximize the ability of jurisdictions to address effectively regional differences in pedestrian accident crash characteristics. The gtr would provide that if a jurisdiction determines that its domestic regulatory scheme is such that full applicability is inappropriate, it may limit domestic regulation to certain vehicle types, or may even impose only some of the gtr requirements to a particular vehicle type.**

**This approach was recommended because it maximizes the discretion of jurisdictions to decide whether vehicles should be excluded from the gtr for feasibility or practical reasons, or for lack of a safety need to regulate the vehicles. It was recognized that the front-end shape of the vehicle is an important factor affecting the kinematics of the pedestrian. However, this approach recognizes that jurisdictions should make their own determinations as to whether the front-end shapes of vehicles in their region fall within the shape corridors upon which the gtr was developed. Niche vehicles that are unique to a jurisdiction could also be addressed specifically by that jurisdiction, without affecting the ability or need of other jurisdictions to regulate the vehicles. When a contracting party proposes to adopt the gtr into its domestic regulations, it is expected that the Contracting Party will provide reasonable justification concerning the application of the standard to the vehicle types.**

**Accordingly, the gtr on pedestrian protection would apply to all vehicles in Category 1-1 and Category 1-2, and to all vehicles in Category 2. A jurisdiction may restrict application of the requirements in its domestic regulation if the jurisdiction decides restricting application in its domestic regulation is appropriate.**"

Page 21, section VII., paragraph (a), subparagraph 2., amend to read:

"2. Rationale for Limiting the Lower Legform Test

The reason that the lower legform test would not be ……

……

For vehicles that have a lower bumper ……, especially the bending angle. 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 group recognizes that …… to knee injuries."

Page 22, section VII., paragraph (b), subparagraph 1., amend to read:

"(b) Lower Legform Test

1. Impactor

It was agreed **to recommend using** the legform impactor developed by TRL, for the time being, to evaluate the performance of vehicles in protecting the lower leg. However, it was also **recommended** to consider the the possible future use of ……

The TRL legform is …."

Page 23, section VII., paragraph (c), amend to read:

"(c) Upper Legform Test for High Bumpers

As discussed above, the informal group recognized that the lower leg impactor test would be inappropriate for vehicles whose bumpers strike the legs above knee level, but the group believed that vehicles with high bumpers should be subject to a test that would require the bumper to be more energy absorbing. For that reason, **the informal working group recommends** an upper legform test for vehicles with a lower bumper height of more than 500 mm.

Data provided ……"

Page 24, section VII., paragraph (c), subparagraph 1., amend to read:

"1. Impactor

As the majority of victims of upper leg injuries are adults, the informal group generally agreed to **recommend** a subsystem test using a legform impactor that ……"

Page 24, section VIII., paragraph 1., amend to read:

"1. Systems or components that change position

Any vehicle system or component which ……. stowed position under a small preload. Finally, the informal group therefore decided to **recommend** such active systems to be set to their stowed position when determining ……"

Page 26, Section IX., paragraph (a), subparagraph 2., amend to read:

"2. Leg Protections

The group did not have assessments of ……. annual pedestrian injuries in the United States.

Target population

The 32 per cent target population from INF GR/PS/169 includes both passenger cars and LTVs. The gtr exempts a rather large percentage of LTVs from having to test with a lower legform, therefore the target population should only include passenger cars and LTVs that have bumper heights below the defined cutoff.

