Cycle / Gearshifting

Status report about the work of the task force on cycle and gearshift issues, amendment proposals for adoption

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Introduction

- The remaining open issues were already presented to the IWG at its 18\textsuperscript{th} meeting in Berne in the status report WLTP-18-05e rev1.

- At 02.05.2017 the chairman sent a revised version of the status report as TF paper WLTP-GSTF-32 rev1 together with excel sheets (calculation examples) and a text proposal for annex 2 of GTR #15 to the TF members.

- At 19.05.2017 the TF had a web-telco, in which the open issues were discussed.

- Those issues, where the group achieved consensus or almost consensus (some members asked for scrutiny reservations) are listed in this report as proposals for adoption by the IWG.
Introduction

• The others will be kept on the agenda for further consideration.

• This revision contains a modified proposal for Paragraph 2 (j), “Exclusion of a crawler gear”, which resulted from discussions of the chairman with the task force member from Ford (Serve Ploumen).

• Although there was no time to discuss this within the task force, the chairman included these proposals in revision 1, because the requests from Ford are well justified.

• All modifications in this revision compared to the previous version are written in pink.
Proposals for adoption by the IWG

• Annex 2, further amendments for adoption by the IWG

  1. Paragraph 2 (g) of annex 2, Definition of $n_{\text{max}}$,

  2. Paragraph 2 (h), $P_{\text{wot}}(n)$ as follow up of 1.,

  3. Paragraph 2 (i), determination of $n_{\text{gmax}}$,

  4. Paragraph 2 (j), exclusion of a crawler gear,

  5. Paragraph 3.3, Selection of possible gears with respect to engine speed, as follow up of 1.,

  6. Paragraph 3.5, Determination of possible gears to be used, as follow up of 1.,

  7. Paragraph 4, Additional requirements,

  ➢ 4 (a) modifications, add a new requirement 4 (g).
Remaining open issues

• 4 (g) resulted from calculations performed within the preparation of the round robin test for calculation tools.

• Further issues, still under discussion or to be performed:
  1. Downshifts during decelerations down to standstill,
  2. Round robin test for gearshift calculation tools.
The Japanese colleagues provided 3 example vehicles for the round robin test of gearshift calculation tools. One of these examples (veh 8) could not correctly be calculated with the ACCESS tool (version 31.01.2017) because the design of the full load power curve led to a too low value for $n_{\text{max}_{95}}$ ($n_{95\_low}$).

As a consequence the 2 second rule for acceleration phases (keep a given gear for at least 2 seconds) would lead to higher engine speeds than $n_{95\_low}$.

The vehicle has an extreme wot power curve with $n_{\text{rated}}$ of 2000 min$^{-1}$, but a usable engine speed range up to 5000 min$^{-1}$. The vehicle speed at rated engine speed is 63.6 km/h, the engine speed at max. vehicle speed is 4480 min$^{-1}$. 
• The available power for different gears and the required power for constant speed driving are shown in figure 1.

• $n_{95\_low}$ is 1893 min$^{-1}$ (indicated by the pink line parallel to the x-axis); this leads to the fact that the 2. gear can only be used for just 1 second at $t = 538$ s and at $t = 1030$ s.

• A similar example is vehicle 78 (a N2 example provided by Japan), whose power curves are shown in figure 2. The 2. gear can only be used for just 1 second at $t = 141$ s, $t = 515$ s and $t = 1030$ s.
Available and required power vs speed

\[ n_{\text{rated}} = 2000 \text{ min}^{-1}, \]
\[ n_{\text{max 95 lo}} = 1893 \text{ min}^{-1}, \]
\[ n_{\text{max 95 hi}} = 3230 \text{ min}^{-1}, \]
\[ n_{\text{min drive}} = 950 \text{ min}^{-1}, \]
\[ n_{\text{ave parts 1-3}} = 1617\text{ min}^{-1}, \]
\[ n_{\text{ave part 4}} = 3042 \text{ min}^{-1} \]
Available and required power vs speed