**Based on cases in the PCDS database, 56 per cent of pedestrians sustain injuries at the MAIS 2-6 severity level, and 42 per cent of those pedestrians have a lower extremity injury as their most severe, or tied for most severe, injury. Therefore, based on the current US injury rate of 68,000 pedestrians, the annual number of pedestrians with a lower extremity injury as their most severe injury are:**

**Number of pedestrians with AIS 2+ lower extremity injuries as most serious injury:**

**= (number of annual injured pedestrians) x (percentage at MAIS2-6 level) x (percentage where LE most serious)**

**= 68,000 x 0.56 x 0.42**

**= 15,994 pedestrians with AIS 2+ lower extremity injury as a highest severity injury.**

**This number is** the target **population** for all lower extremity **(LE)** injuries, not the ones specific to the gtr. Thus, the group had to account for the **percentage of specific** injury types **and vehicles** covered by the gtr. **Of the AIS 2-6 lower extremity injuries in PCDS, 56 per cent are to the knee and lower leg and are considered target injuries for the gtr.** According to the PCDS data, 100 per cent of passenger cars and 87 per cent of light trucks **and vans** have a **lower** bumper height **at or below 500 mm, and could potentially be tested with the lower legform test**. **PCDS data show that passenger cars account for 84 per cent and light trucks and vans for 16 per cent of the total lower leg and knee injuries at the AIS 2-6 severity**

**level. In passenger car impacts to pedestrians, 81 per cent of knee and lower leg injuries were attributed to bumper contact, while in light truck and van impacts**, 72 per cent of the knee and lower leg injuries were attributed to bumper contact. **Based on these proportions, the number of pedestrians with AIS 2-6 lower extremity injuries that could potentially be addressed by the gtr:**

**Estimated number of pedestrians with AIS 2+ lower extremity injuries addressed by regulation caused by vehicles covered by regulation:**

= **(number of annual LE MAIS 2+ injured pedestrians) x (percentage to knee and lower leg) x (percentage sustained by vehicle type x percentage of vehicle type covered by regulation x percentage attributed to bumper contact by vehicle)**

= **15,994 x 0.56 x (0.84 x 1.00 x 0.81+0.16 x 0.87 x 0.72)**

= **6,992 pedestrians with AIS 2-6 knee or lower leg injury as highest severity injury impacted by vehicle bumper covered by regulation**

Lower leg benefits

The United States of America calculated benefits based on experimental testing of 5 vehicles 22/ in collaboration with Transport Canada. An estimate based on the geometry of the 5 bumpers tested showed that the total testable area on the bumpers was approximately 80 per cent of their width. The 264 mm relaxation zone of the bumper that is required to meet the **less stringent** 250 g requirement is approximately 15 per cent of the total bumper width **on average**. The remaining primary test area of the bumper covered by the **more stringent** 170 g requirement is approximately 65 per cent. Results from the testing estimated 42 per cent improvement to the overall **AIS 2-6 knee and lower leg** injury **risk** in the primary test area and 14 per cent improvement in the relaxation zone. Accordingly, the **knee and** lower leg injuries prevented by the gtr:

**AIS 2+ knee and lower leg injuries prevented:**

= **(target population) x (improvement$_{primary}$ x testzone$_{primary}$+ improvement$_{relax}$ x testzone$_{relax}$)**

= **6,992 x (0.42 x 0.65 + 0.14 x 0.15)**

= **2,056**

As stated above the testable percentage of the bumper was estimated to be 80 per cent, about 10 per cent of which is outboard of the gtr-defined bumper "corner". This area is generally oriented laterally and would therefore not be expected to deliver a direct blow to a pedestrian leg. In fact, it is expected that the vast majority of lower extremity impacts would occur between the bumper corners, suggesting that closer to 90 per cent of all bumper-related injuries occur with the testable area, rather than the 80 per cent estimated in these calculations. If the higher testable area number were used, the injuries prevented would be expected to increase by approximately 10 per cent.

22/ Mallory A, Stammen JA, Legault F. "Component Leg Testing of Vehicle Front Structures," Paper No. 05-0194, Nineteenth International Technical Conference on the Enhanced Safety of Vehicles, June 2005.

As a result of these conservatively low estimates of target population, improvement **percentages** and testable area, these estimates of injuries prevented should be considered as the minimum likely benefit from the gtr requirements."