Figure 2

- $n_{\text{rated}} = 2800 \text{ min}^{-1}$,
- $n_{95\_lo} = 2260 \text{ min}^{-1}$,
- $n_{95\_hi} = 2897 \text{ min}^{-1}$,
- $n_{\text{min\_drive}} = 875 \text{ min}^{-1}$,
- $n_{\text{ave\ parts\ 1\ to\ 3}} = 1561 \text{ min}^{-1}$,
- $n_{\text{ave\ part\ 4}} = 2721 \text{ min}^{-1}$

Power in kW vs vehicle speed in km/h
Both cases have an extreme high ratio between the engine speed $n_{\text{max}}(ng_{\text{vmax}})$ at maximum cycle speed in $ng_{\text{vmax}}$ (the gear in which the maximum vehicle speed is reached) and $n_{\text{max}_{\text{95}}}$. This ratio is 2,18 for vehicle 8 and 1,80 for vehicle 78. Typical ratios for “normal” vehicles are between 0,65 and 1,25.

Conclusion: A further requirement needs to be added to paragraph 2 (g) or the current requirements need to be replaced in order to solve this problem.

The addition of a further requirement is not satisfying, because this is then the 3rd time that $n_{\text{max}_{\text{95}}}$ needs to be amended in order to eliminate contradictions with the 2 second rule.
Paragraph 2 (g), Definition of $n_{\text{max}}$

- The following examples make clear that it would be more appropriate to replace the current requirements by a better definition of $n_{\text{max} \_95}$.
- Another option would be to skip $n_{\text{max}}$ requirements completely.
- Figures 3 and 4 show the available power for all gears and the required power for constant speed driving for two other example vehicles with the same transmission design and almost the same wot power curve.
- The rated engine speed for vehicle 2 is at the upper end of the maximum power plateau (3500 min$^{-1}$) while the rated engine speed for vehicle 3 is at the lower end (2000 min$^{-1}$).
Available and required power vs speed

\[ n_{\text{rated}} = 3500 \text{ min}^{-1}, \]
\[ n_{95 \text{ lo}} = 1901 \text{ min}^{-1}, \]
\[ \text{corrected to 2275 min}^{-1}, \text{ because lower than 65\% of } n_{\text{rated}}, \]
\[ n_{95 \text{ hi}} = 3698 \text{ min}^{-1}, \]
\[ n_{\text{min drive}} = 1181 \text{ min}^{-1}, \]
\[ n_{\text{ave parts 1 to 3}} = 1417 \text{ min}^{-1}, \]
\[ n_{\text{ave part 4}} = 1698 \text{ min}^{-1} \]
Available and required power vs speed

- \[ n_{\text{rated}} = 2000 \text{ min}^{-1}, \]
- \[ n_{95 \text{ lo}} = 1900 \text{ min}^{-1}, \]
- corrected to 1909 min\(^{-1}\), because lower than \[ 1.1 \times (n_{\text{idle}} + 0.125 \times (n_{\text{rated}} - n_{\text{idle}})) \times (n/v)_2 / (n/v)_3 \]
- \[ n_{95 \text{ hi}} = 3698 \text{ min}^{-1}, \]
- \[ n_{\text{min drive}} = 994 \text{ min}^{-1}, \]
- \[ n_{\text{ave parts 1 to 3}} = 1263 \text{ min}^{-1}, \]
- \[ n_{\text{ave part 4}} = 1654 \text{ min}^{-1}, \]
• It is obvious that there will be no difference between both vehicles with respect to the driving behaviour in practical use. But the key values for the gearshift calculation are significantly different.

• $n_{95\_low}$ is 1900 min$^{-1}$ in both cases. But 65% of rated engine speed is 2275 min$^{-1}$ for vehicle 2 and 1300 min$^{-1}$ for vehicle 3. $n_{\text{max}\_95}$ needs to be corrected according to para 2 (g) to 65% of rated engine speed (2275 min$^{-1}$) for vehicle 2 and to $1,1\times n_{\text{min\_drive}}\times (n/v)_2/(n/v)_3$ (1909 min$^{-1}$) for vehicle 3.
• Conclusion:

- The two additional requirements for \( n_{\text{max,95}} \), which were already added in paragraph 2 (g) are obviously not sufficient to cover also such cases.