Part B., TEXT OF THE REGULATION,

Page 43, paragraph 4.1.2., amend to read (inserting square brackets):

**[**4.1.2. Upper legform to bumper:

To verify compliance with the performance requirements as specified in paragraph 5.1.2., both the test impactor specified in paragraph 6.3.1.2. and the test procedures specified in paragraph 7.1.2. shall be used.**]**

Page 44, paragraph 5.2.3., amend to read (inserting square brackets):

"5.2.3. The HIC recorded shall not exceed 1,000 over a minimum of **[**one half**]** of the child headform test area and 1,000 over **[**two third**]** of the combined child and adult headform test areas. The HIC for the remaining areas shall not exceed **[**1,700**]** for both headforms. In case there is only a child headform test area, the HIC recorded shall not exceed 1,000 over **[**two third**]** of the test area. For the remaining area the HIC shall not exceed **[**1,700**]**."

## B. JUSTIFICATION

Ad part A., section V., paragraph (b) "Applicability":

The United States of America (US) has completed an assessment of its vehicle fleet based on Gross Vehicle Mass (GVM) (see Attachment 1) and has compared the fleet's profiles to corridors developed by International Harmonised Research Activities (IHRA) (see Attachment 2). Based on these observations, the US believes that the upper limit of 2.5 tonnes is not sufficient to encompass all the vehicles that fit into the IHRA corridors. Limiting the GVM to 2.5 tonnes would exclude from this gtr most of the sport utility vehicles (SUVs) and pick-up trucks in the US market. Additionally, it also excludes almost all of the min-vans, including the Dodge Grand Caravan and Toyota Sienna, and some of the large 4-door passenger cars, such has Audi A8 and the Lincoln Town Car. The SUVs, pick-up trucks, and mini-vans comprise a large percentage of the total US passenger vehicle fleet.

During the discussions on applicability in the informal working group, applying this gtr to vehicles with a GVM not exceeding 3.5 tonnes was also considered. After reviewing the fleet data, the US believes that this limit is also not sufficient. Many of our largest SUVs have vehicle profiles that are within the IHRA corridors, yet have a GVM greater than 3.5 tonnes. Of the vehicles measured, only the 2003 Dodge Ram was well outside the IHRA corridors, but based on US head impact testing (INF GR/PS/132), this vehicle should meet the gtr requirements.

The US recommends the applicability paragraph make no reference to the mass of the vehicle. When the gtr is adopted each jurisdiction can decide to restrict the application in its domestic regulation as appropriate.

Ad part A., section VII., paragraphs (a), (b) and (c) and section VIII, paragraph 1.:

The corrections are editorial. The proposed wording is more appropriate.

Ad part A., section IX., paragraph (a), subparagraph 2.:

The information was based on a draft report on the analysis of target population and benefits. These revisions reflect the changes that were made to the draft. The final report on the leg and head will be submitted as an informal document to the May 2006 GRSP session.

Ad part B., paragraph 4.1.2.:

No data has been presented and the US has not conducted any testing with the upper legform, this data is necessary to fully evaluate this requirement.

- Data is required to show that the legform produces repeatable and reproducible results.
- Data is required to show that the legform can reliably distinguish between good and poor bumper designs. An explanation is needed on how the injury criteria relates to injury risk.

The gtr gives manufacturers the option of performing an upper leg form test instead of a lower legform-to-bumper test on bumpers with a lower bumper height of more than 425 mm but less than 500 mm.

- Data is needed to determine if there is a significant difference between vehicle performances in an upper vs. lower leg test.
- Data is needed to show the number of vehicles in the fleet that have a bumper height in the 425-500 mm range.
- Data is needed to show how the upper legform test addresses knee injuries.

Ad part B., paragraph 5.2.3.:

The US has conducted head impact testing on a cross-section of our own vehicle fleet and we believe that applying a relaxation zone with a HIC of 1,700 is not stringent enough (see Attachment 3). Additionally, no rationale was provided for choosing the sizes of the relaxation zones as it applies to the current vehicle fleet. Data is needed to justify that one third of the windscreen, one half of the child headform test area and one third of the combined child and adult headform test areas are appropriate, rather than an area that is less than those areas.

## ATTACHMENT 1

## 2005 United States Vehicle Fleet with a Gross Vehicle Mass (GVM) greater than 2.5 tonnes

| Make | Model | Body Style | GVM Max (kg) |
|---|---|---|---|
| Lexus | RX400h | SUV | 2504 |
| Buick | Rendezvous | SUV | 2510 |
| Audi | A8 NWB* | 4-dr | 2515 |
| Dodge | C/V Cargo Van-SWB | Van | 2517 |
| Dodge | Caravan | Van | 2517 |
| Audi | allroad | SUV | 2530 |
| Chrysler | Town & Country-LWB | Van | 2540 |
| Mercedes-Benz | SL600 | 4-dr | 2549 |
| Kia | Sorento | SUV | 2560 |
| Audi | A8L | 4-dr | 2570 |
| Chevrolet | Venture | Van | 2570 |
| Pontiac | Montana | Van | 2570 |
| Toyota | Highlaner HV | SUV | 2574 |
| Toyota | Sienna | Van | 2581 |
| Dodge | C/V Cargo Van-LWB | Van | 2586 |
| Dodge | Grand Caravan | Van | 2586 |
| Acura | MDX | SUV | 2599 |
| Lincoln | Town Car | 4-dr | 2599 |
| Nissan | Quest | Van | 2600 |
| Chevrolet | TrailBlazer | 4-dr SUV | 2608 |
| Isuzu | ASCENDER 5 PASS | SUV | 2608 |
| Chrysler | Pacifica | SUV | 2631 |
| Ford | Crown Victoria | 4-dr | 2633 |
| Mercury | Grand Marquis | 4-dr | 2633 |
| Ford | Explorer | 4-dr SUV | 2649 |
| Ford | Explorer Sport Trac | 4-dr SUV | 2649 |
| Mercury | Mountaineer | 4-dr SUV | 2649 |
| Buick | Terraza | Van | 2650 |
| Chevrolet | Uplander | Van | 2650 |
| Pontiac | Montana SV6 | Van | 2650 |
| Saturn | Relay | Van | 2650 |
| Hummer | H3 | 4-dr SUV | 2654 |
| Ford | Freestar | Van | 2658 |
| Mercury | Monterey | Van | 2658 |
| Audi | A8L 6.0 | 4-dr | 2660 |
| Honda | Pilot | SUV | 2699 |
| Honda | Odyssey | Van | 2700 |
| Kia | Sedona | Van | 2703 |
| Mitsubishi | Montero | SUV | 2720 |
| Buick | Rainier | 4-dr SUV | 2722 |
| GMC | Envoy | SUV | 2722 |
| GMC | Envoy Denali | SUV | 2722 |
| Saab | 9-7X | SUV | 2722 |