- A further requirement would need to be added to paragraph 2 (g) or the current requirements need to be replaced in order to solve this problem.

• Proposal for adoption by the IWG:

- Replace \( n_{\text{max,95}} \), which is currently defined as \( n_{95\_low} \), by \( n_{95\_high} \) and amend paragraph 2 (g) as shown in the following slides.
(g) $n_{\text{max}}$

$n_{\text{max}1} = n_{95\_\text{high}},$ the maximum engine speed where 95 per cent of rated power is reached, min$^{-1};$

If $n_{95\_\text{high}}$ cannot be determined because the engine speed is limited to a lower value $n_{\text{lim}}$ for all gears and the corresponding full load power is higher than 95 per cent of rated power, $n_{95\_\text{high}}$ shall be set to $n_{\text{lim}}.$

If $n_{\text{max\_95}}$ is less than 65 per cent of $n_{\text{rated}},$ $n_{\text{max\_95}}$ shall be set to 65 per cent of $n_{\text{rated}}$;

If 65 per cent of $(n_{\text{rated}} \times (n/v)_3 / (n/v)_2) < 1.1 \times (n_{\text{idle}} + 0.125 \times (n_{\text{rated}} - n_{\text{idle}})),$ $n_{\text{max\_95}}$ shall be set to:

$$1.1 \times (n_{\text{idle}} + 0.125 \times (n_{\text{rated}} - n_{\text{idle}})) \times (n/v)_2 / (n/v)_3$$

$n_{\text{max}} (ng_{v_{\text{max}}}) = (n/v)(ng_{v_{\text{max}}}) \times v_{\text{max, cycle}}$
(g) \( n_{\text{max}} \) (continued, insert the highlighted text)

\[
\begin{align*}
  n_{\text{max}2} &= (n/v)(ng_{v_{\text{max}}}) \times v_{\text{max,cycle}}, \\
  n_{\text{max}3} &= (n/v)(ng_{v_{\text{max}}}) \times v_{\text{max,vehicle}}.
\end{align*}
\]

where:

\( ng_{v_{\text{max}}} \) is defined in paragraph 2.(i) of this annex;

\( v_{\text{max,cycle}} \) is the maximum speed of the vehicle speed trace according to Annex 1, km/h;

\( v_{\text{max,vehicle}} \) is the maximum speed of the vehicle according to indent (i) of this paragraph, km/h;

\((n/v)(ng_{v_{\text{max}}})\) is the ratio obtained by dividing the engine speed \( n \) by the vehicle speed \( v \) for the gear \( ng_{v_{\text{max}}} \), \( \text{min}^{-1}/(\text{km/h}) \);

The last paragraph was moved from indent (h) to this place, because it belongs to the equation above and not to indent (h)
(g) \( n_{\text{max}} \) (continued, insert the highlighted text)

\[ n_{\text{max}} \text{ is the maximum of } n_{\text{max,95}} \text{ and } n_{\text{max}}(n_{g_{\text{vmax}}}), \text{ min}^{-1}. \]

\[ n_{\text{max}} \text{ is the maximum of } n_{\text{max,1}}, n_{\text{max,2}} \text{ and } n_{\text{max,3}}, \text{ min}^{-1}. \]

\( n_{\text{max,3}} \) is needed for the calculation of \( n_{g_{\text{vmax}}} \) and \( v_{\text{max}} \).

This proposal would not only avoid conflicts with the 2 second rule but also improve the driveability for low powered vehicles.
Para 2 (h), $P_{wot}(n)$ as follow up of 1.

- The modified specifications for $n_{max}$ make the following modifications in Paragraph 2 (h), $P_{wot}(n)$ necessary:
Para 2 (h), $P_{wot}(n)$ as follow up of 1.