| Make | Model | Body Style | GVM Max (kg) |
|---|---|---|---|
| Toyota | 4Runner | SUV | 2724 |
| Cadillac | SRX | 4-dr | 2725 |
| Dodge | Dakota Club Cab | PU-EC | 2726 |
| Dodge | Dakota Quad Cab | PU-CC | 2726 |
| Chevrolet | SSR | PU-RC | 2744 |
| Honda | Pickup - New Model – No Name (2006) | PU | 2744 |
| Volvo | XC70 | 4-dr | 2758 |
| Volvo | XC70 | SW | 2758 |
| Volvo | XC90 | SUV | 2758 |
| Chevrolet | Astro Cargo | Van | 2767 |
| Chevrolet | Astro Passenger | Van | 2767 |
| GMC | Safari Cargo | Van | 2767 |
| GMC | Safari Passenger | Van | 2767 |
| Jeep | Jeep Grand Cherokee | SUV | 2790 |
| Bentley | Continental GT | 2-dr | 2803 |
| Volkswagen | Phaeton (4 Pass.) | 4-dr | 2811 |
| Lexus | GX470 | SUV | 2812 |
| Lincoln | Aviator | 4-dr SUV | 2817 |
| Mercedes-Benz | ML350 (2006) | SUV | 2830 |
| Mercedes-Benz | ML500 (2006) | SUV | 2830 |
| Toyota | Tundra | PU-EC | 2858 |
| Toyota | Tundra | PU-RC | 2858 |
| GMC | Envoy XUV | SUV | 2892 |
| Chevrolet | TrailBlazer EXT | 4-dr SUV | 2903 |
| GMC | Envoy XL | SUV | 2903 |
| GMC | Envoy XL Denali | SUV | 2903 |
| Isuzu | ASCENDER 7 PASS | SUV | 2903 |
| Volkswagen | Phaeton (5 Pass.) | 4-dr | 2911 |
| Porsche | Cayenne | SUV | 2945 |
| Nissan | Titan Crew Cab | PU-CC | 2958 |
| Nissan | Titan King Cab | PU-EC | 2958 |
| Dodge | Ram 1500 Reg. Cab | PU-RC | 2971 |
| Chevrolet | Silverado | PU-EC | 2994 |
| Dodge | Durango | SUV | 2994 |
| GMC | Sierra | PU-EC | 2994 |
| Toyota | Tundra | PU-CC | 2994 |
| Mercedes-Benz | ML350 | SUV | 3000 |
| Mercedes-Benz | ML500 | SUV | 3000 |
| Mercedes-Benz | G500 | SUV | 3001 |
| Mercedes-Benz | G55 K AMG | SUV | 3001 |
| Bentley | Arnage RL | 4-dr | 3016 |
| Bentley | Arnage R | 4-dr | 3035 |
| Bentley | Arnage T | 4-dr | 3035 |
| Chevrolet | Silverado | PU-RC | 3039 |
| GMC | Sierra | PU-RC | 3039 |
| Toyota | Sequoia | SUV | 3039 |