(h) $P_{wot}(n)$, the full load power curve over the engine speed range. The power curve shall consist of a sufficient number of data sets $(n, P_{wot})$ so that the calculation of interim points between consecutive data sets can be performed by linear interpolation. Deviation of the linear interpolation from the full load power curve according to Regulation No. 85 shall not exceed 2 per cent. The first data set shall be at $n_{min\_drive}$ of $n_{gear} > 2$ (see (k) below) or lower. The last data set shall be at $n_{rated}$ or $n_{max}$ or higher engine speed, or $(n/v)(ng_{v_{max}}) \times v_{max}$, whichever is greater. Data sets need not be spaced equally.

The full load power at engine speeds not covered by Regulation No. 85 shall be determined according to the method described in Regulation No. 85;
Para 2 (i), determination of $n_{g_{v_{max}}}$

- One of the example vehicles for the RRT have a transmission design, so that the maximum vehicle speed is reached in gear $n_{g-2}$ (see figure 5).
- This is not covered by the current specifications in paragraph 2 (i).
- In order to cover also gear $n_{g-2}$ or even lower gears the text needs to be amended as shown in the following slides.
- This proposal is also intended for adoption by the IWG.
Available and required power vs speed

- \( n_{\text{rated}} = 3750 \text{ min}^{-1} \),
- \( n_{\text{max} \_95 \_lo} = 3275 \text{ min}^{-1} \),
- \( n_{\text{max} \_95 \_hi} = 4463 \text{ min}^{-1} \),
- \( n_{\text{min} \_\text{drive}} = 1125 \text{ min}^{-1} \),
- \( n_{\text{ave} \ \text{parts} \ 1 \ to \ 3} = 1419 \text{ min}^{-1} \),
- \( n_{\text{ave} \ \text{part} \ 4} = 2502 \text{ min}^{-1} \)
Para 2 (i), determination of $n_{g_v}$

(i) **Determination of $n_{g_v}$ and $v_{v_max}$**

$n_{g_v}$, the gear in which the maximum vehicle speed is reached and shall be determined as follows:

If $v_{max}(ng) \geq v_{max}(ng-1)$ and $v_{max}(ng-1) \geq v_{max}(ng-2)$ then,

$n_{g_v} = ng$ and $v_{max} = v_{max}(ng)$,

If $v_{max}(ng) < v_{max}(ng-1)$ and $v_{max}(ng-1) \geq v_{max}(ng-2)$ then,

$n_{g_v} = ng-1$ and $v_{max} = v_{max}(ng-1)$,

otherwise, $n_{g_v} = ng-2$ and $v_{max} = v_{max}(ng-2)$

where:

$v_{max}(ng)$ is the vehicle speed at which the required road load power equals the available power $P_{wot}$ in gear $ng$ (see Figure A2/1a).
Para 2 (i), determination of \( ng_{v_{\text{max}}} \)

(i) **Determination of \( ng_{v_{\text{max}}} \) and \( v_{\text{max}} \) (Continued)**

\( v_{\text{max}}(ng-1) \) is the vehicle speed at which the required road load power equals the available power \( P_{wot} \) in the next lower gear (gear ng-1, see Figure A2/1b).

\( v_{\text{max}}(ng-2) \) is the vehicle speed at which the required road load power equals the available power \( P_{wot} \) in the gear ng-2.

Vehicle speed values rounded to one place of decimal shall be used for the determination of \( v_{\text{max}} \) and \( ng_{v_{\text{max}}} \).

The required road load power, kW, shall be calculated using the following equation:

\[
P_{\text{required}} = \frac{f_0 \times v_{\text{max}} + f_1 \times v_{\text{max}}^2 + f_2 \times v_{\text{max}}^3}{3600}
\]
(i) **Determination of $n_{g_{v_{\text{max}}}}$ and $v_{\text{max}}$ (Continued)**

where:

$v_{\text{max}}$ is the vehicle speed, km/h.

The available power at vehicle speed $v_{\text{max}}$ in gear $ng$, $ng-1$ or gear $ng-2$ may be determined from the full load power curve, $P_{\text{wot}}(n)$, by using the following equation:

\[
 n_{ng} = \left(\frac{n}{v}\right)_{ng} \times v_{\text{max}}(ng);
\]

\[
 n_{ng-1} = \left(\frac{n}{v}\right)_{ng-1} \times v_{\text{max}}(ng-1);
\]

\[
 n_{ng-2} = \left(\frac{n}{v}\right)_{ng-2} \times v_{\text{max}}(ng-2);
\]

and by reducing the power values of the full load power curve by 10 per cent.

The above described method shall be extended to even lower gears $ng-3$, $ng-4$, etc, if necessary.
(i) **Determination of** \( \text{ng}_{v_{\text{max}}} \) **and** \( v_{\text{max}} \) **(Continued)**

If, for the purpose of limiting maximum vehicle speed, the maximum engine speed in the highest gear is limited to \( n_{\text{lim}} \) which is lower than the engine speed corresponding to the intersection of the road load power curve and the available power curve, then:

\[
\text{ng}_{v_{\text{max}}} = \text{ng}_{\text{max}} \text{ and } v_{\text{max}} = \frac{n_{\text{lim}}}{\left(\frac{n}{v} \times (\text{ng}_{\text{max}})\right)}.
\]

The modifications resulted from calculations for example vehicles for the gearshift calculation round robin test.
Para 2 (j), exclusion of a crawler gear

- According to paragraph 2 (j), 5 conditions must be fulfilled in order to qualify the 1. gear as crawler gear and disregard it for the gear use calculation.

- Conditions 3 and 4 are as follows:
  
  \[
  (3) \quad (n/v)_1 \times \frac{v_{\text{max}}}{n_{\text{rated}}} > 7
  \]
  
  \[
  (4) \quad (n/v)_2 \times \frac{v_{\text{max}}}{n_{\text{rated}}} > 4
  \]

- The use of \( n_{\text{rated}} \) as calculation parameter could qualify vehicles with engines with extremely low \( n_{\text{rated}} \) values for a crawler gear although the transmission is not designed accordingly.

- This can be demonstrated for the vehicle shown in figure 4 (vehicle 3, \( n_{\text{rated}} = 2000 \text{ min}^{-1} \)).
Para 2 (j), exclusion of a crawler gear

- The transmission design together with the extremely low $n_{\text{rated}}$ value, leads to 9.5 for condition (3) and 4.87 for condition (4) for this vehicle.

- That means, this vehicle qualifies for a crawler gear with respect to conditions (3) and (4), but calculations for vehicle 3 with 1. gear as crawler gear led to driveability problems.

- The database contains 4 other vehicles, whose transmission design together with low rated engine speed values would fulfill the conditions (3) and (4).

- These vehicles would have driveability problems as well, if the 1. gear would be disregarded.

- Conclusion: $n_{\text{rated}}$ is not a good parameter for the criteria (3) and (4).
Para 2 (j), exclusion of a crawler gear

- If $n_{95\text{ high}}$ would be used for the calculation of the conditions (3) and (4) instead of $n_{\text{rated}}$ the requirements would be improved significantly.
- But then, of course, the threshold values of 7 and 4 need to be adjusted.
- In order to find appropriate thresholds for $n_{95\text{ high}}$, the values resulting from the equations (3) and (4) in slide 27 were calculated for all vehicles in the database for the current situation as well as for the new proposal.
- The results for condition (3) are shown in figure 6, the results for condition (4) in figure 7.
Condition (3), new proposal vs current

\[
\frac{(n/v_1)}{(n/v)(ng_{v_{max}})} \times \frac{v_{max} \times (n/v)(ng_{v_{max}})}{n_{95\_high}}
\]

n_{95\_high} instead n_{rated}

Figure 6
Condition (4), new proposal vs current

\[
\frac{(n/v)^2}{(n/v)(ng_{v_{\text{max}}})} \times \frac{v_{\text{max}}}{n_{\text{rated}}} \times \frac{(n/v)(ng_{v_{\text{max}}})}{n_{95_{\text{high}}}}
\]

Figure 7

\(n_{95_{\text{high}}} \text{ instead } n_{\text{rated}}\)
Para 2 (j), exclusion of a crawler gear

- If one takes the pink curves as basis, the thresholds would be transformed to
  
  (3) \(7 \rightarrow 6.74\)
  
  (4) \(4 \rightarrow 3.85\)

- The database contains 8 other vehicles that would qualify for a crawler gear according to conditions (3) and (4), for the current condition as well as for the new proposal.