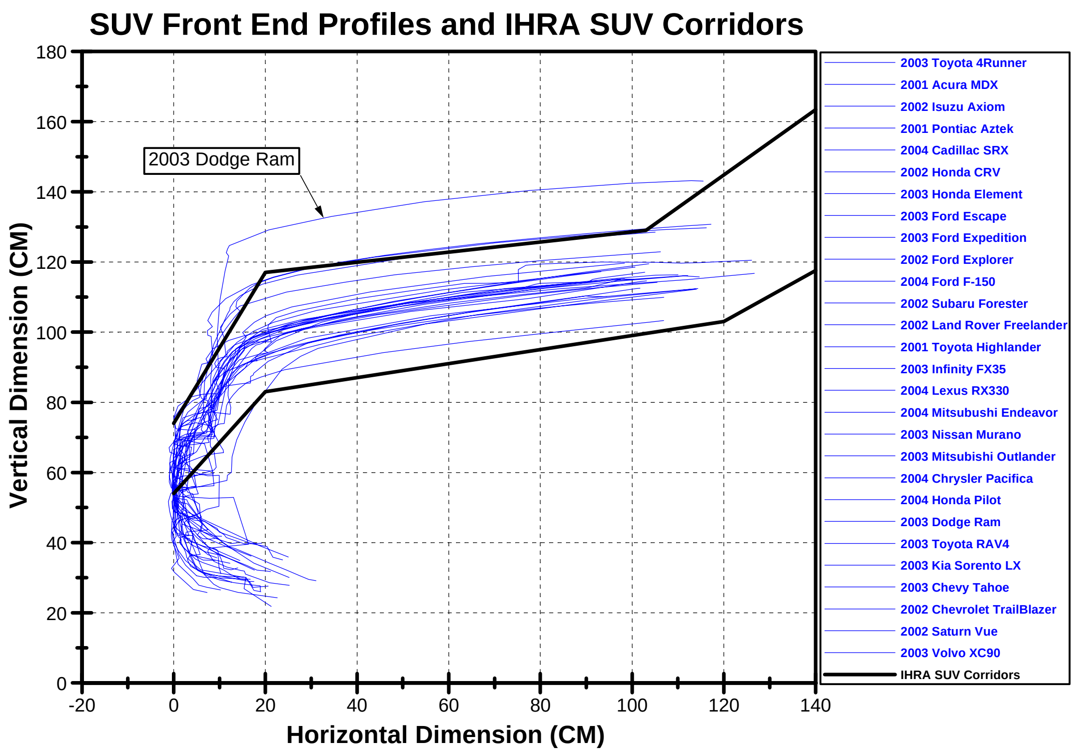
| Make | Model | Body Style | GVM Max (kg) |
|---|---|---|---|
| Land Rover | Range Rover | SUV | 3050 |
| Porsche | Cayenne S | SUV | 3080 |
| Porsche | Cayenne Turbo | SUV | 3080 |
| Dodge | Ram 1500 Quad Cab | PU-CC | 3084 |
| Lexus | LX470 | SUV | 3112 |
| Toyota | Landcruiser | SUV | 3112 |
| Volkswagen | Touareg | SUV | 3158 |
| Cadillac | Escalade | 4-dr SUV | 3175 |
| Cadillac | Escalade EXT | 4-dr SUV | 3175 |
| Chevrolet | Tahoe | 4-dr SUV | 3175 |
| GMC | Yukon | 4-dr SUV | 3175 |
| GMC | Yukon Denali | 4-dr SUV | 3175 |
| Infiniti | QX56 | SUV | 3175 |
| Nissan | Armada | SUV | 3175 |
| Land Rover | LR3 | SUV | 3230 |
| Mercedes-Benz | Maybach 57 | 4-dr | 3261 |
| Cadillac | ESV | 4-dr SUV | 3266 |
| Ford | F-150 Super Crew | PU-CC | 3266 |
| Lincoln | Town Truck | PU-CC | 3266 |
| Ford | Expedition | 4-dr SUV | 3311 |
| Lincoln | Navigator | SUV | 3379 |
| Mercedes-Benz | Maybach 62 | 4-dr | 3382 |
| Ford | F-150 Crew Cab | PU-EC | 3720 |
| Ford | F-150 Regular Cab | PU-RC | 3720 |
| Chevrolet | Express Cargo (=/<8500 lb. GVWR) | Van | 3856 |
| Ford | Econoline Under 8500 LBS. | Van | 3856 |
| GMC | Savana Cargo (=/<8500 lb. GVWR) | Van | 3856 |
| Chevrolet | Avalanche | 4-dr SUV | 3901 |
| Chevrolet | Silverado | PU-CC | 3901 |
| Chevrolet | Suburban | 4-dr SUV | 3901 |
| GMC | Sierra | PU-CC | 3901 |
| GMC | Yukon Denali XL | 4-dr SUV | 3901 |
| GMC | Yukon XL | 4-dr SUV | 3901 |
| Hummer | H2 | 4-dr SUV | 3901 |
| Hummer | H2 SUT | PU | 3901 |
| Dodge | Ram 2500 Reg. Cab | PU-RC | 4082 |
| Dodge | Ram 2500 Quad Cab | PU-CC | 4082 |
| Ford | Excursion | 4-dr SUV | 4173 |
| Chevrolet | Express Passenger | Van | 4355 |
| Ford | F-250 Regular cab | PU-RC | 4355 |

| Make | Model | Body Style | GVM Max (kg) |
|---|---|---|---|
| GMC | Savana Passenger | Van | 4355 |
| Ford | F-250 Crew Cab | PU-EC | 4536 |
| Ford | F-250 Super Crew | PU-CC | 4536 |
| Dodge | Ram 3500 Quad Cab | PU-CC | 5443 |
| Dodge | Ram 3500 Reg. Cab | PU-RC | 5443 |
| Ford | F-350 Regular | PU-RC | 5715 |
| Ford | F-350 Crew Cab | PU-EC | 5897 |
| Ford | F-350 Super Crew | PU-CC | 5897 |