- None of these vehicles showed driveability problems, when the 1. gear was disregarded for the gear use calculation.
Para 2 (j), exclusion of a crawler gear

• The task force member from Ford had scrutiny reservations with regard to $v_{\text{max}}$ in both equations.

• It should be specified that $v_{\text{max}}$ is determined by the intersection of the required road load power curve and the available power curve of the relevant gear, but not by an additional speed limiter.

• This is a justified request, because only these $v_{\text{max}}$ values were used for the development of the conditions (3) and (4).

• In addition to that Ford asked for a deletion of condition (1), because it is not necessary.

• Condition (1) requires that the vehicle does not have a dual-range transmission.
Para 2 (j), exclusion of a crawler gear

- For a vehicle with a dual-range transmission only the range designed for normal on-road operation shall be considered for gear use determination (see paragraph 1.4 of annex 2).

- If in that range the 1. gear would qualify for a crawler gear, why should this not be considered?

- Although there was no time to discuss this within the task force, the chairman included these proposals in revision 1 because both requests are well justified.

- This leads to the following amendment proposal for paragraph 2 (j) for adoption by the IWG:
Para 2 (j), exclusion of a crawler gear

(j) Exclusion of a crawler gear

Gear 1 may be excluded at the request of the manufacturer if all of the following conditions are fulfilled:

1. The vehicle does not have a dual-range transmission;
2. The vehicle family is homologated to tow a trailer;
3. \[ \left( \frac{n}{v} \right)_1 \times \frac{v_{\text{max}} \times (n/v)(ng_{v_{\text{max}}})}{n_{\text{rated}}} > 7; \]
4. \[ \left( \frac{n}{v} \right)_2 \times \frac{v_{\text{max}} \times (n/v)(ng_{v_{\text{max}}})}{n_{\text{rated}}} > 4; \]
5. The vehicle, ……….
Para 2 (j), exclusion of a crawler gear

(j) Exclusion of a crawler gear (continued)

where:

\[ v_{\text{max}} \]

is the maximum vehicle speed as specified in paragraph 2. (i) of this annex. But only the \( v_{\text{max}} \) value resulting from the intersection of the required road load power curve and the available power curve of the relevant gear shall be used for the conditions (3) and (4). \( v_{\text{max}} \) resulting from a limitation of the engine speed and prohibiting this intersection shall not be used.
The amendment proposal for $n_{\text{max}}$ requires the following amendment proposals in paragraphs 3.3 and 3.5 for adoption by the IWG:
3.3. Selection of possible gears with respect to engine speed

The following gears may be selected for driving the speed trace at \( v_j \):

(a) All gears \( i < ng_{v_{\text{max}}} \) where \( n_{\text{min\_drive}} \leq n_{i,j} \leq \frac{n_{\text{max\_95}}}{n_{\text{max\_1}}} \); 

(b) All gears \( i \geq ng_{v_{\text{max}}} \) where \( n_{\text{min\_drive}} \leq n_{i,j} \leq \frac{n_{\text{max}\left(ng_{v_{\text{max}}}\right)}}{n_{\text{max\_2}}} \); 

(c) Gear 1, if \( n_{1,j} < n_{\text{min\_drive}} \).

If \( a_j \leq 0 \) and \( n_{i,j} \leq n_{\text{idle}} \), \( n_{i,j} \) shall be set to \( n_{\text{idle}} \) and the clutch shall be disengaged.

If \( a_j > 0 \) and \( n_{i,j} \leq (1.15 \times n_{\text{idle}}) \), \( n_{i,j} \) shall be set to \( (1.15 \times n_{\text{idle}}) \) and the clutch shall be disengaged.
3.5. Determination of possible gears to be used

The possible gears to be used shall be determined by the following conditions:

(a) The conditions of paragraph 3.3. of this annex are fulfilled, and

(b) If \( n_{i,j} \geq \text{minimum engine speed of the } P_{\text{wot}} \text{ curve (see paragraph 2 (h) of this annex), } P_{\text{available}_{i,j}} \geq P_{\text{required},j} \).

If in (b) \( P_{\text{available}_{i,j}} \geq P_{\text{required},j} \) can only be fulfilled in gear ng-1 when paragraph 3.3.(a) of this annex cannot be fulfilled because the corresponding engine speed exceeds \( n_{\text{max}_{95}} \), this shall be accepted as long as the engine speed does not exceed \( n_{\text{rated}} \).

If in (b) \( P_{\text{available}_{i,j}} \geq P_{\text{required},j} \) can only be fulfilled in a gear in which \( n_{\text{rated}} \) is exceeded, the next higher gear shall be used.

The yellow highlighted part is no longer necessary.
Amendment proposals for paragraph 4

• The calculations performed during the preparation phase of the round robin text and for the further discussions in the TF led also to the following amendment proposals for paragraph 4, “Additional requirements for corrections and/or modifications of gear use”.

• The following amendments should be made in indent (a) in order to make the whole procedure more logical and to improve the calculation result.

• Paragraph 4 (a) should start with the following correction, that is in principle already contained in indent (c), but should be performed as first step:
Amendment proposals for paragraph 4

- If a one step higher gear (n+1) is only required for just 1 second and the gears before and after are the same (n), gear n+1 shall be corrected to gear n.

- The following section (currently the first section in indent (a) should be amended as follows:

  - If a one step lower gear is required at a higher vehicle speed during an acceleration phase for more than 1 second, the higher gears before shall be corrected to the lower gear. This correction shall not be performed for gear 1.

  - If a one step lower gear (n-1) is only required for just 1 second during an acceleration phase and the gears before and after are the same (n) or higher, gear n-1 shall be corrected to gear n.
Amendment proposals for paragraph 4

• The lack of power for just one second, that would require a one step lower gear, would not lead to driveability problems and thus not justify the correction of the gear use in the previous part of the acceleration phase.

• If the lack of power for just one second would require a two steps lower gear (such cases occurred during the calculations), the gear use should be corrected as follows:

• If a two steps lower gear is required at a higher vehicle speed during an acceleration phase for just 1 second, this gear and the higher gears before shall be corrected to a one step lower gear. This correction shall not be performed for gear 1.
The amendment proposal for indent (a) is also intended to be adopted by the IWG and is summarised in the following slide.
Amendment proposals for paragraph 4

(a) If a one step higher gear (n+1) is only required for just 1 second and the gears before and after are the same (n), gear n+1 shall be corrected to gear n.

If a **one step lower gear** is required at a higher vehicle speed during an acceleration phase **for more than 1 second**, the higher gears before shall be corrected to the lower gear. **This correction shall not be performed for gear 1.**

Example: \( v_j < v_{j+1} < v_{j+2} < v_{j+3} < v_{j+4} < v_{j+5} < v_{j+6} \). The original calculated gear use is 2, 3, 3, 3, 2, 2, 3. In this case the gear use shall be corrected to 2, 2, 2, 2, 2, 3.

If a one step lower gear (n-1) is only required for just 1 second during an acceleration phase and the gears before and after are the same (n) or higher, gear n-1 shall be corrected to gear n.

Example: \( v_{j-1} < v_j < v_{j+1} \). The original calculated gear use is 5, 4, 5 or 5, 4, 6. In this case the gear use shall be corrected to 5, 5, 5 or 5, 5, 6.

If a two steps lower gear is required at a higher vehicle speed during an acceleration phase for just 1 second, this gear and the higher gears before shall be corrected to a one step lower gear. **This correction shall not be performed for gear 1.**
As already mentioned, the example vehicle shown in figure 5 has an extreme transmission design, where the two highest gears of this 6-speed transmission are designed as "overdrives", so that the maximum vehicle speed is reached in 4th gear.