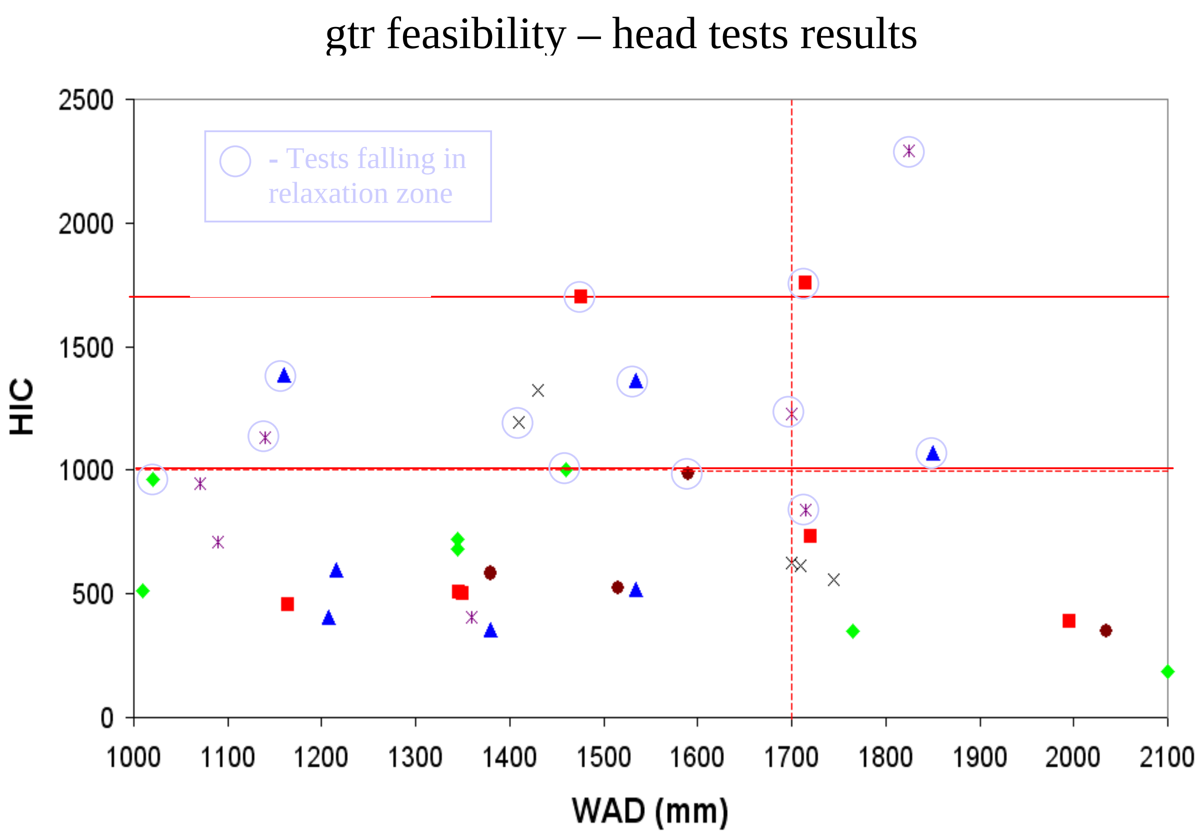
Notes:

4-dr: 4-door
PU: Pick up truck
SUV: Sport Utility Vehicle
1000 kg = 1 tonne

**ATTACHMENT 2**



**ATTACHMENT 3**

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