In this case an upshift to a higher gear could occur at the transition from an acceleration or constant speed phase to a deceleration phase, which is not in line with practical use but not prohibited by the current prescriptions in annex 2.

This is also the case for 4 of the example vehicles for the RRT.

This proposal is intended to avoid unjustified upshifts for adoption by the IWG.
Add a new indent (g) in paragraph 4

- In order to avoid normally unlikely upshifts during the transition from an acceleration or a constant speed phase to a deceleration phase, the following new indent (g) should be added to paragraph 4.

(g) No upshift to a higher gear at the transition from an acceleration or constant speed phase to a deceleration phase, if the gear in the phase following the deceleration phase is lower than the upshifted gear.

Example: If \( v_i \leq v_{i+1} \) and \( v_{i+2} < v_{i+1} \) and gear \( i = 4 \) and gear \( i+1 = 5 \) and gear\(_i\,+2 = 5 \), then gear\(_i\,+1 \) and gear\(_i\,+2 \) shall be set to 4, if the gear for the phase following the deceleration phase is gear 4 or lower. For all following cycle trace points with gear = 5 within the deceleration phase the gear shall also be set to 4. If the gear following the deceleration phase is gear 5, the upshift shall be done.

If there is an upshift during the transition and the initial deceleration phase by 2 gears, an upshift by 1 gear shall be performed.
Amended version of GTR #15

- The previous amendment proposals are also incorporated in the Word document below.
Downshifts during decelerations down to standstill

- At 05.04.2017 Nick Ichikawa made the following amendment proposal for deceleration phases down to standstill:

  - It is allowed to set higher $n_{\text{min\_drive}}$ than defined in paragraph 2 (k) indent (c) of Annex 2. The aim is to improve drivability by excluding the low engine speed with high load. It’s obvious that this option is designed for acceleration, not for deceleration.

  - Since no drivability problem is observed during deceleration, it is more representative to keep the original $n_{\text{min\_drive}}$ definition during deceleration in any cases.

  - This proposal was sent to the GSTF and was discussed in the web-telco at 19.05.2017.
Downshifts during decelerations down to standstill

- The outcome of the discussion can be summarised as follows:
  - The current prescriptions in paragraph 2 (k) allow manufacturers to use higher values for gears > 2 than the default, which is defined by the following equation:

    \[ n_{\text{min\_drive}} = n_{\text{idle}} + 0.125 \times (n_{\text{rated}} - n_{\text{idle}}) \]

  - The TF proposes that the manufacturer may specify higher values, but different for acceleration and constant speed phases on one side and deceleration phases on the other side.
Downshifts during decelerations down to standstill

- Since there was not enough time left to assess this proposal with respect to possibly necessary limitations or to possible conflicts with other gearshift specifications, it is not yet ready for adoption by the IWG and will therefore be further considered in the TF.
Round Robin tests for GS calculation tools

- At IWG #16 Christoph Lueginger proposed a round robin test for gearshift calculation tools in order to check the tools as well as the common understanding of the text in annex 2.
- The chairman asked the TF members to provide input data of example vehicles for this exercise.
- The deadline for the delivery was set to end of March.
- Meanwhile datasets of 22 example vehicles were provided by 3 OEMs and JARI. 4 of these vehicles have variants with speed caps or ASM.
- The chairman added 6 vehicles intended to cover the whole variation ranges of technical design parameters (e.g. different vehicle classes).
Round Robin tests for GS calculation tools

- It is recommended to wait for the adoption of the proposed amendments by the IWG and then amend the ACCESS tool accordingly, before the start of the round robin test.
- Once the ACCESS calculation tool has been amended, the amended tool and the example vehicles will be distributed to those participants that use own calculation tools and the RRT will be started.
- The results of the calculations with the different tools will then be collected and compared.
Amendments in the ACCESS tool

- Meanwhile, EVAP purge cycles were added to the ACCESS calculation tool.
End

Thank you for your attention!